

Edited by Gaby-Fleur Böhl, Astrid Epp, Rolf Hertel

# **Perception of Nanotechnology in Internet-based Discussions**

The risks and opportunities of nanotechnology and nanoproducts: results of an online discourse analysis

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Perception of Nanotechnology in Internet-based Discussions – The risks and opportunities of nanotechnology and nanoproducts: results of an online discourse analysis

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## Preface

The statutory remit of the Federal Institute for Risk Assessment (BfR) is to identify potential risks that foods, substances and products may pose to consumers, to assess these risks scientifically and to involve all interested parties concerned in an active process of communication and information. Nanotechnology is one of the topics that are relevant to BfR in this context. With the aid of nanotechnology it is possible to develop structures, techniques and systems that present entirely new properties and functions. Industry, medicine, science and consumers all hope that this potential will be realised in beneficial applications, including further developments in foodstuffs, consumer goods and cosmetic products. Consumers today are already coming into contact with products that contain elements manufactured with the aid of nanotechnological processes. Consequently, questions concerning the safety and potential risks posed by nanotechnology are becoming increasingly pertinent.

For this reason, not only has research into the risks of nanotechnology been intensified worldwide since the year 2000; discussions of possible risks have also involved increasingly wide sectors of the public. In May 2004, for instance, the European Commission published its communication "Towards a European strategy for nanotechnology", which also takes into account research into environmental and health risks. October 2006 saw the launch of the "NanoDialog" initiated by Germany's Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, in which stakeholders from politics, business, academia, public institutions and associations discuss the opportunities and risks of nanomaterials. All relevant nanomaterials are currently being investigated with respect to their risk potential in a process organised by the OECD.

As BfR has been able to demonstrate in various studies of risk perception, the use of nanomaterials in foodstuffs is particularly controversial in society. A telling example is provided by the participants in a consumer conference organised by BfR in 2006, who demanded mandatory labelling of nanofoods. The potential uses and risks of nanoproducts as perceived by consumers are often the subject of discussions in Internet forums, blogs and chatrooms. As well as recommending certain nanoproducts for purchase and providing other information about these products, consumers in these forums develop – almost incidentally – perception patterns relating to nanotechnology as a whole, prompting BfR to conduct an analysis of Internet-based discussions of nanotechnology.



Professor Andreas Hensel  
President of the Federal Institute for Risk Assessment



## Summary/Abstract

### Novelty of the approach: target group, object of the investigation and methodology

This study investigates the **perception** of **nanotechnology** in **Internet-based discussions**, thereby entering uncharted territory in a number of respects. First, it specifically investigates the **perceived risks and benefits** of nanotechnology in a particular sector of the population which, of its own accord, has displayed at least an **initial interest in the subject** or in **actual nanoproducts** and at the same time is active in **Internet forums**. Second, through its chosen object of investigation (posts in **online forums** and **weblogs aka “blogs”**) and method (**online discourse analysis**) it is focusing on a form of everyday interpersonal communication that has not yet been explored in previous studies of the ways in which the risks of nanotechnology are communicated and discussed.

### Subject of the study: online forums and blogs on nanotechnology

The study's central focus is on German-language discussions that have taken place in **online forums** and **blogs** since the beginning of the decade. These online discussions cover a broad spectrum of topics and product groups, thus reflecting the multifaceted character of nanotechnology as an interdisciplinary technology. The most prominent forums in terms of sheer quantity (with the exception of forums on computer games and shares, which were not investigated for the purposes of the study) are those dealing with **vehicles**, and in particular with nanosealing for vehicle care. Certain topics such as the use of **nanotechnology** in **foodstuffs**, on the other hand, have only very recently become the subject of more intensive discussion. Overall, one has the impression of a discourse that is conducted in numerous places on the Internet and in which competing interpretations of nanotechnology and indeed **perceptions** of its **risks** are brought to public attention, yet in which there is comparatively little debate between the individual areas.

### Nanoproducts in online discourse: little fear of risks, but doubts about the benefits

The results of an in-depth analysis of the discussion contents, based on around **500 individual posts**, confirm in many respects what is already known from surveys and other studies: overall, the level of **acceptance** of **nanotechnology** is currently **high** within the German population. It is noticeable, however, that the **beneficial aspects** of nanotechnology or of specific nanoproducts are **assessed more negatively** in a considerable proportion of the reviewed discussion contributions. Clearly, in this **particular group** of consumers that are active in Internet forums, first generation nanoproducts face **acceptance problems** less as a result of fears of their risks than as a result of doubts about their benefits.

At the same time, an analysis of the **online discussions** over **the course of time** shows that both references to risks and negative views of nanotechnology or nanoproducts are increasing. More in-depth analyses of the quality of individual discussion contributions, such as an analysis of the imagery used to depict nanotechnology, provided indications that a not inconsiderable **potential for conflict** exists here, especially in the areas of **foodstuffs** and **cosmetics**, which have only recently become the subject of more intensive discussion.

Given the study's novel approach of using Internet-based discussions to investigate the perception of risks and benefits, it is hard to predict the extent to which the results of this study of a specific group of consumers active in Internet forums can be used to draw conclusions about the **perception of nanotechnology** in society as a whole. However, it is likely that the **experiences of consumers with nanoproducts** – the central focus of this study – will become more significant in future as nanoproducts become more widespread in their respective marketplaces.



## 1 Introduction

Since the end of the 1990s, nanotechnology has evolved worldwide to become a recognised key field of technology. Any state wishing within its borders to advance cutting-edge research and technology makes dedicated funding available for this field. Many governmental action plans and parliamentary debates are devoted to nanotechnology. Numerous universities, other research and educational institutions and specialist academic publishers have included nanotechnology in their programmes or activities. Reporting of the topic has also increased significantly in the mass media.

Overall, a wide range of applications for nanotechnology and nanomaterials is evident, which is why it has now become common practice to talk about nanotechnology in the plural – that is to say nanotechnologies (and nanosciences). For the purposes of this study, however, which addresses the public perception of the risks of nanotechnology, we have chosen to use the old singular form. This is not merely for stylistic reasons, but also because the terms “nanotechnology” or simply “nano” are still often used in the emerging public discourse.

As in previous BfR studies on the subject (e.g. Zimmer et al. 2008b), one central and fundamental assumption is that a meaningful analysis of the perceived risks of nanotechnology is only possible if the entire breadth of nanotechnology applications is taken systematically into account. This applies particularly to this study, the focus of which is the concrete risks, opportunities and benefits perceived by consumers. Much has already been learnt about the perceived risks of individual nanotechnology applications and visions in accompanying research and other concomitant activities, which variously enjoyed considerable political support shortly after nanotechnology began to gain a higher profile; yet it is indisputable that there continues to be a great need for research in this area.

This study differs from previous studies in two respects in particular: first, an analysis of relevant online discussions is designed to elicit insights into the perception of nanotechnology in existing consumer-relevant applications. Second, the aim in this context is to analyse the small minority of the population that already has experience of nanoproducts or has at least demonstrated (through their participation in online discussions on the subject) an initial interest in this field of research and development and its products. On the other hand, survey results (e.g. in Germany and the USA) indicate that a large section of the population still has no associations even with the word “nanotechnology” and that reflections on the field are still a rarity at this point in time. For the purposes of this study, “nanoproducts” include all products that are labelled by providers as being products based on nanotechnology or which are regarded as such by consumers.

In other words, the research project “Perceived risks of nanotechnology – Analysis of Internet forums” explored new or hitherto rarely used avenues in terms of its objectives and subject (and thus to some extent also with respect to its methods and investigative strategies).

The study’s research objectives will be briefly outlined below; this will be followed by a short introductory examination of the states and approaches of relevant research, in which the key issues addressed by the study will be elaborated.

## 1.1 Issues and objectives

The primary purpose of this study is to analyse German-language online discussions of nanotechnology in an attempt to identify the perceived risks, opportunities, benefits and expectations associated with this field of research and development.

The study focuses on consumer-relevant applications in which considerable product experience has already been gained or in which this is likely to be the case in the near future. The study thus complements the BfR media study (Zimmer et al. 2008c) which found that consumer-relevant issues play only a minor role in mass media discourse. The study should not be seen as a representative survey of the public's perception of the risks of nanotechnology such as was undertaken recently by BfR in 2008 (Zimmer et al. 2008b). Unlike a representative survey, this study employs qualitative methods and focuses on those people who are already interested in the subject of nanotechnology. Nonetheless, there are interesting correlations between the two studies; these are discussed particularly in Chapter 5.2.

The perceived risks of nanotechnology which form the central focus of this study are analysed in the context of the perceived benefits and opportunities of nanotechnology. Particular attention is paid to the discursive construction of the field that is already taking place or is beginning to become apparent in online discussions, taking into account the imagery used, typical patterns of argumentation, interpretative frames influenced by life-worlds and other aspects.

Following a brief introduction to the contents of the study (Chapter 1.2) and an explanation of the methodology (Chapter 2), the results of broad-ranging research into German-language online discussions of nanotechnology will be presented and discussed (Chapter 3), as will the results of an analysis of the contents of over 500 contributions to online discussions (Chapter 4). The focus will be on criteria for the perception of risks, opportunities and benefits; these will then be raised again in the final discussion and classification of the overall results (Chapter 5).

One might ask, however, why discussions amongst laypersons on the Internet should have any relevance for an examination of the perceived risks of nanotechnology. Analysing the contents of online discussions has various disadvantages as compared, for example, with public surveys, especially when it comes to questions of representativeness. Ultimately, little can be determined with any reliability about the situation of contributing Internet authors in the structure of society or about their long-term political views. One major advantage of this analysis, however, is the fact that it is able, as it were, to look over the shoulder of the contributors as they communicate with one another and as they help at the same time to shape the (Internet) public's perception of nanotechnology. Unlike the ultimately contrived interview situation typical of conventional survey methods or the "guided" discussion in consumer forums (Zimmer et al. 2008a; Pidgeon/Rogers-Hayden 2007), this study examines a discussion and evaluation of nanotechnology by users that takes place on the basis of a relatively "natural" standpoint, that is to say one that is spontaneous, experience-oriented and rooted in the everyday world. Moreover, as already mentioned above, the study deals with a group of people who have at least an initial interest in nanotechnology, while large sections of the population still know nothing whatsoever about the subject.

To avoid any misunderstandings, it is important to emphasise that the aim is not to evaluate one form of study, namely the study of online communication, by comparing it with another, namely surveys and dialogue activities. Instead, the objective is to complement previous studies in a meaningful way, as regards both the risks and benefits actually perceived by the general public and the appropriateness of existing activities designed to communicate risks and of accompanying research into the social and ethical aspects of nanotechnology.

The central questions to be addressed by the study are thus as follows: How is “nanotechnology” viewed, portrayed and assessed by a segment of the population that displays a relatively high level of interest in this field of technology and research? How do these people find out more about “nanotechnology”? And what can be ascertained from online discussions with regard to the perceived risks and benefits of specific nanoproducts?

## 1.2 Nanotechnology and the public sphere

### 1.2.1 History and definition of nanotechnology

The term “nanotechnology” was first coined in the mid-1970s by the Japanese engineer and researcher Norio Taniguchi and initially referred specifically to work carried out using materials at the level of an individual atom or molecule, that is to say high-precision construction on a scale of less than one nanometre. Eric Drexler, an engineer and technology visionary from the United States, played a key role in popularising the term nanotechnology. His far-reaching nanofuturistic visions (Drexler 1986) predicted that nanotechnology would bring about massive changes in society and the *conditio humana*, yet he also created explicit nightmare scenarios such as the destruction of all life by out-of-control, self-replicating nanomachines, the “grey goo” scenario. Nanofuturism is one element of a broader view of the world that incorporates visions of technology and these days is often dubbed “transhumanism”. At the centre of this ideology are hopes of human enhancement, greater fusing of man and machine and the ascent into space of a transformed human race (cf. Coenen 2009, TAB 2008). Richard Feynman, an American scientist and winner of the Nobel Prize in Physics who died in 1988, is regarded as the founding father of nanotechnology. In a lecture he gave in 1959 (Feynman 1959), he developed the vision of construction at the atomic level (“arrange the atoms one by one the way we want them”).

Since the end of the 1980s, research policy, especially in the USA, has embraced the term “nanotechnology” and has begun to use it for a wide variety of promotion activities. In the USA, this development reached its first climax in 1999 with the launch of the National Nanotechnology Initiative (NNI) which the then President Bill Clinton announced to great public effect, referring to Feynman’s vision. Ever since, nanotechnology, usually referred to nowadays as “nanotechnologies” or “nanotechnologies and nanosciences”, has developed to become a recognised new field of key technology and research, something that is reflected, for example, in the EU’s current Seventh Research Framework Programme (funded to the tune of approximately € 3.5 billion). At the same time, the term has also gained considerable importance in the area of science and engineering. Nanotechnology, particularly in the field of materials science, is regarded as an object of research and development (one that itself crosses disciplinary borders): a convergence of nanotechnology with biotechnology, information technology and other fields of technology is often presented as the way forward, for example in the “Science Express” exhibition train promoted by the Federal Government (for more on “Converging Technologies”, see: TAB 2008).

As the term “nanotechnology” has become established, it has undergone a change in meaning (on the question of defining nanotechnology, see for example Decker et al. 2004; Decker 2006). Admittedly, the old definitions – especially those associated in some cases with far-reaching visions (including a number of nightmare scenarios) – continue to play a role, particularly in ethical and to some extent also in sociopolitical and academic discourse. More widespread, however, are definitions of nanotechnology based on a scale of up to 100 nanometres (see for example NanoKommission 2008); there is a tendency – irrespective of the methods and objectives of specific interventive techniques at this order of magnitude – to subsume under “nanotechnologies” a variety of both longer-established and new procedures. While most definitions, even those employed by political institutions, do continue to refer to new functionalities and properties achieved by effects on the nanoscale, an understanding of

nanotechnology has de facto emerged – one which is also shared by this study – in which the word serves as an umbrella term to describe a diverse range of technologies whose main common feature is the fact that they deal with structures and processes on the scale referred to above.

### 1.2.2 Aspects of nanotechnology discourse

One noteworthy feature of nanotechnology's progress towards the status of a recognised key technology is the fact that accompanying research in the social sciences and humanities was undertaken comparatively intensively and from an early stage. This research initially focused on the technology's socioeconomic implications, then more broadly on its social implications and, finally, on its ethical and legal implications (see for example Coenen 2009, TAB 2008). Research into public acceptance of nanotechnology and activities aimed at fostering a dialogue on nanotechnology in civil society also took place at a comparatively early stage.

Within this process, which in the USA was driven primarily by science managers with a scientific, engineering or traditional social science background, as well as directly by politicians, a more conventional understanding of scientific and risk communication predominated. The declared objective was to ensure that the general public should be educated about nanotechnology, with its opportunities emphasised. The counterparts to nanofuturistic nightmare scenarios, that is to say far-reaching visionary expectations of opportunities, were widely used in public information campaigns; this was already the subject of critical debate at an early stage (e.g. Paschen et al. 2004).

Alongside this debate, the accompanying research on nanotechnology conducted in the social sciences, cultural studies and humanities gave rise to discussions and activities which are based on a changed understanding of the role of science in society and of the cultural aspects of academic practice, and which wish to anchor this new understanding more firmly within the political context. Essentially, their aim is, on the one hand, no longer to regard the opinions of laypersons, based on their own particular "life-world", as an expression of knowledge deficits that need to be overcome, and, on the other, to comprehensively analyse the forces that drive scientific and technical progress without reference to conventional conceptualisations. This development, which has in particular been promoted in Europe, has already had a considerable impact on the discussion of the public perception of nanotechnology (see Chapter 5.2). There is currently broad consensus in this respect that the perception of opportunities and risks and the political assessment of nanotechnology are partly determined by fundamental cultural, political and ideological attitudes held by the general public (see Currall 2009, Kahan et al. 2009, Scheufele et al. 2009, Wintle et al. 2007; cf. for example also Smiley Smith et al. 2008).

In Germany, the NanoCommission of the Federal Government writes (2008) that activities that were initiated early on and were soon coordinated systematically in these areas promoted a discourse that by international standards is relatively advanced and plural (for international comparisons of such discourses, see for example Malsch 2007, TAB 2008).

A key driving force in the development of funded accompanying research on nanotechnology (besides the example set by human genome research) was the concern that this technology might encounter similar social acceptance problems as green biotechnology, nuclear energy and some aspects of red biotechnology. Furthermore, the asbestos issue served as a warning example. In this connection, Wiedemann and Schütz (2005) expressed the expectation that nanotechnologies, if associated with various fields of application, would also differ in terms of risk perception, with medical applications – like red biotechnology – likely to result in the lowest perceived risks. This expectation, however, could not be proved in experiments (ebd.).

Besides such comparisons, one central aspect of nano-discourse has long been the question whether greatly exaggerated expectations with respect to nanotechnology will emerge, with the inevitable subsequent disappointments. This concern emerged partly as a result of the extremely far-reaching visions (e.g. Roco/Bainbridge 2002), which in the USA had been developed as part of a nanotechnology strategy of “hype and hope” (cf. Paschen et al. 2004, TAB 2008). In a current market study of synthetic biology conducted by Lux Research (2009) – previously, Lux Research had itself contributed significantly to the expectations of nanotechnology – an assessment of nanotechnology and other fields is undertaken: “Prior waves of promising technologies, such as artificial intelligence or nanotechnology, were misunderstood and overhyped, bringing many investors and firms to grief (even as those who understood them correctly quietly profited). Others blew past early doubters and led to prominent restructurings of entire industries that were slow to react – take for example personal computers or digital media” (Lux Research 2009, p. 3). If synthetic biology were to develop in a similar manner to “nanomedicine versus nanofood”, the following could be expected: “Consumers will weigh the potential upside (medicines, high; foods and cosmetics, low) against the uncertainty, and show greater acceptance of products where the benefits seem to outweigh the risks” (Lux Research 2009, p. 17). These quotations highlight one aspect of the interactions between perceived expectations and benefits, suggesting that this interplay can ultimately help decide on the development of a field of technology: consumer decisions can be the critical corrective factor for exaggerated expectations. At the same time, excessive expectations can also make consumers suspicious of an entire field of research, consequently keeping investors from contributing to its advancement.

### 1.2.3 Public perception of nanotechnology

The political and academic discussions of nanotechnology have been and still are characterised to some extent by the concern that large sections of the population could react to the newly established field of research and development with similar scepticism and objection as they have to some areas of biotechnology. It was feared, for example, that “nanotechnology” could still be associated with such extreme nightmare scenarios as those depicted in a number of literary works (e.g. Michael Crichton’s thriller “Prey”) and by various technology visionaries (e.g. Bill Joy in his essay “Why the future doesn’t need us” in 2000; cf. Joy 2000). There was also the concern early on, partly as a result of warning cries sounded by some non-government organisations (above all the ETC Group; for a more recent publication, see ETC Group 2006), that, in the perception of risks, conceivable health and ecological impacts could result in a blanket rejection of nanotechnology.

More recent empirical studies of the perceived risks of nanotechnology, however, show that these fears are currently unfounded. A representative survey of public risk perception carried out by the Federal Institute for Risk Assessment revealed that two thirds of respondents expect nanotechnology to bring more benefits than risks and have particularly high expectations with respect to medical applications (Zimmer et al. 2008b). The perception differs considerably from one application to another, however, with the use of nanotechnology in food-stuffs being viewed more critically by consumers.

One noteworthy aspect of the perceived risks of nanotechnology on which older studies agree (for an overview, see Grobe et al. 2008) is the fact that many respondents express an opinion of the opportunities and risks of nanotechnology despite having little or no knowledge of the technology. In a study conducted in 2006, for example, 60% of those surveyed expressed an opinion regarding the ratio of opportunities and risks of nanotechnology, although only 35% actually had any notion of what the term might mean (von Rosenbladt et al. 2007). The distribution of opinions largely corresponded to the way science and technology are generally viewed by the public. Such results call for a certain degree of caution when it

comes to interpreting the findings of risk perception surveys where they relate to technologies that are neither well-known nor widespread.

This is certainly the case with nanotechnology, as the last-mentioned study shows. Of the 35% of respondents who had some idea of what the term “nanotechnology” means, nearly two thirds had only a vague notion of nanotechnology and no knowledge whatsoever of the scientific or technological fields or social applications in which it might be relevant (von Rosenblatt et al. 2007). The general observation that public knowledge about nanotechnology remains at a relatively low level has in recent years been confirmed in other countries too (BMRB 2004; Cobb/Macoubrie 2004; Decima 2005; Hart 2006 and 2008; Siegrist et al. 2007a; Scheufele/Lewenstein 2005; Scheufele et al. 2007).

According to the cited BfR study, however, the evolving situation in recent years in Germany provides evidence of considerable change (Zimmer et al. 2008b; cf. also the qualitative study conducted by Grobe et al. 2008). During a study carried out in 2004, just 15% of the respondents were able to state where they had come across the term “nanotechnology”; by the time the current study was conducted in 2007, a good half of the respondents were. Particularly in this development phase, continuous monitoring of the perceived risks is of great interest, though it is also important to take into account the sources that feed individual perceptions.

How have those members of the population who know something about nanotechnology formed their opinions and acquired their knowledge?

The overwhelming majority of the population (at least to the best of their knowledge) has no direct experience of nanotechnology or specific nanoproducts to date. In the cited study from 2006, for example, over 80% of the respondents claimed not to know or use any nanoproducts whatsoever (von Rosenblatt et al. 2007). This finding was also confirmed by means of participatory survey methods such as focus groups (Fleischer/Quendt 2007). To the extent that nanotechnology is known at all, public knowledge and opinion of it is thus formed above all on the basis of secondary information communicated via the mass media or by word of mouth; this includes media reports, advertising, literature and films (e.g. science fiction) or the opinions and experiences of acquaintances. The current BfR study concluded that consumers draw their information about nanotechnology mainly from the mass media (television, daily newspapers, magazines) and to a lesser extent from the Internet, from talking to acquaintances and from the radio (Zimmer et al. 2008b).

Several studies of media reporting on nanotechnology have already been conducted, including the current BfR study mentioned above (Zimmer et al. 2008c). This study found that nanotechnology reporting focuses almost exclusively on opportunities, risks being addressed in only a small proportion of the reports. Nanotechnology is discussed above all within the context of research and development and of progress and economic benefits. Grobe et al. (2005) presented an empirical study for Germany in which the perception of nanotechnology was classified by the reporting media as predominantly positive. According to the study, no more than a tenth of the analysed reports stress the risks. A variety of studies of the same subject have also been published in recent years in the Anglo-Saxon research world: they concentrate on their respective nation’s reporting (as in the case of Gorss/Lewenstein 2005) or compare print media in Europe and North America (Stephens 2005, Gaskell et al. 2005) and arrive at similar conclusions.

On the basis of the use and contextualisation of illustrations in German-language journal contributions on nanotechnology, Lösch (e.g. 2006) showed that a considerable change has taken place since the end of the 1990s in the way nanotechnology is portrayed in the media: far-reaching visionary scenarios and fantasies (such as nano-submarines inside the human body) were initially viewed as realistic visions of the future. During the course of critical discussions about the ideas of Bill Joy, Eric Drexler and other technology visionaries, however,

these images were then often seen as a threat to the economic future of nanotechnology and were replaced by more sober pictures from the everyday work of researchers and future users, or were only used in a more distanced, metaphorical way.

Such studies, however, are able to say relatively little about the extent to which the public perception of nanotechnology is influenced by the way it is portrayed in the mass media, beyond making general assessments based on the findings of research in media impact studies and other disciplines. Gaskell et al. (2005) therefore combined a media analysis with results from representative surveys and drew far-reaching conclusions as regards the differences between the perception of risks in the USA and in Europe. The outcome, however, which in effect shows the USA as having an optimistic attitude towards technology and Europe adopting more of a sceptical “wait-and-see” stance, was not confirmed by a more recent study (Scheufele et al. 2009). This found that only just under a third of those surveyed in the USA considered nanotechnology to be morally acceptable, yet substantial majorities regard it as acceptable in some European countries like Germany, France and Great Britain. Interestingly, the study found that many Americans who condemn nanotechnology on religious grounds (e.g. because of their aversion to visions of “human enhancement” and the idea of scientists “playing God”) are in fact those who are relatively well-informed about nanotechnology. In this context, in other words, a high level of information is accompanied by strong aversion.

#### 1.2.4 Online communication and risk perception

After television, and ahead of newspapers and magazines, the Internet is the second most important source of information about nanotechnology (Zimmer et al. 2008b, see also Fleischer/Quendt 2007). It has generally become established in society as a medium with wide reach (van Eimeren/Frees 2008). Contrary to initial fears that subjects could be trivialised, Internet communication has proved to be of high quality in many studies (Largier 2002, Albrecht 2006, Wright/Street 2007).

Online communication potentially has a dual role to play as regards risk perception: it serves both as a source of assessments and perception frames in much the same way as the mass media do, and as a place where an interpersonal discussion of the risks and benefits can take place and consumers can exchange experiences – interpersonal communication, in other words. Thanks to its technical potential, interactive online communication in “personal public spheres” (Schmidt 2007) may also become widespread on a huge scale. This may potentially undermine the two-stage flow of information that has hitherto been assumed in media research – where information is channelled via the mass media to specific gatekeepers who then pass it on via interpersonal communication to the general public (Bennett/Manheim 2006).

Research into risk communication on the Internet, however, is still at a rudimentary stage. What is more, the few studies that do exist focus on Internet content with a mass media character (e.g. websites with the views of actors who are also present in the mass media) in order that they may be compared with conventional media content (cf. Rucht et al. 2008, Gerhards/Schäfer 2007, Krimsky 2007; Rodrigue 2001; Carvalho/Pereira 2008). This ignores the specific everyday character of interactive online communication. Research still needs to be done in this area, as it does with respect to the significance of interpersonal risk communication in general (Lehmkuhl 2006).



## 2 Project design and methodology

Given the situation of research into the perceived opportunities and risks of nanotechnology as outlined above, the present study fills a research gap by specifically examining two aspects of risk communication. It focuses for one thing on consumers, that is to say people who are interested in nanoproducts and actual applications for nanotechnology. For another, it takes advantage of the particular opportunities offered by the observation of interpersonal communication on the Internet in order to analyse the perception of benefits and risks in everyday communication rather than within the framework of an expert or media discourse or under conditions of artificial stimuli.

Both aspects influence the design and methodology of the project in their own special way, and therefore require brief explanation. The focus on consumers initially suggests a broader understanding of nanotechnology than is afforded by the scientific definition. To investigate risk perception, the study is also interested in those products and procedures that are merely claimed to count as nanotechnology (use of the prefix “nano” in product names, for example), as well as taking far-reaching nanofuturistic visions into account. In view of the considerable breadth and heterogeneity of the nanoproduct range, a more recent study has accordingly noted that an analysis of the social relevance of nanotechnology should initially be based on everything “that is termed ‘nanotechnology’ in society or is associated with it – including, for example, the opportunities and risks of products that are merely described as ‘nanotechnology’, or future expectations of particular nanotechnologies (e.g. in medicine or computer technology) which shape society’s understanding of ‘nanotechnology’ even if their realisation is as yet uncertain” (Lösch et al. 2008, S. 14).

The consumer-relevant applications that are the central focus of the present study and also play an important role in political risk discourse (see for example the Commission of the European Communities 2008) include, besides those listed in the above quotation, areas such as vehicles (especially cars, but also boats and motorcycles, for example) in which surface sealing is used, cosmetics (including sunscreen products), textiles (especially outdoor clothing) and foodstuffs (including food packaging). While there is considerable uncertainty in some areas (e.g. foodstuffs) even about what constitutes relevant nanoproducts, they are already a firmly established and recognised phenomenon in other areas (especially vehicles). These differences, as the study will show, are also reflected in the perception of risks, opportunities and benefits, for example as regards discussions of “nanofood” – that is to say the use of nanotechnology in foodstuffs – which have recently begun to appear but are still very isolated on the Internet.

The focus on communication in the everyday world is most easily explained by the concept of “the public”. Studies based on surveys of the general public, for example, adopt a very specific approach to the problem of public assessment of nanotechnology. In these studies, the terms “public” and “public opinion” are in fact only used in the narrower sense of a general opinion held by a majority of the population. A representative random sample is surveyed who are collectively claimed to represent the general public. The resulting data set gathers together reactions – which have ultimately been generated artificially – to predefined questions. This method, however, allows stable political and cultural attitudes of the surveyed individuals to be ascertained, together with their distinctive features in relation to social structure.

The sociology of the public sphere (Gerhards/Neidhardt 1990), however, and more generally the disciplines of communication studies and linguistics, point to the limitations of this interpretation of public opinion, which historically speaking (cf. Habermas 1990, p. 343ff.) is still fairly new. They interpret the received view of the public sphere in the sense of a discourse that is conducted publicly (e.g. Arendt 1960). Within this viewpoint, it is not the attitude patterns rooted in the minds of the population but all the instances where society has publicly

addressed the issue that together comprise the public sphere, or public opinion with respect to nanotechnology. A form of public consciousness concerning this new technology thus exists that is interpreted not as the sum of individual attitudes but as the discursive fabric of public expressions of opinion and “common parlance” (Böke et al. 1996). In the words of modern sociologists, the public sphere, besides the spheres of politics, business or, for example, religion, is a sphere of action that comprises communications with an incomplete group of addressees and (ideally) encompassing all of society’s individuals and groups.

Traditionally, the mass media, and particularly the quality newspapers, are regarded as being the central place where public opinion as defined above is manifested and updated (Habermas 2008). Research to date has therefore concentrated in this regard on the reporting of nanotechnology in the mass media. It is true that this approach has the advantage over population surveys that it views public opinion as a coherent context of meaning that is generated by communication. However, it cannot claim to be comprehensively representative of public opinion as a whole. After all, besides mass media communication, the political public sphere is made up of a communicative network that ultimately always eludes one’s interpretative grasp, composed of interlinked public spheres, interpersonal communications on public issues and events etc. (cf. Gerhards/Neidhardt 1990).

In this sense, focusing on general media reporting entails a limitation, as it is clear from mass media reporting which assessments of nanotechnology can claim to reign supreme in public opinion and which organised political actors – that is to say experts, political decision-makers, business actors, representatives of civil societies etc. – have a major influence on the general public assessment of nanotechnology. After all, the mass media themselves determine to a not inconsiderable extent how nanotechnology is assessed in this general media public sphere. Where they are generating a political public sphere rather than entertainment, the mass media tend to use a specific language, one that reduces authentic personal impressions, experiences and perceptions to abstractions, and discusses issues in a non-personal, sober manner from common moral perspectives (cf. Weßler 2007).

Analysing mass media reporting thus also leaves a research gap that is highly relevant to the question of how nanotechnology is publicly assessed. Experiences of earlier technologies such as genetic engineering show that the relevant sociopolitical controversies emerge not so much at the heart of the political public sphere but predominantly at its edges (e.g. Rucht et al. 2008). The focus, in other words, should also be on the more peripheral-seeming communications in the public sphere that look ahead to the future and potential of the technology, rather than restricting themselves to the here and now as the basis of all rational validity.

This is all the more the case when one takes into account that the introduction of new technologies itself follows the conventional political pattern of agenda setting, negotiation and implementation less and less often. Instead, the greater importance and political relevance of consumer power and consumption (Baringhorst et al. 2007) show that discussion topics, once they have been agreed to in the general public sphere by experts and decision-makers, can quickly come under pressure.

As far as the public’s assessment of nanotechnology is concerned, more therefore needs to be learnt about those forms of peripheral communication in the public sphere (Peters 1993) that are characterised overall by a relevance to everyday life. As interactive online communication becomes more widespread, this form of public discourse becomes visible and as such can also be researched. This is because users, in forums, blogs and other interactive elements – such is the assumption of this study – hold casual discussions from an everyday standpoint, thus representing a wider bandwidth of views than mass media communication (Fraas/Meier 2004). Online discussions take over elements from offline discourse, especially from the mass media, but reveal a greater variety of viewpoints due to the individual style of

communication in forums. They are less focused on well-known people and allow niche communication, together with the creation of sub- and micro-public spheres (see Meier/Pentzold 2009). Such areas on the Internet can be regarded as casual 'backstage communication' as described by Erving Goffman, largely free from the pressures to perform that characterise the mass media centre stage (Yang 2008).

Admittedly, it is virtually impossible to draw conclusions about the discussion participants due to the anonymous nature of the arenas; nonetheless, their horizons of meaning and life-worlds (Habermas 1987) can be discovered by observing their communication. What is capable of expression or at least remains undisputed in this domain reveals potential paths that the general public debate might take, as was already argued above.

Furthermore, this type of online discourse analysis uncovers a specific everyday understanding of "experience" in its pragmatistic sense (e.g. Sennett 2008). For these users, it is not the knowledge that they have at some point encountered nanotechnology that constitutes experience with this technology, but rather the fact of being able to live with it in practice. Interactive online communication contains numerous discussions that report on trial-and-error experiences and about ways of living with (or without) nanotechnology. In this respect, an analysis of online discourse tells us something about the wealth of experience among users, some of whom have already lived for some considerable time with (or without) nanotechnology.

Ultimately, the reviewed discussion contributions (known as "posts") depict more comprehensive and more complex perceptions of nanotechnology than surveys or newspaper reports could ever reveal. In this connection, perception means that the perspective of those discussing nanotechnology is extensively analysed in an interpretative sense. When examining these perceptions by laypersons, it is furthermore assumed in a phenomenological tradition that this makes possible general statements about the underlying horizons of knowledge. Thus the various perceptions of Internet users do not, as is often assumed, represent absurd or idiosyncratic individual opinions but should be taken seriously as modes of expression and constituent features of a linguistically represented society. They can claim indexicality as described by Garfinkel (1967), in that they initially appear as index entries, a random listing of individual episodes, yet upon closer examination refer to underlying societal structures of meaning. These collectively available stocks of knowledge are the central focus of this study. They give rise to a structure of statements that constitutes the horizons of possibility for the assessment of nanotechnology on the Internet and thus becomes the prerequisite for interpersonal communication and action in the public sphere.

Consequently, these considerations would suggest that an online discourse analysis should be conducted, that is to say a qualitative analysis of the contents of contributions to interactive online communication in forums, blogs and the like. To summarise, it can be noted that this method is particularly well-suited to examining the risk perception of consumers for the following reasons:

- Data is collected in a non-reactive way and also not in artificial experimental situations but in a natural setting in which the communicators are largely uninfluenced. Thus no artificial stimuli are needed, although the communication may be influenced by real stimuli (e.g. media articles, results etc.).
- Texts of high data quality are available that are comparatively easy to collect and analyse by computer.
- Discussion contexts are mostly easy to ascertain, e.g. by following hyperlinks that point to reference texts.

- Online communication constitutes an open forum in which both laypersons and experts communicate and in which mass media selection factors with respect to communicators and contents have no bearing.
- A special form of communication logic can be observed in Internet discussions (“viral dissemination”) that is similar to the spread of rumours yet does not take place in the “real world” (cf. Drezner/Farrell 2004, Albrecht et al. 2008).

At the same time, there are methodological challenges, including the following:

- The context of statements in online communication can only be identified to a limited extent; it usually remains unclear who is speaking and what interests they are pursuing with their communication.
- The participants in online communication are self-selective; in addition, Internet users have a specific sociodemographic profile, meaning that they cannot be assumed to be representative of the population as a whole.
- The prevalence and reach of individual forums are comparatively limited.

## 2.1 Project design

For the purposes of this study, a project design was developed that was tailored specifically to the questions to be answered; it combines elements of online content analysis with questions of risk perception and discourse analysis. Because online communication is characterised by heterogeneity of formats, a high degree of dynamism and a network-like topology, it is not possible to conduct a selective search for specific individual posts; instead, they usually have to be found by means of simple or combined search processes. There is no central directory of all texts, nor can any centralised storage of texts – or even their technical accessibility – be assumed. This is the case both across and within individual Internet services, in particular the World Wide Web.

Contributions to a discussion forum may, for example, be indicated by a search engine like Google, or they may not (the problem of inadequate search engines); they may be filed on a server as individual HTML documents (and therefore be technically quite accessible), or they may be stored in a database and only issued in readable form by the server on request (the problem of the “hidden web”). Finally, certain posts or entire discussion forums may only be accessible to certain users or reachable only from certain areas (IP addresses) within the network (the problem of selective publication of online communication). Not least, the highly dynamic nature of online communication makes it difficult to record it because the object of study may change fundamentally during the course of the data collection process (“moving target” problem; cf. Albrecht et al. 2005, Jung 2005: 356).

This means that online communication cannot be collected representatively however hard one tries. For this reason, the present study chose an approach based on qualitative-heristic social research. The fundamental characteristics of this approach are, on the one hand, a focus on the structure of meaning (and less on representativeness) and, on the other hand, a transparent documentation of the process which allows the inevitable systematic errors to be identified and their bearing on the results assessed.

As far as the present study is concerned, this results in two maxims for the project design: to make the individual steps of the analysis visible by means of a transparent process of collection and coding, and to maximise variance in collecting examples of the object of study in order to be able to include, if possible, all the facets of meaning of the online discourse in the relevant areas. The arenas of communication, the thematic areas, the participating actors

and the time at which communication took place can be identified as relevant dimensions of the online discourse on nanotechnology.

To restrict the subject of the study, the analysis of online discourse is limited to contributions in arenas of interactive online communication. In this context, the word “arenas” refers to virtual public places in which discussions of certain topics take place. The study focuses solely on interactive communication in which interested parties can take part not only as listeners but also as speakers.

The arenas include the following:

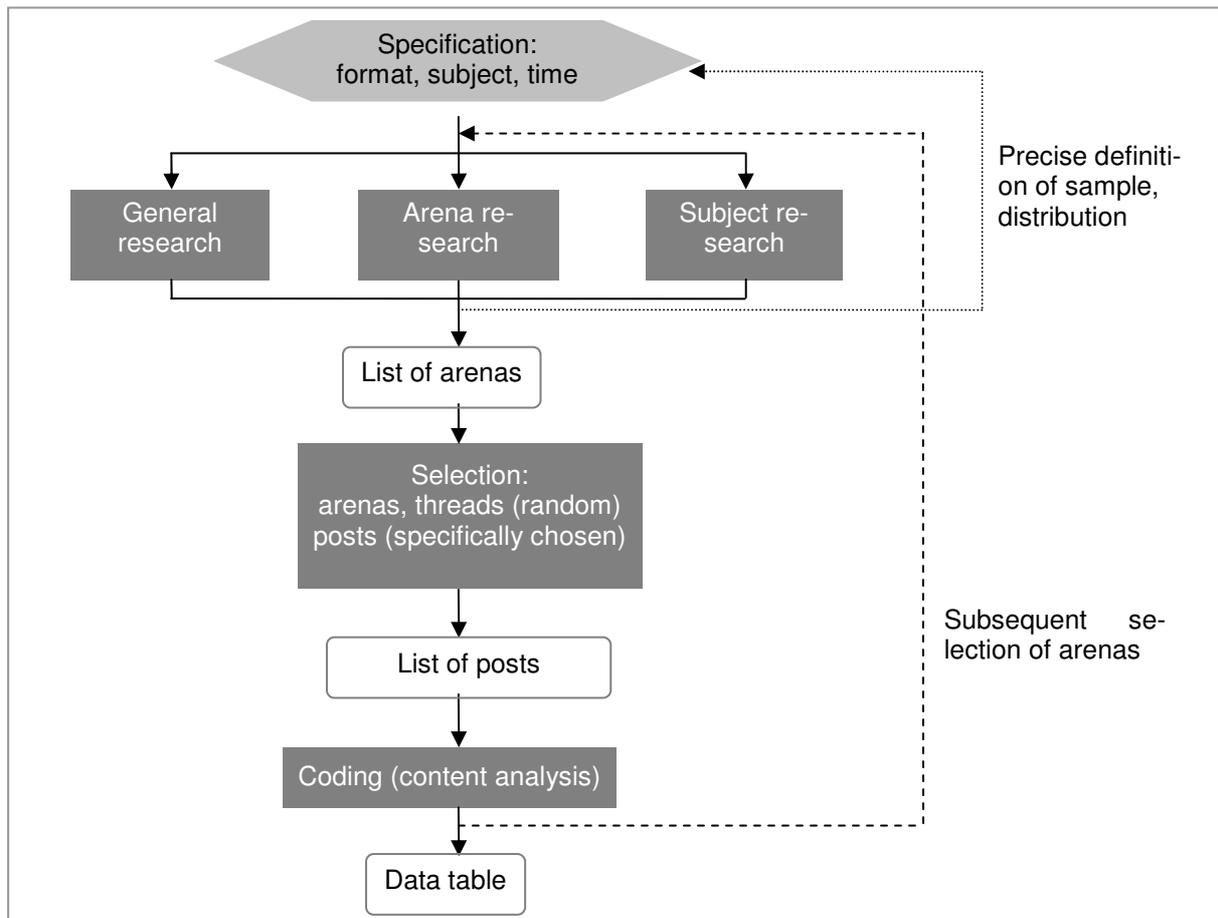
- discussion forums and groups on the Internet,
- blogs with a comments function,
- chats (for practical reasons, the study is limited to chats whose communication is documented and accessible in the form of records) and
- comment sections and forums on the websites of mass media and discussions in video portals that have become increasingly popular in recent times.

Other limiting criteria are that the posts should address

- nanotechnology in general,
- individual applications or
- individual products

in the form of statements that are based on experiences, convictions or knowledge and/or pose questions. Furthermore, they must be written in German and have been published between 2001 and 2008. This latter restriction is intended to capture as far as possible current discourse and to make the study comparable with other studies of risk communication in Germany.

Figure 1: Study overview



A three-stage project design was chosen in order to answer the central research question of how nanotechnology is perceived and linguistically construed in Internet forums. The first step was to identify relevant arenas of interactive online communication on the subject of nanotechnology in order to allow the topology of the discourse, that is to say the distribution of different topics and discussion contexts, to be assessed. The second step was to specify relevant topics and specifically select posts from the relevant arenas that would constitute a systematically designed text corpus to form the basis for the content analysis. The third step was to code the posts in relation to the content analysis and to assess the results.

## 2.2 Search for arenas of online communication on the subject of nanotechnology

The search for arenas of interactive online communication on the subject of nanotechnology was carried out in four interlinked main steps:

- a general examination of the Internet public sphere related to nanotechnology; initially, this did not involve searching specifically for arenas of interactive communication but attempting to acquire a picture of the overall online discourse as it would present itself to the user of a search engine,
- systematic search for arenas relating to nanotechnology (according to the above specification of the study subject),
- additional targeted searches, for example using local search engines to sift through the offerings of the mass media and certain actors relevant to nanotechnology, and
- collection of data relating to the arenas found.

“Google” was the primary search engine used for the purposes of the research, since it is currently the most popular research tool. In the case of the discussion forums, the search engine “Yahoo” was used for confirmation,<sup>1</sup> while the “Technorati” search engine was used for confirmation of the blogs. Wherever available, the German-language version of the tool was used. During perusal of the results attention was paid to hyperlinks to other arenas which were also included in the study (snowball method).

To achieve the widest possible coverage of the discourse, several search terms were combined: a search was conducted for “Nano”, “Nanotechnik” (nanotechnology), “Nanotechnologie” (nanotechnology) and “Nanotechnologien” (nanotechnologies). Specifically excluded from the search were uses of “nano” which clearly had nothing to do with nanotechnology and which generally meant merely “(very) small” or, non-specifically, modern (products like the “iPod Nano”, the Indian car “Tata Nano” and the practice of “Nano-Aquaristik”, that is to say “nano fishkeeping”). The search likewise ignored any advertising which could be unmistakably identified as such (in the case of blogs, so-called spam blogs or link farms). Not excluded, on the other hand, were products which in a dubious manner claimed or sought to give the impression that they are manufactured or effective on the basis of nanotechnology (as, for example, in the case of the spray “Magic Nano”), as discussions of such products can influence the perception of nanotechnology.

### 2.3 Selecting posts for a text corpus for the content analysis

When selecting individual posts for the content analysis, it was important to remember the study’s focus on everyday communication among consumers (rather than on an expert or media discourse) and to base the selection on the results of the research. The following five subject areas or categories were chosen to cover consumer discourse, all of which are relevant to actual applications of nanotechnology:

- Vehicles
- Foodstuffs (including their packaging)
- Medicine
- Cosmetics
- Textiles

To complement these, the category “general discussion” was included in order to be able also to examine posts not dealing with actual applications.<sup>2</sup> Posts were selected on the basis of these subject areas, for each of which specific post quotas were determined.

This type of differentiation of risk communication according to various applications has rarely been undertaken in research to date (for examples, however, see Currall et al. 2006, Siegrist et al. 2007a, Pidgeon et al. 2009; Zimmer et al. 2008b), yet research results prove that differences between nanotechnology applications have a greater bearing on risk perception than, for example, the cultural context (Pidgeon et al. 2009). With this in mind, the present study complies with a proposal recently put forward by Currall (2009: 79): “Examining specific applications and/or commercial products based on nanotechnology, as opposed to nanotechnology in general, is an important direction for additional work.”

The results of the searches for arenas have shown that only comparatively few posts can be found in cosmetics and textiles, which is why the target quota of posts in these areas was defined as 50. In each of the other categories, it was decided that 100 posts should be col-

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<sup>1</sup> Choosing Google and Yahoo meant that the two globally dominant “cartels” (Jung 2005: 357) of the search engine market were covered.

<sup>2</sup> The following topics were deliberately excluded: electronics; stock exchange, finance and business; building, DIY and garden; degree courses and arenas in which nanotechnology appears exclusively as a futuristic element of computer games.

lected. Furthermore, the research showed that discussions in chats, newsgroups and video platforms have only a very low level of importance, allowing the survey formats to be limited to forums and blogs. Formats like Wikipedia and the interactive services offered by the mass media were classified according to their degree of technical implementation (newspaper contributions linked to reader commentaries, for example, were included together with blogs).

The first step was to randomly select arenas for each topic from the arenas identified in the research and within these arenas to select – likewise randomly – individual “threads” (sequences of posts in an Internet forum) in which the subject of nanotechnology is raised. Within these threads, relevant posts were specifically selected, that is to say posts that not only mention nanotechnology by name but also connote it in some way, e.g. by using a judgemental adjective or by linking it to a linguistic image. In threads with more than ten posts, two relevant posts were selected, and in shorter threads only one. In both cases, the thread’s original post (also known as the “thread starter”) was additionally included in order to document the context of the discussion. This process was repeated until the target quota for the topic in question was reached (the thread starters in this context were only included if they raised the issue of nanotechnology).

The second step, which took place at the same time as coding of the posts themselves, was to check that the individual posts genuinely fell within the scope of the respective topic; if necessary they were regrouped and further posts added as in the first step. In topics with a low number of posts, a selective search for additional arenas and posts was conducted; within individual threads, more than three posts could also be included in the survey in these cases. Finally, all the posts, together with the necessary meta-data (URL, date, author information, forum, thread, position within thread etc.), were saved in a database (based on Microsoft Excel) for further analysis.

504 posts in total were collected. The target quotas were reached for all the topics except for textiles; in this area, even intensive research was unable to locate sufficient relevant posts. 103 posts were collected in vehicles, 100 each in foodstuffs and medicine, 50 in cosmetics, 45 in textiles and 106 in the “general discussion of nanotechnology”.

## **2.4 Analysing the content of the selected posts**

Given the novel nature of the subject study and the study’s aim of exploring the perceptions of nanotechnology, the content analysis was initially designed as an inductive and exploratory process in accordance with qualitative methodology. Due to the already fairly advanced state of research into nanotechnology risk perception, however, the starting point can be stated more precisely than is typically the case with, for example, a study conducted according to the “grounded theory” model (Strauss 1994). For this reason, the present study combined elements of a qualitative heuristic analysis (especially the iterative interplay of questions, results and new questions, cf. Kleinig 1995) with elements of a systematic and quantifying content analysis (Gerhards 2003). This type of multistage content analysis appears particularly well-suited to reflecting the novel nature and complexity of the research subject on the one hand and the state of research into nanotechnology risk perception on the other.

Essentially, a content analysis involves interpreting textual data. Because any interpretation necessarily depends on the recipients’ background knowledge and perspective, the research team for the present study was composed in such a way as to represent as broad a range of competencies and perspectives as possible. In the explorative phase, i.e. during examination of the material, the first trial coding and compilation of the code book, researchers from different social science disciplines (psychology, political science and sociology) and with different levels of knowledge of nanotechnology (from everyday knowledge to expert knowledge from the area of technology assessment) worked together. All the participating researchers

have experience of discourse analysis, especially with respect to online communication. The coding process itself was carried out by two of the researchers, though one part of the posts was coded twice in order to verify the reliability of the systematic content analysis.

The code book was developed iteratively on the basis of a pre-selection from the text corpus. First, the individual dimensions were described and categories identified for each of them (on the basis of the current level of knowledge in the literature and in the existing studies of risk perception in the public sphere and mass media); these categories were subsequently broadened or narrowed following an examination of the material. Pretesting of the coding revealed scope for simplifying and extending the initially chosen coding scheme. Finally, each category of the coding scheme was described in detail in the code book and illustrated using examples from the material. In a second step, the coding scheme was used by two researchers – working independently at this stage – to code the posts from the text corpus. At this point, the quotas defined in the sampling strategy were reviewed and any need for additionally selected posts identified. Furthermore, 50 posts randomly selected from the sample were coded twice and the results subjected to the sort of reliability test that is recommended for systematic content analyses (Krippendorff 2004; Früh 2007). Representing approximately 10% of the sample, this follows the recommendations contained in the literature (cf. Lombard et al. 2008). In a third step, the subsequently selected samples were also coded following an analysis of the results of the reliability test and corresponding adaptation of the coding scheme. The final coding scheme is fully documented in the annex in Section 9.3; its key dimensions are presented briefly below.

- Information about the speaker:

*Sex*

- Subject and statement of the post:

Coding of the *range of the post* (nanotechnology in general, specific application, actual products), of the *central statement* and *statement type*, of the mentioned *products*, of the *subject area* (vehicles, foodstuffs, medicine, cosmetics, textiles, general discussion, other), *assessment of nanotechnology*

As regards the dimension “assessment of nanotechnology”, for example, the overall statement expressed by the post was coded in relation to the individual subject of the statement. These assessments could be implicit or explicit. The available categories were “positive”, “negative”, “neutral/neither positive nor negative” and “partly positive, partly negative”.

- Benefits and risks:

*Benefits vs. risk dimension*

For the dimension “benefits vs. risk dimension”, the coding was determined on the basis of whether the post saw nanotechnology as offering benefits or harm (benefits dimension), opportunities or risks (risk dimension), or a combination of the two. The difference between the two dimensions lies in the concrete or abstract nature of the expected effects: in the case of a benefit or harm it is a question of concrete effects such as smears on a pane of glass following nano-sealing. In the case of opportunities or risks it is a question of effects that are expected but have not (yet) actually arisen. The individual categories that were coded are the result of a comparison of the benefits and risk dimensions (combinations that do not occur are indicated by a dot):

**Figure 2: Categories of the benefits vs. risk dimension**

	Opportunities	Risks	Both	Neither
useful	Cat. 1	.	.	Cat. 4
useless/ harmful	.	Cat. 2	.	Cat. 5
both	.	.	Cat. 3	.
neither	Cat. 6	Cat. 7	.	Cat. 8

### *Opportunities/risks*

For the dimension “opportunities / risks”, detailed coding was carried out of the opportunities or risks nanotechnology is expected to bring, i.e. those that are associated causally or connotatively with nanotechnology. In this context it is a question of opportunities for or risks to the environment, health and society, and of other opportunities and risks. In addition, the mentions are summarised according to a variable of their own that indicates whether the post associates opportunities or risks, both opportunities and risks or neither opportunities nor risks with nanotechnology.

Further dimensions: *Products compared* (were nanoproducts or nanoprocesses compared with conventional ones?) and *Arguments* (which arguments were put forward to support the statement?).

- Linguistic means:

The *linguistic imagery* used to describe nanotechnology was noted, as were the *key words* used (e.g. flag words or stigma words) and the *interpretative frames* with which nanotechnology is assigned to certain knowledge contexts and forms of interpretation.

- Sources and knowledge:

Coding of *sources* and *references* (from which media and from which actors do information and knowledge about nanotechnology come?) and of the *level of knowledge of the speakers* with respect to nanotechnology (to the extent that this is indicated by the post), characterisations of the *discourse* on nanotechnology in the posts and *comparisons* with other areas of technology development (e.g. genetic engineering, nuclear power etc.).

- Scope for action:

Coding of the actors who are regarded as being in a position to intervene and in whom explicit trust or mistrust is expressed and of the demands that are put forward in the posts as regards the further development of nanotechnology.

These different dimensions were recorded with a view to documenting in as broad a way as possible the perception of opportunities and risks in online discourse. Only certain of the dimensions were taken into account for the purposes of the analysis, principally because some dimensions only produced results in a small number of posts and were therefore felt to have little significance. This applies in particular to the dimensions in the area “scope for action”. Further dimensions (e.g. sources, references, knowledge level) showed themselves during coding to be not sufficiently reliable (see below) with the result that they could not be included in a detailed analysis.

For the reliability test, Krippendorff’s alpha<sup>3</sup> was chosen as the index and calculated using software from the University of Leipzig (Jenderek 2006). Krippendorff’s alpha was chosen

<sup>3</sup> The index is used to measure the agreement in the judgements of two (or more) coders. It is calculated as the ratio of observed to expected deviation and can assume values between 1 (perfect agreement) and 0 (no agreement apart from random

partly because this index is very flexible and can be used for variables of different scale levels, and partly because it is regarded as conservative (random correlations between the coders, for example, are discounted) and is therefore a particularly critical measure of intercoder reliability. A value of 0.65 was defined as the lowest acceptance value; this appears justified in view of the subject of investigation and a conservative index such as Krippendorff's alpha.

The results of the reliability test initially pointed to insufficient agreement between the coders for surprisingly many variables. Of the 25 quantitatively coded variables of the code book, a value of over 0.7 was achieved only in ten cases; in one case, the value, at 0.65, was on the acceptability borderline (see Table 1). Such a low level of agreement is an indication of difficulties with coding that have less to do with the code book or the coders than with the particular characteristics of the material. For instance, it can be assumed that the brevity of the posts in interactive online communication, their ambiguity and typically strong dependence on the context of the communication (and especially on the course taken by the thread in question) make it difficult to arrive at an intersubjectively convergent view of their semantic content. For another thing, problems with coding reliability are well known from risk communication research. Peters and Heinrichs report, for example, that reliability values of only around 0.5 were achieved during an analysis of the content of media reports on climate change, despite extensive training of coders (using a similarly conservative index like Krippendorff's alpha, Peters/Heinrichs 2005: 22). Singer and Endreny (1993) came up with similar low values in a media analysis.

Given that nanotechnology is an emerging technology that is only gradually beginning to penetrate the public consciousness, the results of the reliability test would appear not particularly surprising. Instead, they prove that the characterisations of nanotechnology in the Internet users' discourse cannot be interpreted as clearly as researchers are accustomed to expect from analyses of the contents, for example, of media reports. Because the researchers cannot claim to have any privileged interpretational access to the material when conducting the content analysis, the posts of an online discussion forum are just as ambiguous and open to different interpretations to those taking part in the discussion as they are to the coders.

It would therefore be inappropriate to try to improve the coding by more thoroughly training the coders or by making the categories more precise. The interpretative flexibility of the online discourse on nanotechnology rather represents an initial central result of the content analysis. However, in order not to excessively restrict the analysis possibilities, certain central categories for which reliable coding was not achieved were recoded, that is to say different categories were grouped together and thus standardised. This ultimately meant that acceptable reliability values were reached for the variables "assessment", "benefits vs. risk dimension", "opportunity / risk" and "interpretative frames", reflecting the material's characteristics through the use of a more approximate analysis grid. Those variables for which no acceptable reliability values were achieved were only listed supplementarily in the analysis and were not used for generalisations.

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hits):  $\alpha = 1 - D_o / D_e$ , where  $D_o$  is a measure of the observed deviation and  $D_e$  is a measure of the deviation that would be expected given a purely random allocation of codes. For a more detailed description of the calculation, see Krippendorff 2004, p. 211ff.

**Table 1: Reliability values for the quantitatively coded variables of the code book**

Dimension	Krippendorff's alpha	Recoding procedure	Krippendorff's alpha
Speaker	0.79		
Range	0.73		
Actual products	0.81		
Subject area	0.88		
Statement types	0.48		
Question types	0.73		
Assessment	0.43	Reduction from five-point scale to three-point scale	0.64
Benefits vs. risk dimension	0.50	Grouping together with opportunities/risks	0.72
Opportunity/risk	0.60	Recoding according to variables for detailed risks and opportunities	0.67
Risks in detail: environment	0.72		
Risks in detail: health	0.65		
Risks in detail: society	0.71		
Opportunities in detail: environment	0.71		
Opportunities in detail: health	0.71		
Opportunities in detail: society	0.72		
Product comparison	0.56		
Arguments	0.01		
Interpretative frames	0.47	Reduction to three frames	0.87
Sources	0.34		
References	0.29		
Speaker's level of knowledge	0.52		
Scope for intervention	0.48		
Trust	0.56		
Mistrust	0.08		
Demands	0.50		

Following the coding process, which also included those posts subsequently collected to fulfil the quotas, the data were subjected to a consistency and plausibility analysis and the data set was cleansed. All data were saved in an Excel-based database and additionally transferred to an SPSS data set for quantitative analysis.

### 3 Internet public sphere relating to nanotechnology

This chapter presents the central results of Internet research into German-language online discussions of nanotechnology. This research was based mainly on the Google search engine and on a targeted selection of websites of relevant actors. Focusing on the forum, chat and blog arena types and formats, the research represented the first step of an examination of the perceived risks of nanotechnology in Internet discussions. (By “arenas” is meant public virtual places in which interactive communication can take place.)

Forums offer arenas for the discussion of specific topics, usually by a wide-ranging group of participants. There tends to be a low level of differentiation between participants; the level of experience is the main differentiation criterion, with more experienced participants often assuming a moderator role, for example. Within a forum, participants can initiate a discussion by posting a “thread starter” (the original post) or can contribute to an ongoing thread (“reply”). From a technological standpoint, the discussions are represented in the form of a tree structure that shows the interactions (known as “threads”) between the posts. For the purposes of the study, these threads are distinguished according to size as long (>100 posts), medium-length (11-100 posts), short (2-10 posts) and “single post threads” (comprising just one post without any replies). Replies to posts may be submitted in something approaching real time (see chats), though it is not unusual for them to cover several years because the posts are archived for long periods and remain open for responses (asynchronous communication). A special search engine usually allows users to search for particular posts within a forum.<sup>4</sup>

Blogs are websites that regularly feature new posts. Some are similar in character to a diary or journal, some document the author’s (“blogger’s”) paths through the Internet, and others offer quality reporting on specific topics (specialist or theme blogs). They are characterised by reverse chronological listing of posts, in which new posts appear at the top of the list, and by their focus on one blogger (or a small group of bloggers), the author. This author focus, however, entails a strong culture of referencing; many posts are simply comments or references to posts in other blogs or are discussed by readers directly in the blog’s comment columns.

Unlike the asynchronous form of communication practised in forums and blogs, chats are real-time discussion platforms where participants meet and communicate at a particular time. A distinction is made between general chats and chats on specific topics, and between permanently open chats (chat rooms) and organised chats that are staged just once. Characteristic features of chats are the short response time between related posts and the short “memory” – often, older posts can no longer be commented on purely for technical reasons. As a result, chats resemble verbal conversations (synchronous communication). For the purposes of this study, only completed organised chats were researched whose protocols were available online. Because monitoring chat rooms requires researchers to take part in the chat in real time, is time-consuming and not without problems from an ethical and methodological viewpoint, this was neither possible nor desirable within the framework of the study.

In addition to these three formats, discussion groups in Usenet (as well as Google Groups) and Yahoo (Yahoo Groups) were researched. The former are similar to forums, while the latter are arenas offered especially by Yahoo to provide greater scope for group work in addition to a discussion forum. Furthermore, discussions in the forums and comments sections of selected newspapers, magazines and TV programmes were also researched. These are

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<sup>4</sup> In one version of a forum, discussions are initiated by the organizers and participation is limited to responses to the discussions (e.g. organized political online discussions). Such forums are of less interest here, especially when the organizers are political institutions: the central focus of this report and of the project as a whole is on the particular perception of risks among the population (and especially among laypersons), with the result that forums that are offered within the framework of political activities relating to risk communication are of lesser relevance.

either forum-like formats that focus on the discussion or blog-like formats that focus on isolated comments on articles. Finally, there was an investigation of the extent to which more modern formats of Web 2.0, like video portals for example, are used for the discussion of nanotechnology.

On the basis of this research, posts were then selected for content analysis. As they show a “snapshot” of the summer of 2008, the research results give only a limited insight into the Internet public sphere. They have a wider interest, however, in that they allow the discursive sphere of online communication on the risks and benefits of nanotechnology and its products to be surveyed.

The results of the Internet research, summarised for each individual step, will be presented and provisionally assessed below. An overview of the results can be found in Section 9.2 of the annex.

### 3.1 Nano Internet public sphere

A comparison of two Google searches conducted on 13 August 2008, one using a search string excluding and one including well-known brand names of no relevance to the topic in question (such as “iPod nano”), showed no evidence that relevant websites were lost by excluding brand names etc.<sup>5</sup> For the purposes of the study, only those results were therefore used that were obtained from searches in which brand names were excluded.

Over 600 results were obtained in all, automatically ignoring “very similar” hits. It should be mentioned that there were various nanoproducts in the search results that had not been identified in advance, e.g. hearing aids and dental fillings. A search of the 500 highest-ranking hits was conducted to identify arenas; a total of 15 websites with arenas were found. The arenas identified in this step either featured very extensive discussions, some of which were also interesting from the risks perspective, or were fairly small arenas that nonetheless had relevant discussion contents with respect to risk perception.

#### 3.1.1 Search engine research: hits 1-20

A good half of the 20 highest-ranking hits were the websites of political and scientific institutions<sup>6</sup> which did not offer any arenas. In addition, there were the websites of the online version of the highly influential “Spiegel” magazine and of the important German daily newspaper “Welt”<sup>7</sup>, a forum on nanoproducts ([www.nanoproducts.de](http://www.nanoproducts.de)) and the “nanotechnology” entry in the German version of Wikipedia.

The Wikipedia article was the first-listed search result. Little advantage was taken of the opportunity to discuss the article, however. In total, roughly 15-20 relevant posts were found relating to this and other Wikipedia articles on nanotechnology that Google automatically filtered out as being “very similar”. These were mainly concerned with defining nanotechnology and distinguishing it from nanofuturism, and hardly focused on risk aspects at all.

The website [www.nanoproducts.de](http://www.nanoproducts.de) was listed in 15<sup>th</sup> place and featured a forum ([www.nanotechnologie-forum.de](http://www.nanotechnologie-forum.de)). As such, it was the highest-ranked website with an arena geared especially to nano issues. The forum offered a broad range of topics but was not

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<sup>5</sup> It turned out, however, that other brand names containing the word “nano” were relatively frequent (e.g. Intel’s “VIA Nano” processor).

<sup>6</sup> Hits 52 and 134 led to the website [www.bfr.bund.de](http://www.bfr.bund.de).

<sup>7</sup> Hit 18, for example, was an article from the “Welt” newspaper about the risks of nanotechnology which attracted 24 reader comments.

much used (with a total of 152 posts). There were no long or medium-length threads. One of the two sub-forums with the most posts was devoted to the risks of nanotechnology.

### 3.1.2 Search engine research: hits 21-100

Number 26 on the hit list was an article from the online magazine “Telepolis” that is published by Heise-Verlag ([www.heise.de](http://www.heise.de)). The Heise portal specialises in computer technology, although “Telepolis” in particular also features background articles and news about other technologies. There were 24 comments on the article, with a medium-length thread among them. It should be noted that no hits appeared relating to the online German-language version of the US magazine “Technology Review” that also belongs to the Heise portal. It regularly publishes articles on nanotechnology and also allows comments to be posted on blog entries and articles. Number 35 was the forum of [www.golem.de](http://www.golem.de) ([forum.golem.de](http://forum.golem.de)), another website specialising in information technology. The forums it offers included some sub-forums and numerous posts about nanotechnology, where the focus appears to be on nanofuturistic topics.

One characteristic of the online discussions of nanotechnology on the Heise and Golem websites was that not only topics relating to research and technology policy and far-reaching visions (including science fiction), but also the latest results of nanoscientific research and nanoproducts were discussed.

Number 98 on the list was an article from the online version of the magazine “Focus”, which also offers a forum ([bb.focus.de/focus](http://bb.focus.de/focus)). A medium-length thread dealt with the opportunities and risks of nanotechnology. Philosophical aspects of nanotechnology and nanoproducts in the area of car care were also raised sporadically.

### 3.1.3 Search engine research: hits 101-500

Number 130 on the list was a hit that led to the nanotechnology sub-forum of the financial portal [wallstreet-online.de](http://wallstreet-online.de) ([www.wallstreet-online.de/forum/100-1-50/nanotechnologie](http://www.wallstreet-online.de/forum/100-1-50/nanotechnologie)). This sub-forum contained 864 threads with many thousands of posts. A brief inspection revealed that the great majority of the threads are concerned with the shares of individual nano companies or with nanotechnology funds. Sporadically, the future prospects of nanotechnology and “hype” in this connection were the subject of a general discussion.

The very extensive car and motorcycle portal [www.motor-talk.de/forum](http://www.motor-talk.de/forum) was listed in 211<sup>th</sup> place. There were many relevant discussions to be found here, above all about the use of nanoproducts in vehicle care. Many posts concerned the question of whether advertising (often prohibited in forums) or anti-advertising was taking place here and whether nanoproducts are a “rip-off” and a “swindle”. In addition, the concrete experiences of users and professionals play a role, as do (to a lesser extent) scientific and risk aspects. Discussions of nanoproducts and nanotechnology that had continued for weeks were found, together with many medium-length and short threads and at least one long thread (165 posts). Over 40 threads had the word “nano” in their titles.

## 3.2 Relevant forum, chat and blog discussions

Another Google search, this time using relevant search words (like “forum”, “blog”, “thread” etc.) to find specific formats, uncovered a considerable number of other arenas. A comparison with the results from the Yahoo search engine revealed no significant differences to the Google results (apart from the order in which they were listed). Additional finds from the Yahoo search were included in the results list.

In the case of hits that appeared of interest due to the scope or theme of the located arenas, a more detailed investigation of the websites was carried out, for example by using relevant search strings to search in forums. Comments relating to online articles and user reviews on amazon.de were included together with the forums.

It was noticeable that no or hardly any arenas were found for some entire product areas or industries in which nanoproducts already play a role, e.g. in the case of sunscreen products and foodstuffs. This was taken into account during the subsequent selective search for relevant arenas (cf. Chapter 3.3.3).

### 3.2.1 Forums

The selective search for forums produced 62 other forums.<sup>8</sup> A significant number of medium-length threads was found.

The majority of forums found were discussions about nanosealing, above all in the realm of vehicle care; this is also where the most extensive threads were found. Besides numerous car forums, there are also boat forums with similar topics. In both, motor additives were discussed as well as vehicle care (albeit to a much lesser extent). There were various examples indicating that risk aspects and nanotechnology in general are discussed in relative detail in vehicle forums.

As compared with the discussions in the vehicle forums, almost all other discussions found were considerably smaller in terms of number and scope.<sup>9</sup> Other topics that arose fairly frequently were nanotechnology in general, different medical products and degree courses in nanotechnologies and nanosciences. A variety of books about nanotechnology have as many as four user reviews on amazon.de.

Noteworthy individual arenas were a cancer forum that contained discussions of nanotherapies, a thread dealing with health risks at the workplace caused by toner dust, and a robotics forum in which nanotechnology featured sporadically in the discussions.

### 3.2.2 Chats

The selective search for chats revealed that many of the results lead to websites offering chats, though these were often not accessible, not relevant or not searchable. An unintended result of this search was many other forums because forum sites often also offer chats. These were incorporated into the forums list.

Five transcripts were found of organised chats in which nanoscientists and nanotechnology experts answered questions by the chat participants, as well as a number of out-of-date chat advertisements. Some of the chats involving scientists and experts for which transcripts were found are of interest with respect to certain risk aspects and visions of nanotechnology.

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<sup>8</sup> Once again, other brand names containing the word “nano” were found here, e.g. in the area of “electronic cigarettes” and in the case of drugs taken by bodybuilders.

<sup>9</sup> One exception here is a forum that is run for one of the science fiction online role playing games which contain numerous references to nanotechnology (visions): <http://forums-de.anarchy-online.com>.

### 3.2.3 Blogs

A search using the Technorati blog search engine on 22 July 2008 initially produced 623 hits. Searching through these results according to the thematic relevance and type of blog revealed 68 blogs in which at least one post on nanotechnology or nanoproducts was published. Google research uncovered 37 additional blogs, which together with seven hits from the other search steps meant that a total of 112 blogs with relevant posts were identified.

The blogs in question were either personal diaries in which the author decides, as it were at whim, on a relevant theme, or were thematic specialist blogs like the blog of the aforementioned magazine "Technology Review". A number of blogs were also found that are used as a PR channel by companies, e.g. those offering sealing services. Unlike in specialist magazines, for example, specialist blogs also feature many posts that reflect the personal interests of the authors rather than the thematic orientation of the blog. The blog authors were both laypersons and experienced expert authors, both groups being represented more or less equally in the results.

Generally speaking, there was only a small number of posts relating to nano-topics. Approximately 50 blogs contained just one relevant post, and in 97 blogs the number of posts was below 10. Among the 15 blogs with 10 or more posts there were only two blogs that also contained posts describing personal experience; in all other cases posts with a thematic focus predominated.

The overall spectrum of topics covered by the blogs was very broad and ranged from relevant nano-blogs via science and technology blogs to blogs relating to advertising, nutrition, health, architecture, literature, business and finance. More than a quarter of the blogs dealt with risk aspects of nanotechnology, among other things. Other nano-topics were research results, scientific progress in general and future visions, the significance for the economy, nanomaterials and production technologies, and products such as batteries, clothing and fibres, paper, sealing methods and nanofood.

Interestingly, there were only few discussions of nanotechnology that continued beyond the discussion sphere of an individual blog through the use of hyperlinks to other blogs. Examples of such discussions included a debate on a design study carried out by mobile phone manufacturer Nokia (featuring eight blogs in all with relevant posts), reports on nano "invisibility cloaks" and discussions of two studies of nanorisks (from Swiss Re and the organisation BUND), and the discourse on "Morgellons disease" and the supposed relevance of nanotechnology in this context.

## 3.3 Further research results

For the selective search for other relevant arenas the internal search functions in forums were used in some cases to locate any discussions concerning nanotechnology. This research step also took specific account of formats other than forums, chats and blogs.

### 3.3.1 Internet services offered by mass media

Research on the websites of selected daily newspapers, magazines and TV programmes was hampered by the very limited range of internal search options. Many media organisations nowadays allow their readers to post blog-style comments on individual posts rather than giving them the chance to participate in some sort of forum. Only the "Financial Times Deutschland (FTD)", the news magazines "Focus" and "Spiegel" and a handful of TV programmes work with forum systems. Conducting a keyword search in posts was limited in

some of the comments to the article texts, while in the print media forums only entire threads (some containing several hundred posts) were listed as hits.

The results showed an overall low level of posts and discussions of nanotechnology and related subjects. The “Frankfurter Rundschau” and TV science programme “nano”, for instance, contained no relevant posts with reader reactions, while the “taz” newspaper featured only one relevant article, about consumer protection in the context of nanoproducts.

The arenas of the remaining media outlets each contained fewer than 10 relevant posts (despite significant activity in the arena); only the forums of the “FTD” (13 threads) and of the magazine “Spiegel” (65 threads) listed more hits. It should be noted here, however, that entire threads were listed as search results, yet due to the size of the threads only spot checks could be carried out to establish whether and to what extent they actually contained a reference to nanotechnology.

In terms of subject content, the discussions tended to cover scientific or politically influenced perspectives of nanotechnology. They dealt with nanoresearch and nanotechnology in general, with innovations and risks of nanoproducts, as well as with economic questions.

### 3.3.2 Other online communication formats

Too few posts about nanotechnology were found, both in the Usenet and Yahoo groups (being older technical formats) and in the reviewed video portals (being trendsetting technical formats), to give them any consideration in the current project.

Because video portals are formats that attract a special type of user, namely those with a strong Internet affinity and wide-ranging Internet knowledge, they should at least be borne in mind for future studies, especially given that they are already used sporadically today as an advertising channel by providers of nanoproducts.

Google Groups was found to contain seven sites relating to nanotechnology which contained discussions from the areas of religion, UFOs, research and science. Health problems were raised in just one discussion (with a comparison to fine dust), while in four of the hits the discussions had additionally taken place some time ago.

Research in the Yahoo Groups was even less fruitful. Apart from a forum for those interested in transhumanism, there was also a group for field service staff in the nano surface sealing industry; with just one member, this latter group contained no posts.

The video portals YouTube and MyVideo featured hardly any German-language videos on nanotechnology, and the discussions in the comments sections were limited to no more than four posts. A small number of videos were found that demonstrated the benefits of nanoproducts such as sealants. Overall, the way the video portals are currently used revealed nothing about the perceived risks of nanotechnology, and at best provided information about its marketing strategies.

### 3.3.3 Specific product groups and industries

When searching for further discussions relating to the particularly interesting areas of application, specific websites were no longer targeted in view of the high number of results already found in the category of vehicles.

The search thus concentrated mainly on websites whose arenas were likely to relate to the use of nanotechnology in foodstuffs (including packaging and storage) and in cosmetics and health (including sunscreen products). Once again, Google was employed, using a variable set of relevant search terms (for nanotechnology or arena formats).

A number of discussions about nanofood were found in the category foodstuffs. Almost all of these focused on risk aspects and appeared to have increased considerably in number in recent times, presumably partly as a result of the activities of BfR.

In cosmetics, the term “nano” appears to be en vogue (as it is in vehicles). Large companies offer products whose name includes the word “nano”, and many smaller suppliers and service providers likewise take advantage of the term. One of the few examples found of a more extensive discussion in cosmetics, one which particularly addressed risks, was a long thread on sunscreen products.

As far as health and medicine are concerned, discussions were found not only about nanosilicon “wonder drugs” but also about possible harmful effects on health brought about by nanoparticles. A handful of forums were also found in which cancer sufferers and their families discussed clinical nanotherapies.

Overall, the selective search for forums or portals relating to particular product groups and industries produced only a small number of new forums. However, the finds complement the thematic spectrum of search results in that they allowed research of discussions of issues that had not appeared or had only appeared to a limited extent in the previous research steps.

## 3.4 Conclusion

The chosen research strategy resulted in a sufficient number of arenas with relevant posts to permit an in-depth content analysis (see table in annex). These cover a very wide spectrum of topics and product groups, thus reflecting the multifaceted character of nanotechnology as an interdisciplinary technology. It was not necessarily to be expected, however, that this diversity would be expressed and evident in the online communication. Conversely, this finding corroborates the assumption upon which the study is also based that online communication has become so widespread in society that it is relevant for an observation of risk communication and perception.

Despite this diversity, however, significant differences were found in the various topics (see table in annex): vehicle forums are by far the most numerous among the arenas and posts, especially those concerned with nanosealing for vehicle care (for the purposes of this assessment, forums are ignored that feature very extensive discussions of shares and of computer games with nanofuturistic elements whose contents have virtually no relevance to the study).

It should generally be remembered that the character of a website or forum or the topic of a thread say nothing in themselves about the contents and quality of the discussions: for example, serious posts that are interested in the current state of research and development can be found in forums that one would presume would focus only on futuristic prospects. Discussions can also be found in product forums in which wide-ranging aspects and risks of

nanotechnology are discussed. Risk aspects of nanoparticles are repeatedly raised in the vehicle forums, but also in forums about cosmetics and health, for example. In isolated cases, there are also general discussions of nanotechnology.

Although only a small number of chats were found, some of them were of interest from a risk perception point of view. By contrast, there was a surprising number of blogs with posts about nanotechnology, although only a few maintained a continuous discussion of these topics. Little use was also made of the comments function in the blogs that were found, to the extent that this could be ascertained by the research. A nano-discourse in the sense of a series of interrelated posts was only noted in isolated cases among the identified blogs. Overall, a large number of arenas exists, yet the discussions in them, to the extent this could be ascertained, are largely single-stranded.

The search results give the impression that discussions of nanotechnology have occurred in numerous places on the Internet and in a variety of thematic contexts in recent years. Conflicting interpretations of nanotechnology and perceptions of their risks are revealed in these discussions. The first impression gained when reviewing the discussion contents is that there is still great uncertainty about what this field of technology and research is all about and which risks it entails (including those associated with existing products). The question is, to what extent have images of nanotechnology already become firmly established in this new field of discourse and which facets do the risk discussions hitherto show.

## 4 Results of the content analysis

Before presenting and discussing the content analysis results relating to central questions to be addressed by the study, characteristics of the sample and a number of basic results will be initially outlined below.

### 4.1 Overview of the sample and basic results

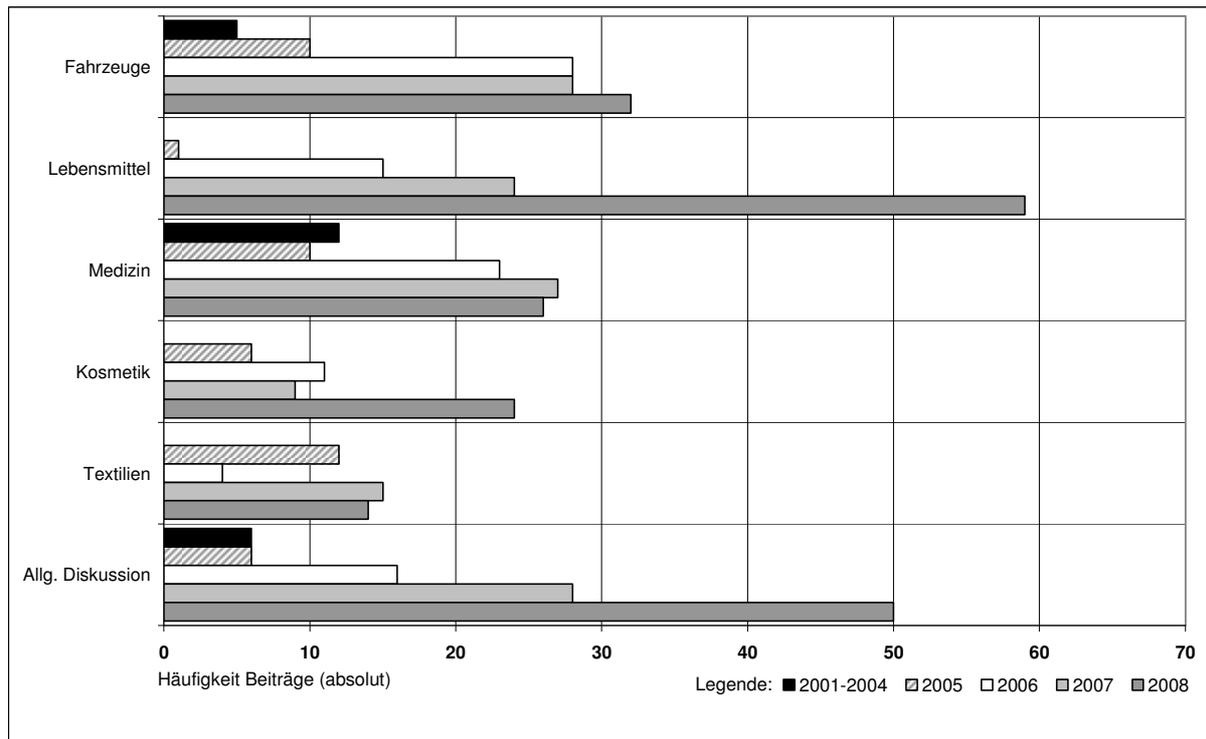
As explained above, the sample was selectively compiled in order to cover the consumer-relevant and (according to the underlying hypothesis) product-oriented subject areas of vehicles, foodstuffs, medicine, cosmetics and textiles. To gain a picture of nanotechnology in general in the online discourse, a sixth area, “general discussion”, was included. When it came to weighting these categories during selection of posts, representativeness was not the goal (and, as already explained, can also not be achieved in the case of online discourses). Instead, the aim was to find as many different positions on nanotechnology as possible and in each area to collect a sufficient number of posts to allow quantitative assessments to be carried out.

As far as the following overview of the sample and the analysis results are concerned, this means that any overall review of the sample must take into account the fact that the representation of the subject areas is in some cases greatly distorted in terms of their relative weighting when compared to the online discourse as a whole. On the basis of the research results (see Section 3 above), for example, it can be assumed that the vehicles category dominates the online discourse on nanotechnology, while it is discussed only comparatively rarely with respect to foodstuffs – the two categories are represented in the sample with 100 and 103 posts respectively. The overall review of the sample below is thus undertaken merely for descriptive purposes; the distortion in terms of weighting must always be taken into account.

#### 4.1.1 Distribution of posts by time of publication

The discourse analysis uncovers its subject – rather like an archaeological dig – in reverse chronological order (Foucault 1973). The posts about nanotechnology represented in the sample can therefore initially be charted chronologically, which gives an impression of the development of the online discourse (cf. Figure 3). It should be remembered that information on the Internet is often volatile. For example, even if posts dating back some considerable time are not deleted in many forums, the possibility cannot be ruled out that online discussion arenas in which discussions of nanotechnology took place have meanwhile been removed from the Internet; equally, it is possible that some posts have been deleted in forums or blogs that still exist. In addition, the algorithms of search engines like Google give preference to more recent websites, making them easier to find than older ones.

Despite these reservations, a review of the chronological listing of posts in the sample would lead one to presume that the growing importance of nanotechnology as a field of research and subject of public discussions, as noted since 2002/2003, is also reflected in German-language online discussions. This is supported by the fact that awareness of nanotechnology in the German public sphere (Zimmer et al. 2008b) has increased significantly since the middle of the decade. The relatively new nano applications (such as nanofood) have also resulted in additional online discussion contributions (albeit, until the end of 2008 at least, only in very small numbers, it would seem).

**Figure 3: Distribution of posts by category and time of publication**

Explanatory note: Number of posts in the sample that were assigned to the respective subject areas. The different colours reflect the distribution over time. For the figures relating to this figure, see Table 2.

**Table 2: Distribution of posts by application and category and time of publication**

Category	Posts collected	thereof published in ... <sup>10</sup>				
		2001-2004	2005	2006	2007	2008
Vehicles	103	5	10	28	28	32
Foodstuffs	100	0	1	15	24	59
Medicine	100	12	10	23	27	26
Cosmetics	50	0	6	11	9	24
Textiles	45	0	12	4	15	14
Gen. discussion	106	6	6	16	28	50
Total	504	23	45	97	131	205

In four of the six subject areas, an increase in the number of posts between 2001 and 2008 is evident. Only in the categories medicine and textiles were most posts published in 2007 – though it should be noted that the survey was conducted before the end of 2008. In these categories too, the number of identified posts later than 2005 is considerably higher than before 2005. Foodstuffs, cosmetics and general discussion in particular show a strong increase in 2008, the last year to be reviewed. Overall, over 95% of the examined posts were published between 2005 and 2008, and over 86% between 2006 and 2008.

<sup>10</sup> For three contributions in all, the time of publication could not be ascertained.

#### 4.1.2 Arenas and formats

The aim is to analyse the distribution of posts among forums and blogs – being the main formal categories – and the position of the posts within the discussion structure of the various arenas (within threads).

Nearly 80% of the posts in the sample are distributed among forums, while a good 20% are distributed among blogs. The latter play a role above all in the foodstuffs and general discussion categories (proportion of posts in blogs: 30% and 43% respectively). By contrast, posts in vehicles and textiles are to be found almost exclusively in forums (proportion of forum contributions: 100% and 96% respectively); medicine and cosmetics lie in between (proportion of forum contributions: 78% and 86% respectively).

In 70% of the cases, the posts are responses to existing posts rather than new thread starters. Their proportion is lowest in cosmetics (18%) and highest in medicine (41%). The number of answers generated by each of these thread starters fluctuates between zero and a maximum of 191 posts. The most responses on average were generated by thread starters in vehicle arenas (22.4 comments on average), while the fewest were registered in medicine (3.1 comments on average).

Finally, the distribution of posts by length should also be mentioned. The posts in the sample varied in length from a minimum of 36 and a maximum of 32,118 characters (equivalent to a shortish essay in a scientific journal). In this respect, there was no significant difference between the subject categories. The longest posts on average are to be found in arenas hosting general discussions (with an average of 1,493 characters), while the shortest are to be found in textiles (799 characters).

**Table 3: Distribution of posts by formal category**

Category	Posts collected	thereof ...				
		in forums (%)	in blogs (%)	thread starters (%)	responses (%)	Ø no. characters
Vehicles	103	100	0	20	80	1,105
Textiles	45	96	4	29	71	799
Cosmetics	50	86	14	18	82	1,077
Medicine	100	78	22	41	59	1,295
Foodstuffs	100	70	30	27	73	1,429
Gen. discussion	106	57	43	40	60	1,493
Total	504	79	21	30	70	1,258

Explanatory note: Rounded percentages; listed according to the number of posts in forums as a proportion of the total number of posts in the respective subject area.

#### 4.1.3 Speakers and objects

It was only possible to make statements about the speakers to a very limited extent because of the anonymous nature of the reviewed arenas; for this reason, only the speaker's gender was especially investigated, this being possible mainly on the basis of the chosen user name and/or from information provided by the speakers themselves. To further qualify the following results, it should be remembered that it is possible for participants in online discussions to choose a gender at will and that nearly half of the posts in all gave no indication of gender.

Bearing these limitations in mind, it is noticeable that male participants are significantly over-represented in online discussions. Nearly twice as many posts were assigned to this category as to recognisably female participants – an imbalance that representative studies of Internet use have also observed among forum users (though not among participants in blog discussions) (cf. ACTA 2008). The two gender groups are distributed within the individual

subject areas as follows: men are particularly over-represented in the vehicles category (which is dominated by discussions about cars), while women are over-represented in cosmetics (cf. Table 4).

**Table 4: Perceived gender of authors of posts**

Category	Posts collected	Perceived gender		
		female (%)	male (%)	not identifiable (%)
Cosmetics	50	54	8	38
Medicine	100	21	45	34
Gen. discussion	106	18	38	44
Foodstuffs	100	16	32	52
Textiles	45	13	40	47
Vehicles	103	6	36	58
Total	504	19	35	46

Explanatory note: Gender identities were coded on the basis of information given in the posts (nicknames, greeting type etc.); rounded percentages; listed according to the number of authors coded as "female" as a proportion of the total number of posts in the respective subject area.

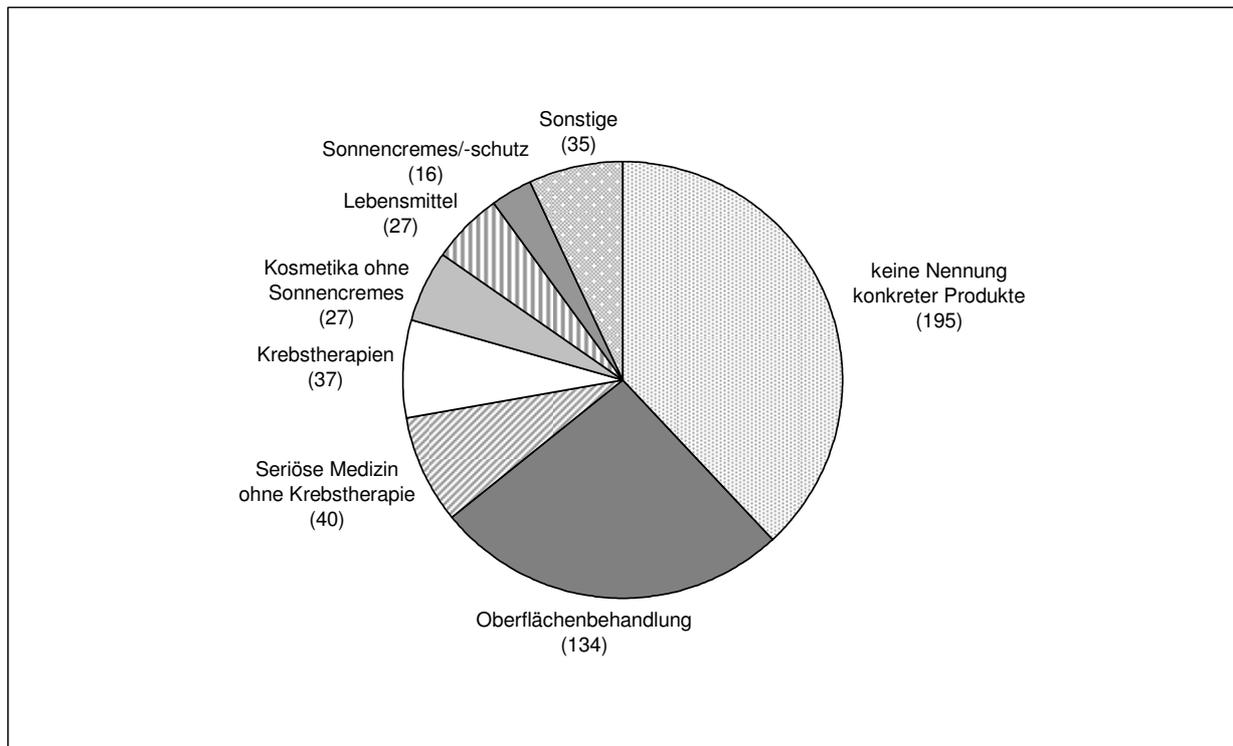
The reviewed online discussion contributions were also distinguished according to thematic range: the lowest range was assigned to posts that dealt with only one or several specific nanoproducts. Medium-range posts were those concerned with entire areas of application. Posts featuring a general discussion of nanotechnology were classed as having the widest range.

**Table 5: Thematic range of posts**

Category	Posts collected	Range of posts		
		Actual products (%)	Areas of application (%)	Nanotechnology in general (%)
Textiles	45	98	2	0
Vehicles	103	93	4	3
Cosmetics	50	76	24	0
Medicine	100	73	19	8
Foodstuffs	100	9	84	7
Gen. discussion	106	3	12	85
Total	504	52	26	21

Explanatory note: Posts were classified according to their widest range in each case; rounded percentages; listed according to the number of posts about actual products as a proportion of the total number of posts in the respective subject area.

In line with the decisions regarding sample selection, a high proportion of posts (more than 50%) can be found whose range is limited to actual products. Worthy of note here, however, is the fact that it is already evident that nanotechnology has actually become so normal in certain parts of society that more general questions concerning this new field of research and application are no longer raised in the majority of posts in discussions of individual nanoproducts.

**Figure 4: Mentions of actual products or applications**

Explanatory note: Distribution of mentions of actual nanoproducts according to product areas, stating the absolute frequency of mentions in posts (7 post in all with multiple mentions); among other things, mentions of nanotextiles and “wonder drugs”, nanofood packaging and fuel additives were included under “Other”.

In the categories textiles and vehicles, the discussions were strongly characterised by posts in which only actual products or processes are discussed. These account for 98% and 93% respectively of all posts there. In the discussions of nanotechnology in the medical and cosmetics categories too, the focus is very often exclusively on actual products (in at least roughly three quarters of all cases). By contrast, the posts dealing exclusively with actual products or processes in the foodstuffs and general discussion categories are noticeably in the minority.

If the posts with a wider thematic range are included, it can be seen that actual products are mentioned even more frequently in posts dealing with entire areas of application of nanotechnology. This is almost no longer the case, however, in posts in which nanotechnology is discussed on a general level. Overall, actual nanoproducts or processes are mentioned in over 60% of all reviewed posts (in 309 cases).

In this context, mentions of surface treatments lead the field, accounting for a good quarter of all posts. Of these, approximately three quarters concern vehicles. Mentions of applications in medicine come next, accounting for 15% of the total sample. Mentions of cosmetics, including sunscreen products, occur in a good 8% of all posts; this figure is approximately 6% for mentions of nanofood or nanofood packaging, with mentions of foodstuffs being very much in the majority.

Finally, the statements about nanotechnology were classified according to whether they describe experiences, express convictions or put forward opinions (beliefs) or whether they communicate knowledge or pose questions (the latter were then further classified according to whether they asked about experiences, convictions or knowledge).

**Table 6: Statement types and question types**

Category	Posts collected	Statement of post communicates ...			
		experiences (%)	convictions (%)	knowledge (%)	questions (%)
Vehicles	103	50	25	7	18
Textiles	45	49	18	4	29
Cosmetics	50	28	50	10	12
Medicine	100	17	44	19	20
Foodstuffs	100	4	87	5	4
Gen. discussion	106	3	67	15	15
Total	504	22	52	11	16

Explanatory note: Posts are classified preferably by experiences, then by convictions, then by knowledge and then by questions; rounded percentages; listed according to the number of experience-based posts as a proportion of the total number of posts in the respective subject area.

Using these criteria for the analysis reveals considerable differences between the individual subject areas. While approximately 22% of the posts in all report on the author's experiences of nanotechnology, the proportion in the categories of vehicles and textiles is roughly 50%. The proportion of experienced-based posts is comparatively high in cosmetics, too, yet only very few posts in the general discussion and foodstuffs categories are about experiences. Especially the discussion in the latter category is characterised particularly by opinions and convictions, followed by the general discussion in which two thirds and cosmetics in which half of the posts are based on convictions. Knowledge plays a role only in a comparatively small number of the posts (between 4% and 19% in the individual subject areas). It should be remembered, however, that the coders, in cases where several different classifications were possible, were instructed to code first by experiences, then by convictions, then by knowledge and then by questions. This means that even posts that were coded as experience-based may additionally communicate knowledge about nanotechnology. Finally, a total of 16% of the posts in the sample pose questions; the highest number of posts containing questions occurs in Textiles, while the lowest is in foodstuffs.

#### 4.1.4 Interim conclusion

This overview of basic characteristics of selected posts in the online discourse already shows that the study succeeded in surveying a wide bandwidth of the nanotechnology discussion. The posts in the six subject areas vary both with respect to their formal characteristics (time of publication, length, communication format, speaker) and with respect to their content (object, reference to knowledge). As far as further analyses are concerned, it should be noted that the distribution according to subject areas was undertaken on the basis of contents, and that an overall review of the sample might reveal distortions as compared to the real online discourse.

Initial results can already be noted on the basis of this overview. For example, nanotechnology in the online discourse is clearly becoming more important over time; a relatively large number of posts can be found in the last year under review (2008). A closer look reveals that the categories foodstuffs, general discussion and cosmetics are developing with particular dynamism.

Comparing the range and statement types of the posts on the one hand and the subject areas on the other leads one to conclude that the focus of the individual subject areas is fundamentally different in each case. While the discussion in the categories of vehicles, textiles, cosmetics and medicine is related more to actual products, posts in foodstuffs and general discussion tend to discuss nanotechnology in a more abstract way, not in terms of specific (and commercially available) products. An examination of the knowledge reference shows, however, that even the discussion of nanoproducts is conducted only in part on the basis of

actual experiences. As one would expect with a technology that is still at the development stage, the majority of reviewed posts are ones comprising opinions and convictions (beliefs).

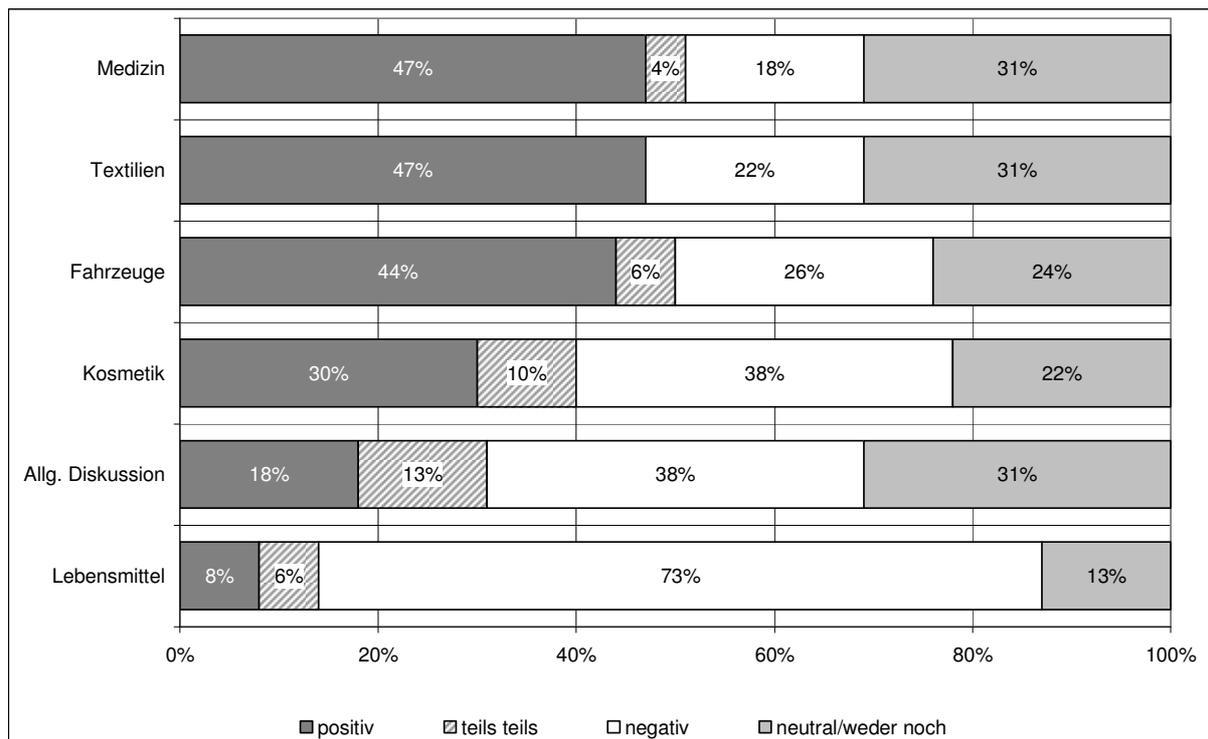
## 4.2 Assessing nanotechnology

Although the results of an analysis of online discussions can by no means be seen as equivalent to the results of representative surveys of the population, it is nonetheless of particular interest how the participants in the online discussions assess nanotechnology and its individual aspects and products. The main results relating to this set of issues are to be presented below.

### 4.2.1 General assessment of nanotechnology

In order to ascertain how nanotechnology is generally assessed, the posts were coded according to how the speakers assess the respective subject overall. Although the posts deal with different subjects, a general assessment of nanotechnology is always expressed in the verdicts; this is to be examined in this section (see Section 4.2.2 below for details of how the posts are classified according to different subjects). Significant differences are to be found in the individual subject areas (see Figure 5). The most posts containing a positive assessment of nanotechnology are to be found in the categories of medicine, textiles and vehicles, each with just under 50%. By contrast, between 18 and 26% contain negative assessments. The share of neutral assessments, or assessments that cannot be identified, is between 24 and 31%.

In the remaining three categories, there are more posts with a negative assessment than with a positive assessment. While the ratio of positive to negative assessments is comparatively balanced in cosmetics, at 30% to 38%, the authors in the general discussion category (18 to 38%) and, especially, in foodstuffs (8 to 73%) express clear opposition to nanotechnology and related products. In the latter category, the posts are also most polarised; the proportion of posts containing neutral or non-identifiable assessments here is a mere 13%. Cosmetics and general discussion, on the other hand, contain 22 and 31% of such posts respectively. Finally, analysing posts with a balanced assessment ("partly positive, partly negative") reveals proportions in excess of 10% only in cosmetics and general discussion, while in the other categories no more than 6% of all posts cannot make up their minds clearly between the pros and cons.

**Figure 5: Assessment of nanotechnology and its products in the different categories**

Explanatory note: Coding was carried out on the basis of how the speakers assess the subject of the post's statement overall. Rounded percentages; listed according to the ratio of posts containing a positive and negative assessment in the respective subject area.

Viewed overall, these results point to a variety of perceptions of nanotechnology among active users of online forums and blogs. This ranges from a predominantly positive assessment in the categories of textiles, vehicles and medicine via a more or less neutral assessment in cosmetics to a mainly or unequivocally negative assessment in the general discussion and foodstuffs categories. In comparison to existing population surveys, the assessment as a whole is more negative. In the most recent representative survey of the German population, for example, 77% of respondents expressed a generally very good or good feeling about nanotechnology, while 22% claimed they had a bad or very bad feeling about the technology (cf. Zimmer et al. 2008b, p. 22). Even in those areas with the most positive assessments (and even if one takes into account only those posts containing an identifiable assessment), the perception of nanotechnology in online discussions does not achieve such positive levels. Another striking finding is that around a quarter of the posts in all contain neither a positive nor a negative assessment of nanotechnology. This could be attributable to the as yet low level of knowledge of the speakers, or could point to a technology that is already established and that does not require any discussion of its pros and cons.

Above and beyond these general conclusions, two questions would appear to be of interest: first, the assessment may relate to quite different subjects, depending on the range of the post (nanotechnology in general, areas of application, actual products), so the area or product the assessment refers to would need to be investigated in each case. Second, a glance at Table 6 reveals that the assessment is more positive in areas in which products are already on the market (textiles, vehicles) or are named in sufficiently concrete terms (cancer treatment in medicine). In contrast, the discussion in the other areas, which is mainly characterised by negative assessments, either does not relate primarily to products (general discussion) or relates to products that are not yet ready for application (foodstuffs); in this context, cosmetics lies somewhere in between the two. To this extent, it appears particularly

interesting to examine more closely the relationship between actual experiences with nanotechnology and/or nanoproducts and the way they are assessed.

#### 4.2.2 Assessment by statement range and product reference

When analysing the posts according to the range of their central statements it is important to remember that the different subject areas address issues typical of that particular area (see Section 4.1.3 above). A distinction can be made between roughly four thematic groups: discussions relating to vehicles and textiles are primarily concerned with actual products; cosmetics and medicine additionally deal with areas of application; applications are the main focus in foodstuffs, while the general discussion addresses nanotechnology as a whole.

The assessment of nanotechnology is most negative when it is a question of applications for nanotechnology (cf. Table 7). This category was coded whenever nanotechnology was mentioned in the context of an actual area of application (such as foodstuffs, textiles or cancer therapy), but not in cases which focused on nanotechnology in general or on actual products or processes (e.g. including individual forms of treatment). There are hardly any posts from the areas of vehicles and textiles here; the majority of posts is from the area of foodstuffs, where 56% of posts contain a negative assessment, 17% a positive assessment, 7% are partly positive and partly negative and a further 20% do not contain any clear assessment.

The assessment in posts that deal with nanotechnology in general – that is to say irrespective of actual applications or products – is likewise predominantly negative. In these posts, 83% of which can be attributed to the general discussion category, nanotechnology is assessed negatively in 42% of cases and positively in 16% of cases, while 15% contain a partly positive and partly negative assessment. The proportion of posts without any assessment is 28%.

By contrast, a considerably more positive assessment can be found in posts about actual products. 44% of these posts assess nanotechnology positively, 4% are partly positive/partly negative, and 26% are negative; the proportion of neutral posts and those without any assessment is 27%. To this extent, consumers who express an opinion about actual nanotechnology products or processes tend to reflect a more positive picture of nanotechnology than others contributing to the online discourse. All the same, the proportion of negative assessments is still over a quarter in this group too.

The group of posts that focus on actual nanotechnology products or applications will be analysed in more detail below with respect to the assessments they contain. While the individual products can essentially be assigned to the various subject areas to produce merely a more nuanced picture, this type of differentiation allows the assessments of different products in the online discourse to be compared to those in representative population surveys.

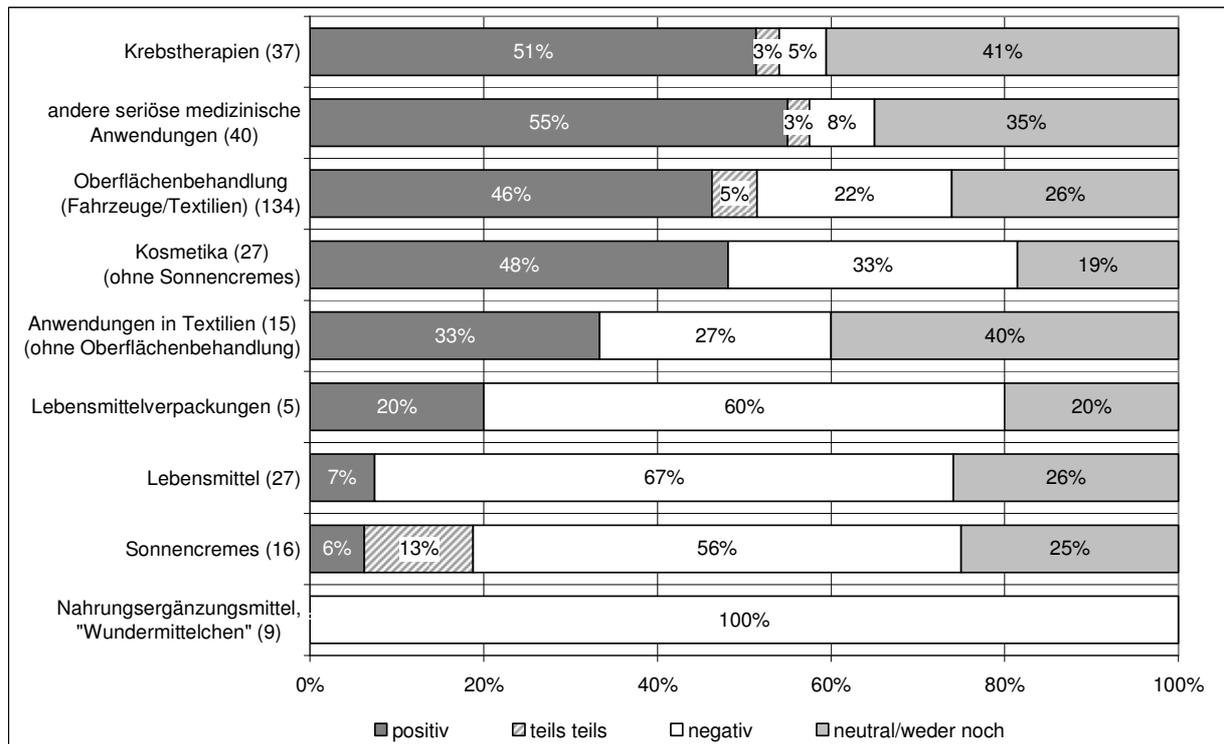
**Table 7: Assessments by range of the posts**

Range	Posts collected	Assessment of nanotechnology ...			
		positive (%)	negative (%)	partly pos/partly neg (%)	neutral/neither pos nor neg (%)
Actual products	263	44	26	4	27
... are discussed, above all, in the categories vehicles, medicine, cosmetics and textiles. The assessment in vehicles, medicine and textiles corresponds roughly to the overall assessment, but is more positive in cosmetics.					
Areas of application	133	17	56	7	20
In addition to the foodstuffs category (in which 63% of posts discuss applications), nanotechnology applications are also raised in medicine, cosmetics and general discussion. The assessment in foodstuffs is somewhat more negative than in foodstuffs in general but less negative in medicine, though there is a relatively large number of neutral posts here. In cosmetics there are considerably more negative and partly positive/partly negative posts than in posts with a different range; by contrast, the general discussion is significantly more positive in this range.					
Nanotechnology in general	108	16	42	15	28
... is raised almost exclusively in the category general discussion, where the picture that is painted is even slightly more negative than in general discussion as a whole.					
Total	504	31	37	7	25

Explanatory note: Rounded percentages; listed according to the number of experience-based posts as a proportion of the total number of posts in the respective category; the basis for comparisons in the individual categories is the proportion of posts with the respective assessment in the category as a whole (cf. Figure 3).

To this end, nine groups of products specifically mentioned in the online discourse (see Figure 6) are compared with those product groups that were assessed in the 2007 survey of the German population (see Zimmer et al. 2008b, p. 17). Although an online discourse analysis and a population survey can only be compared to a limited extent – because the former makes statements on the post level and the latter on the level of individual opinions – the assessments of products can nonetheless be compared. It must be noted, however, that representativeness can be claimed only in the case of the population survey. Furthermore, concrete purposes were associated in the population survey with the use of nanotechnology in products (e.g. “prevention of unpleasant odours in textiles”), whereas the assessments in the online discourse may relate to quite different perceptions of the application in actual products.

The assessments in the online discourse initially correspond to the already analysed distribution across the subject areas: applications in medicine, the surface treatment of vehicles and the treatment of textiles in general tend to be assessed positively, while the use of nanotechnology in foodstuffs tends to be more negative. The different views of cosmetic products in particular are revealing: in this area, a more negative verdict is given only for sunscreen products, whereas cosmetic nanoproducts are positively assessed in the majority of cases. A further distinction can be made in the area of foodstuffs, where applications in packaging are more positively assessed than ones in the foodstuffs themselves. By contrast, nanotechnology applications in dietary supplements or other products with allegedly healing properties receive a more negative assessment – although it should be noted that due to the character of the posts scepticism towards nanotechnology in general cannot be examined separately from scepticism towards the products.

**Figure 6: Assessment of different nanoproducts and applications**

Explanatory note: The graph shows the assessments in posts dealing with actual products (N=316 mentions of products in 309 posts); dietary supplements were not counted as foodstuffs if the authors of the posts did not portray them as foodstuffs but as a product group in their own right; figures given in brackets indicate the number of posts containing mentions of the corresponding product category (categories with fewer than five posts were disregarded); rounded percentages; listed according to the ratio of positive to negative assessments.

Comparing the assessments of different product groups in the online discourse with the assessments in the population survey conducted by BfR (Zimmer et al. 2008b) reveals broad correspondence in the way products are ranked according to their assessment. In both studies, applications for the surface treatment of vehicles and textiles receive the most positive assessments (in the area of medicine, the population survey asked only about applications designed to promote the recovery of tooth enamel, which could also be classified as cosmetic applications). Likewise, the assessments of applications in foodstuffs are fairly negative in both studies, while food packagings are regarded as more acceptable.

Two deviations between the studies can also be noted. For one thing, the level of approval in the population survey is generally higher than in the online discourse if one compares, for example, the purely positive and the purely negative mentions (cf. Table. 8). Deviations from this observation can be explained by the fact that the population survey often asked about special application possibilities in such cases (e.g. about the "recovery of weakened tooth enamel" rather than about medical applications in general, or about "improved skin cleansing and disinfection in soaps and creams" rather than about cosmetics in general). To this extent, the perception of nanotechnology in the online discourse proves also to be more negative than the representatively surveyed perception among the population when actual products are the subject. Given that more of the online discourse participants have their own experiences of nanoproducts than is the case among the average population, this finding is remarkable.

For another thing, the assessments relating to food packagings and sunscreen products are fundamentally different. Both product categories are assessed more negatively in the online discourse than in the population survey. Disregarding the methodological differences between the studies, which could have a bearing on the results, it is worth noting that the re-

sults for food packagings are based on a small number of cases and, furthermore, that four of the five posts simultaneously discussed application of nanotechnology in foodstuffs, making it impossible to clearly separate the assessments. In the case of sunscreen products, on the other hand, perceptions appear to vary considerably; one explanation for this may be that the online discussion of this product group is still very recent – nine of the 16 posts in all were only written in 2008, and the earliest post dates back to September 2006.

**Table 8: Comparing the results of online discourse analysis and population survey with respect to the assessment of nanoproducts**

Product category	Ratio of pos. to neg. assessments		Notes
	Online discourse	Population survey	
Cancer therapies	90 : 10		<i>(not asked)</i>
Other serious medical applications	88 : 12	87 : 13	<i>(recovery of tooth enamel)</i>
Surface treatment	67 : 33	93 : 7 91 : 9	<i>(in paints and varnishes)</i> <i>(in textiles)</i>
Cosmetics (excl. sunscreen products)	59 : 41	51 : 49	<i>(for skin cleansing and disinfection)</i>
Other applications in textiles	56 : 44	76 : 24	<i>(prevention of unpleasant odours)</i>
Food packagings	25 : 75	81 : 19 64 : 36	<i>(detection of spoilt goods)</i> <i>(improvement of foil quality)</i>
Foodstuffs	10 : 90	25 : 75 10 : 90	<i>(prevention of lumps)</i> <i>(keep looking good for longer)</i>
Sunscreen products	10 : 90	78 : 22	<i>(increasing efficiency)</i>
Dietary supplements	0 : 100		<i>(not asked)</i>

Explanatory note: The ratio of positive to negative assessments is stated in each case; the "Online discourse" column compares the numbers of posts containing positive and negative assessments for the product category in question; the "Population survey" column shows the numbers of respondents who "completely approve of" and "completely reject" the applications in question; for the exact wording of the question in the population survey categories, see Zimmer et al. 2008b, p. 84; rounded percentages; the basis is the total number of positive or negative assessments – ignoring moderate or neutral statements – in order to make the two studies comparable.

#### 4.2.3 Assessment by statement types

Before examining the perception of nanotechnology over time, it should first be checked to what extent the assessments in the online discourse are genuinely experienced-based or whether they draw more on general knowledge or elements of belief. To this end, the following section refers to the dimension of the statement type in which coding was carried out according to whether experiences, knowledge, beliefs or ignorance (or non-knowledge, in the form of questions) were communicated in a particular post.

As far as the discussion relating to individual nanoproducts is concerned, the first thing that is relevant is what statement types the assessments of products are associated with (see Table 9). This shows that product-based statements, while in the majority, are ultimately based on experiences in only 39% of cases. Equally well-represented are opinion-based posts about actual products (30%); these are followed by questions (21%) and posts expressing knowledge (9%). Almost all (92%) experience-based posts relate to actual products; opinion-based posts are clearly in the majority in posts about applications and in posts about nanotechnology in general (79 and 70% respectively).

**Table 9: Range of posts in conjunction with statement types**

Range	Posts collected	Statement of post communicates ...			
		experiences (%)	convictions (%)	knowledge (%)	questions (%)
Actual products	263	39	30	9	21
Applications	133	2	79	12	7
Nanotechnology in general	108	5	70	13	12
Total	504	22	5	11	16

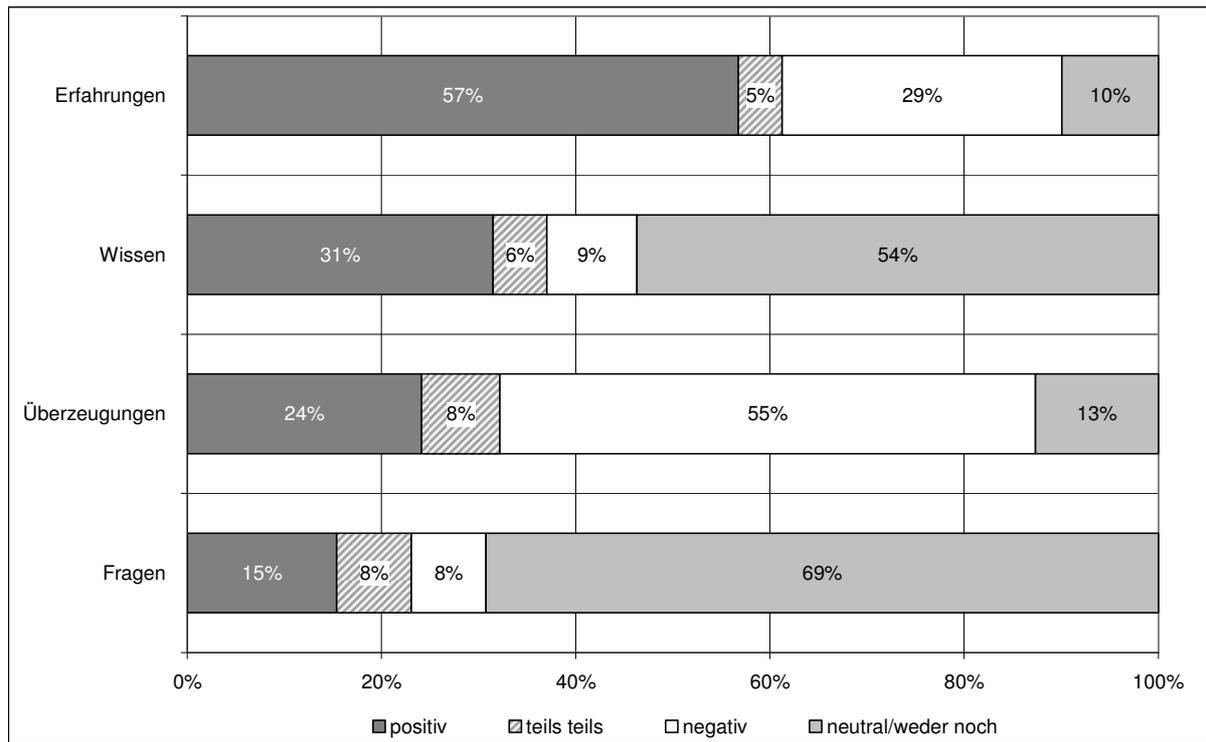
Explanatory note: Posts are classified preferably by experiences, then by convictions, then by knowledge and then by questions; rounded percentages.

The assessment of nanotechnology in experienced-based posts is predominantly positive (see Figure 7); in posts expressing knowledge or ignorance, the positive assessments are also in the majority. When a post communicates opinions or convictions, on the other hand, nanotechnology tends to be assessed more negatively. By contrast, a balanced assessment can only be found in a small proportion of posts (between 5 and 8%), regardless of the statement type. It is also striking that a particularly large number of the knowledge-based posts and questions refrain from giving a clear assessment, while this proportion among the other statement types is around 10%.

These results might indicate that experiences with nanoproductions or knowledge about nanotechnology can contribute to a positive perception of nanotechnology. However, apart from a general caution regarding causal conclusions drawn on the basis of correlations, it should be remembered that online discourse is characterised overall by greater knowledge about and/or more experience of nanotechnology and its products yet offers a more negative perception than representative population surveys would lead one to expect – despite consideration being given to the differences in perception between individual applications.

Furthermore, the correlation between experiences and positive perception is less clear in the individual subject areas as it may appear overall (cf. Table 10; the categories of foodstuffs and general discussion are ignored here because only very few experience-based posts can be found in these areas). In the vehicles category, for example, the proportion of positive assessments in experience-based posts is above the average for this category, yet the same is true – albeit to a lesser extent – of the negative assessments. The same finding is even more noticeable in the textiles category. While the proportion of posts with no clear assessment is lower among the experience-based posts, positive and negative assessments are more strongly represented accordingly, to roughly the same extent.

In the area of medicine, the proportion of negative assessments among experience-based posts corresponds to the average in this category, yet the proportion of positive assessments is lower than the average. Clearly, experiences of medical applications of nanotechnology are not suited to painting a positive picture of nanotechnology, although it should be added that the majority of applications discussed in the medical domain are still at the trial stage. Only in the cosmetics category are the proportions of positive posts among experience-based posts higher and the proportion of negative posts lower than the average for this category.

**Figure 7: Assessment of nanotechnology by statement type**

Explanatory note: For posts with different statement types, the proportion of posts with positive, negative, neutral or "partly positive/partly negative" assessment are stated in each case; rounded percentages; listed according to the proportion of positive assessments.

**Table 10: Assessment of nanotechnology by statement types in selected categories**

Category/ statement type	Posts collected	Assessment of nanotechnology ...			
		positive (%)	negative (%)	partly pos/partly neg (%)	neutral/neither pos nor neg (%)
<b>Vehicles</b>					
Experience-based	51	65	28	4	4
Total	103	44	26	6	24
<b>Medicine</b>					
Experience-based	17	41	18	12	29
Total	100	47	18	4	31
<b>Cosmetics</b>					
Experience-based	14	64	29	0	7
Total	50	30	38	10	22
<b>Textiles</b>					
Experience-based	22	55	32	0	14
Total	45	47	22	0	31

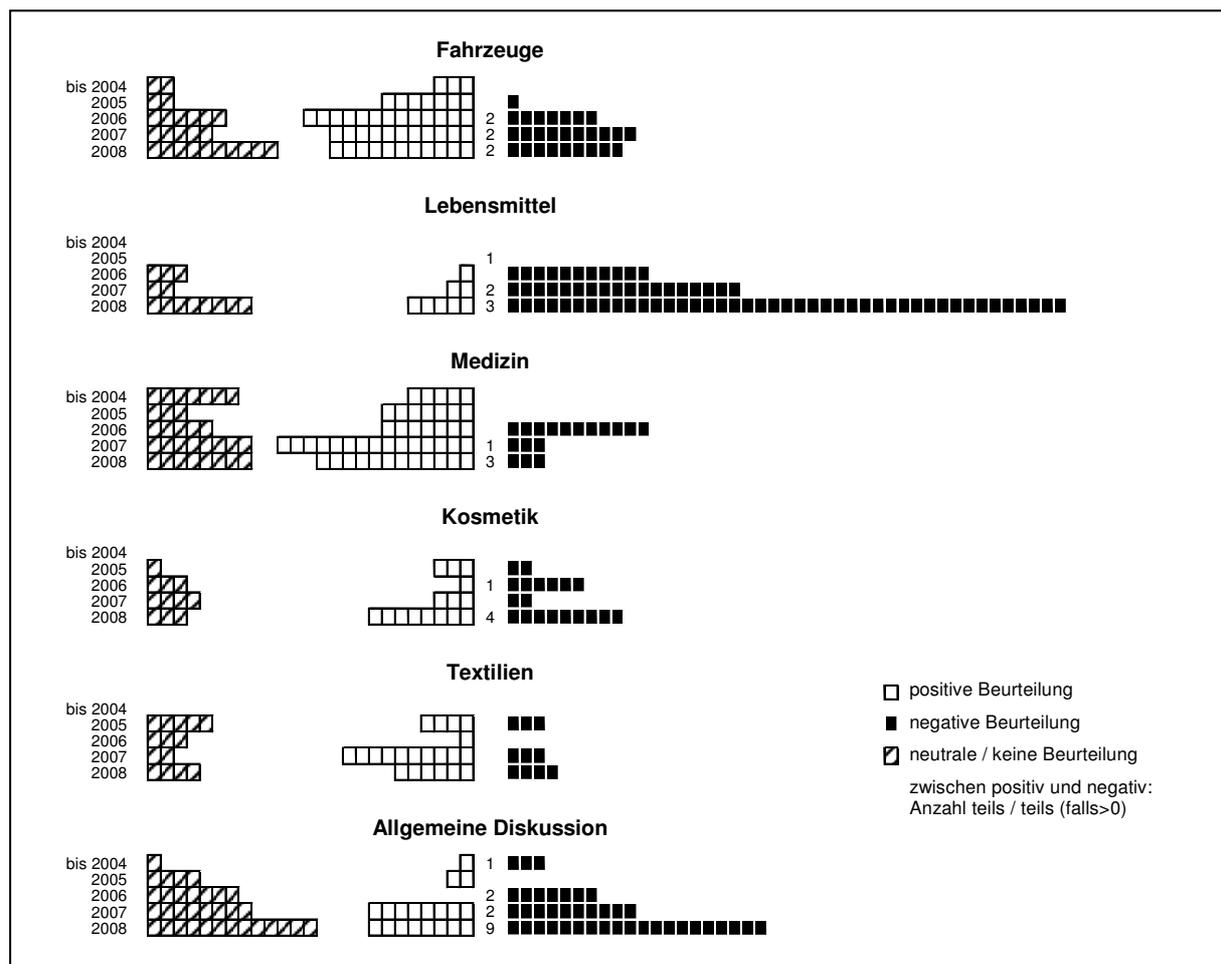
Explanatory note: The distribution of assessments among the experience-based posts of a category is compared in each case to the distribution among all the posts of a category; rounded percentages; the categories of foodstuffs and general discussion are not included because they contain only 4 and 3 experience-based posts respectively.

### 4.2.4 Assessment over time

The sample overview and results so far have already made it clear that the time when the posts were published plays a role. Given the development of nanotechnology it is not surprising that its perception in online discourse also changes over time. The assessment of nanotechnology in the posts is thus to be examined over the course of time (see Figure 8). This analysis will once again distinguish between the categories in order to avoid a distorted picture due to the sample composition.

Let us initially examine those posts that indicate no clear assessment (hatched grey on the left-hand side of the graph) or a partly positive, partly negative assessment (numerical values in the middle column of the graph). If their proportion of the posts in the respective time period and subject area is low, this is indicative of a more polarised debate. If their proportion is high, the opinions are less clearly divided according to those for and those against nanotechnology. Although the number of posts without any clearly positive or negative assessment appears to increase in the categories of vehicles, foodstuffs and general discussion, this impression is not confirmed if the general rise in post numbers in these categories is taken into account. Only in the areas of foodstuffs and textiles can a slightly below-average proportion of posts without a clear assessment be noted in the last two years, pointing to a slight polarisation of the discussion in these areas.

Figure 8: Assessment of nanotechnology over time, grouped by category



Explanatory note: The graph shows the absolute frequencies of posts with the respective assessment of nanotechnology. Each box represents one post. Posts with a neutral assessment or with no clear assessment are shown separately to the left. The incidence of posts with a mixed assessment (partly positive / partly negative) is stated as a numerical value between the posts with positive and negative assessments. For each category, the period of time covered is 2001–2004 as the time of publication of posts in the first line, while in the following four lines the years 2005 to 2008 are covered.

By contrast, the distribution between positive and negative assessments can provide an insight into the relative shifts in the perception of nanotechnology in the different subject areas. It may therefore be possible to fine-tune the results already presented above (see Section 4.2.1). In three of the six subject areas, however, hardly any changes with respect to the assessment of nanotechnology are evident (once again taking into account the changes in the subject areas as a whole).

In the foodstuffs category, the assessment has remained fairly negative for years, while in medicine a predominantly positive assessment has been maintained. Only in 2006 is there a surprisingly large number of negative assessments: of these eleven posts, however, seven come from one and the same forum and are clearly part of a campaign against alleged charlatanism in medicine, to which the authors also count various nano-applications (nanosilicon, nanoparticle analyses). In the cosmetics category, positive and negative assessments are more or less equally balanced from 2005 to 2008, with a slight predominance of negative assessments. Here too, 2006 is an exception, with an above-average number of negative posts. This may have been the result of increased media reporting of nanotechnology in cosmetics (by the German magazine *Ökotest* in particular). While the reporting was not negative in character, it clearly sensitised consumers to possible risks of nanotechnology.

No clear trend is recognisable in the textiles and general discussion categories. The respective proportions of positive and negative assessments deviate – sometimes more, sometimes less – from the generally rather positive assessment (textiles) or rather negative assessment (general discussion). It is noticeable in both cases nonetheless that the negative assessments in 2008 slightly predominated as compared to the years before.

There is also an above-average incidence in 2008 of more negative assessments in the category of vehicles. This is no special case, however, but points to a tendency towards increasingly negative perceptions of nanotechnology in the area of vehicles that continues over the entire period under review. From 2005 on, the proportion of more positive assessments declines (from 70% to 34%); posts with a more negative assessment cannot be found at all in the years 2001 to 2004, yet are disproportionately represented from 2007 onwards.

**Table 11: Assessments over time across all subject areas**

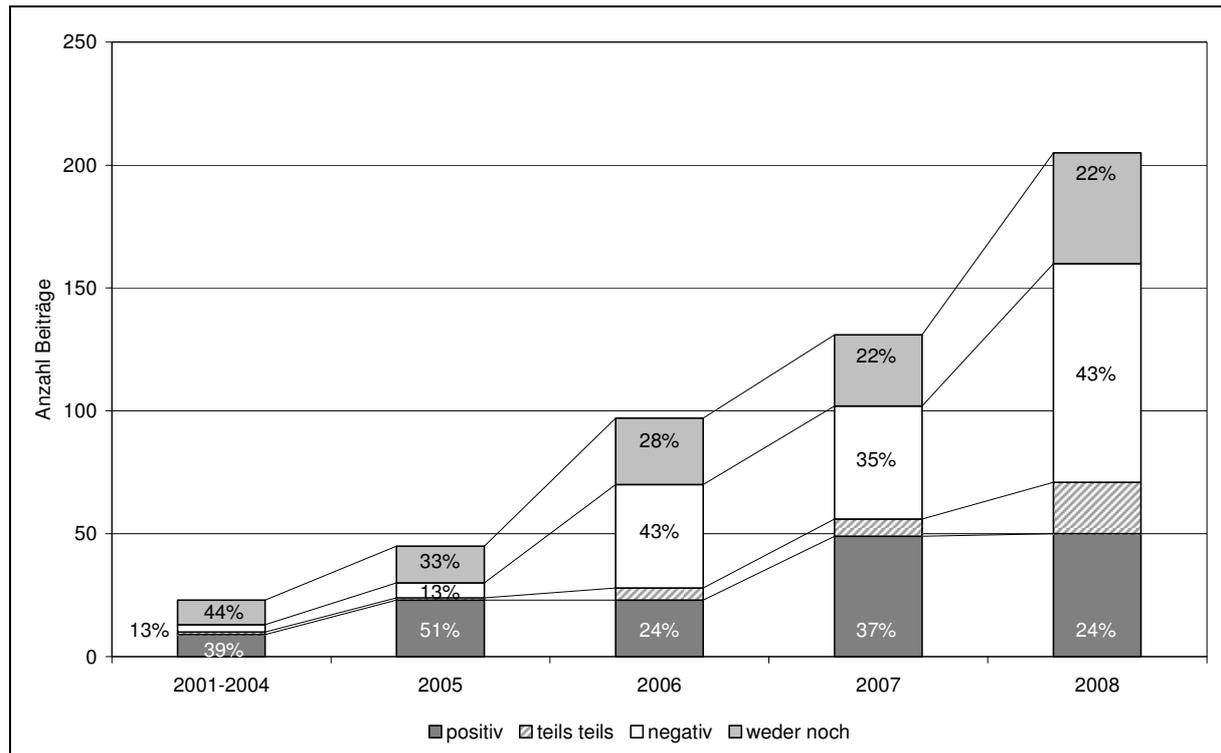
Period	Posts collected	Assessment of nanotechnology ...			
		positive (%)	negative (%)	partly pos/partly neg (%)	neutral/neither pos nor neg (%)
2001-2004	23	39	13	4	44
2005	45	51	13	2	33
2006	97	24	43	5	28
2007	131	37	35	5	22
2008	205	24	43	10	22
Total	501	31	37	7	25

Explanatory note: Rounded percentages; three posts were excluded from the analysis because their date of publication could not be ascertained; the overview does not take any distortions into account that may be caused by arranging the sample by subject areas.

Overall, it is noticeable that the posts from the early years of the period under review (up to and including 2005) assess nanotechnology more positively than in the years 2006 to 2008. Above all the years 2006 and 2008 are particularly negative in some subject areas, with

more negative than positive assessments to be found in the sample in these years. Based on the respective average values, the proportions of positive assessments in the years 2001 to 2005 and 2007 are below average, while there is an above-average incidence of negative assessments in 2006 and 2008 (see Table 11). What is more, the relative proportion of posts with no clear assessment appears, when viewed globally, to decline. Differentiation of the posts according to subject area has shown, however, that this is only sometimes the case and cannot be regarded as an indication of increased polarisation of the discussion as a whole.

**Figure 9: Assessments over time across all subject areas**



Explanatory note: Chart showing the assessment of nanotechnology over time in the surveyed posts; cf. explanatory note for Table 11.

In 2006, cases of poisoning caused by a household hygiene product named “Magic Nano” caused a debate to flare up – apparently more intensely in the USA than in Germany, despite the cases having actually occurred in the latter – that also had an impact on the reviewed online discussions (see also Zimmer et al. 2008b and the information about the activities of BfR in this context). Following first media reports on 29 March 2006 of health problems in connection with “Magic Nano” spray, the rapidly ensuing online discussions that were found initially concentrated solely on risks posed by “chemicals” in general. This was evidence once again of how quickly the discursive Internet public sphere reacts to mass media reporting of risk issues. It was only in mid June 2006 that nanotechnology moved into the spotlight of online discussions, however; after this point, right up to 2008, sporadic references to “Magic Nano” can be found in the discussions of the risks of nanotechnology. Of the 16 more closely investigated online discussion contributions about “Magic Nano” in all, half contain negative assessments of nanotechnology, no posts with a positive assessment can be found – not even more recently – and ten of the 16 posts focus primarily on harm and risks.

#### 4.2.5 Interim conclusion

A study of the assessments of nanotechnology can provide an initial impression of how nanotechnology is perceived in online discourse, much in the same way as population surveys ask respondents about how they feel about nanotechnology in general. To summarise, the following can be noted with due caution:

- The assessment of nanotechnology in the mainly product-based categories of vehicles, textiles and medicine is predominantly positive and predominantly negative in the foodstuffs and general discussion categories, which are less concerned with specific products. In cosmetics the assessment is largely negative where sunscreen products are concerned, but largely positive when it comes to other products.
- Overall, the assessment is more negative than in current population surveys in Germany; this is also true within the individual product groups that are the subject of discussion in online discourse.
- No less than a quarter of the reviewed posts do not reveal any clear assessment. This proportion is less among those posts that are based on opinions or experiences. There is no evidence, however, to indicate that experiences result in a positive assessment; they merely correlate with a more decisive assessment that may be positive or negative.
- No clear trends are evident over time. Yet, the discussion in recent years has broadened to include, above all, posts in the categories of general discussion, foodstuffs and cosmetics, in which a mainly negative perception of nanotechnology prevails. The current development appears insufficiently uniform, however, to permit any statements to be made about the future development of discourse; only additional studies (e.g. a follow-up study) will be able to give a clearer prediction of this.

As far as the more negative assessment of nanotechnology in online discourse as compared to the state of research is concerned, it should be pointed out by way of qualification that the communication form of the interactive discussion can also play a role in this (entirely independently of the medium, incidentally). It can be assumed, for example, that people who perceive nanotechnology as being completely unproblematic are, as a rule, less motivated to spend time on a discussion than people who are worried about this new field of technology or are not satisfied with individual products (for more on this subject, cf. Ha 2002). Because the latter group are potential opinion-makers and multipliers, however, this finding needs to be taken into account.

Consideration must also be given to the unequal representation of the categories in the sample as compared to the results of the research into the nano Internet public sphere. Whereas several hundred posts can be found for the category of vehicles, for example, it was hard to find 100 posts in foodstuffs, and not even 50 could be found in textiles. If one also considers that the number of positive assessments would have been even higher had the study included nanoproducts in the field of information and communication technology, a more technophile area with a more optimistic view of progress, it becomes clear that the total numbers relating to a general appraisal of nanotechnology cannot be interpreted as statements applying to overall online discourse: without the differentiated weighting according to applications, the large number of posts found in the vehicles category alone would have tipped the scales noticeably in favour of the positive posts.

For two reasons, however, the quantitative results of the content analysis that was conducted according to areas of application should be taken seriously: first, the incidence of more negative assessments (with at least roughly a fifth of all posts in each case) is also not insignificant in the much-discussed applications; in the general discussion of nanotechnology that goes beyond discussions of specific issues, they are considerably more numerous than the positive posts. Second, the differentiated weighting was able to show that there is a consid-

erable degree of scepticism noticeable in two emerging and as yet small specialised discussions of specific applications (cosmetics – sunscreen products in particular – and foodstuffs).

### 4.3 Opportunities and risks of nanotechnology and perceived benefits

Besides the overall assessment of nanotechnology, the present study is interested above all in how the opportunities and risks, and indeed the benefit or harm of nanotechnology are perceived in online discourse. As already explained, the two dimensions were plotted by means of an instrument in the style of a contingency table (see Figure 2 above). The benefit dimension covers concrete and current experiences and expectations (both positive and negative), while the risk dimension covers abstract hopes and fears to be realised in the future.

#### 4.3.1 General perception of opportunities, risks, benefits and harm

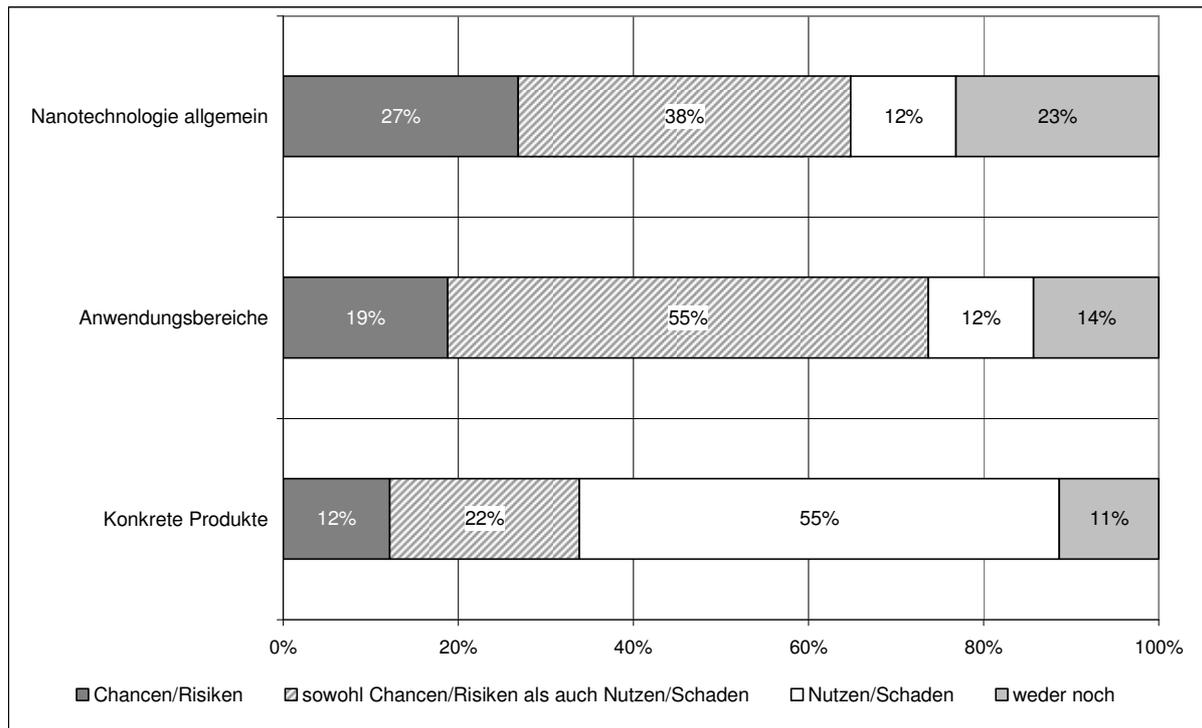
If one looks at the entirety of the reviewed online discussion contributions, it is noticeable that merely around half of the posts discuss opportunities or risks of nanotechnology in the first place: by contrast, more than two thirds of the posts discuss benefits or harm in connection with nanotechnology (see Table 12). A greater focus on opportunities and risks can be found in the categories of medicine, general discussion and foodstuffs, while the areas of vehicles and textiles are characterised by mainly benefits-related posts; cosmetics takes a middle of the road position, though the perceptions of benefits/harm are clearly in the majority. It is also interesting that more than a quarter of the posts in the general discussion do not deal at all with opportunities, risks, benefits or harm of nanotechnology. Obviously, the discussion pursued here is to a not insignificant extent non-judgemental; this is much less important in the other categories.

**Table 12: Perceived opportunities and risks, benefits and harm**

Category	Posts collected	Nanotechnology is associated with ...			
		opportunities/risks (%)	benefits/harm (%)	both (%)	neither (%)
Medicine	100	27	19	46	8
Gen. discussion	106	23	14	38	25
Foodstuffs	100	22	10	55	13
Cosmetics	50	16	38	30	16
Textiles	45	9	62	13	16
Vehicles	103	1	80	9	11
Total	504	17	34	34	15

Explanatory note: Proportion of posts in the respective category that relate nanotechnology solely to opportunities and/or risks, benefits and/or harm, both opportunities and benefits or neither of the two; categories 6 and 7 from were combined for the column "opportunities/risks"; categories 4 and 5 for the column "benefits/harm", categories 1, 2 and 3 for the column "both" and category 8 for the column "neither"; rounded percentages; listed according to the proportion of posts which associate nanotechnology with opportunities/risks.

These results show that one can distinguish within the online discourse between an opportunities/risks discourse and a benefits/no benefits discourse, which furthermore are clearly distributed over different subject areas. It seems reasonable to presume that this has to do with the differing proportions of product-based posts in the individual categories. The proportion of perceived benefits and/or harm is by far the highest in posts dealing with actual products (see Figure 10).

**Figure 10: Perceived opportunities/risks and benefits/harm by range of posts**

Explanatory note: The values are calculated in the same way as in Table 12; rounded percentages; listed according to the proportion of posts that associate nanotechnology with opportunities/risks.

Opportunities and risks play only a subordinate role here and are mentioned in 34% of the posts. When it is a question of entire applications, on the other hand, or when nanotechnology is discussed in general, opportunities or risks of nanotechnology are mentioned particularly frequently (in 74 and 65% of the posts respectively). References to the benefits dimension are to be found most rarely in posts about nanotechnology in general, though even here they can be found in 50% of the posts. The highest proportion of posts that refer neither to the opportunities nor to the benefits can be found among posts that discuss nanotechnology in general (at 23%).

#### 4.3.2 Perceived opportunities and risks

By looking more closely at the perceived opportunities and risks, it is possible to further differentiate the opportunities/risks discourse that is pursued, above all, in the areas general discussion, medicine, foodstuffs and cosmetics (cf. Table 13). Only in the area of medicine are opportunities ascribed to nanotechnology in a majority of posts, while risks are the dominant aspect in the other areas. The areas of medicine and foodstuffs are more or less the exact mirror opposites of one another as far as their proportions of posts that ascribe opportunities or risks to nanotechnology are concerned. The categories of general discussion and cosmetics can both be characterised as more risk-centred. However, only between 56 and 60% of posts in these areas refer to opportunities or risks at all (as compared with around 75% each in the areas of medicine and foodstuffs). In textiles and vehicles, on the other hand, only a small proportion of posts associate nanotechnology with opportunities or risks (20 and 9% respectively); as mentioned before, their central focus is on the usefulness of nanotechnology.

A further aspect of the opportunities/risks discourse is the fact that the number of posts that associate nanotechnology with both opportunities and risks is very low in all categories (13%

at most). No doubt a role is played here by the fact that posts in online discussions (as in discussions in general) are formulated to be concise and participants choose not to contribute lengthy elaborations, especially about the pros and cons (of nanotechnology or of a specific product). Nevertheless, the high proportion of posts that clearly ascribe opportunities or risks to nanotechnology is evidence of a polarisation of opportunities/risks discourse in online discussions.

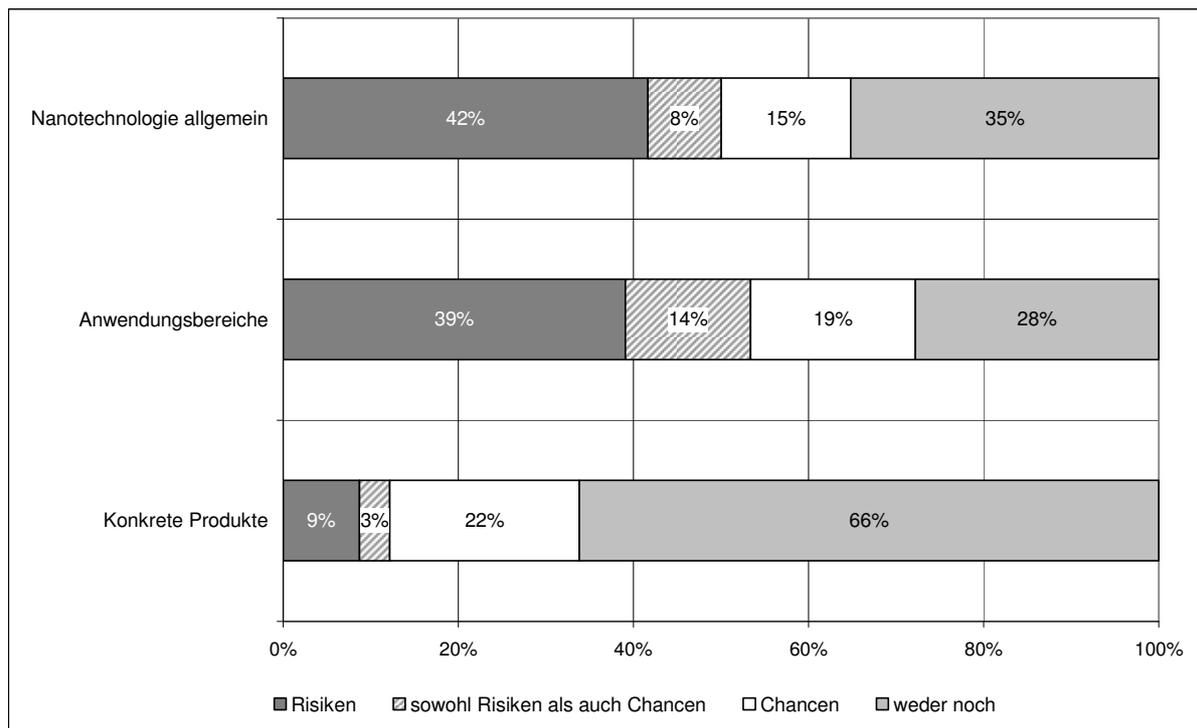
**Table 13: Perceived opportunities and risks by category**

Category	Posts collected	Nanotechnology is associated with ...			
		risks (%)	opportunities (%)	both (%)	neither (%)
Medicine	100	6	57	10	27
Foodstuffs	100	55	7	13	25
Gen. discussion	106	36	15	9	40
Cosmetics	50	32	10	4	54
Textiles	45	4	16	2	78
Vehicles	103	3	6	1	90
Total	504	19	24	7	49

Explanatory note: Proportion of posts in each category which associate nanotechnology solely with opportunities or risks, or with both opportunities and risks, or with neither opportunities nor risks; rounded percentages; listed according to the predominant perception of nanotechnology in each case: primarily associated with opportunities in medicine, primarily associated with risks in foodstuffs, associated with risks or not associated with opportunities or risks at all in general discussion and cosmetics, not associated with opportunities or risks in textiles and vehicles.

If one further considers that the risk ascriptions are mainly to be found in more recent publications – the proportion of risk ascriptions has, since 2006, been consistently higher than the proportion of opportunities ascriptions, and is rising steadily – the evidence that online discourse exists that is polarised in terms of opportunities and risks should be regarded as relevant: even if this were mainly due to the particular characteristics of online discussions, a broad and polarised debate on the Internet would nonetheless be relevant to the perceived risks of nanotechnology among the population. Admittedly, an analysis of the imagery and argumentation patterns (cf. Chapters 4.2 and 4.3) also shows that both risk perception and scepticism towards nanotechnology correlate to a considerable extent with the perceived high level of consumer and expert ignorance concerning the potential dangers of nanotechnology. In this context, more research into the risks and corresponding communication of the risks could change the perception of nanotechnology, and possibly also reduce the levels of its rejection.

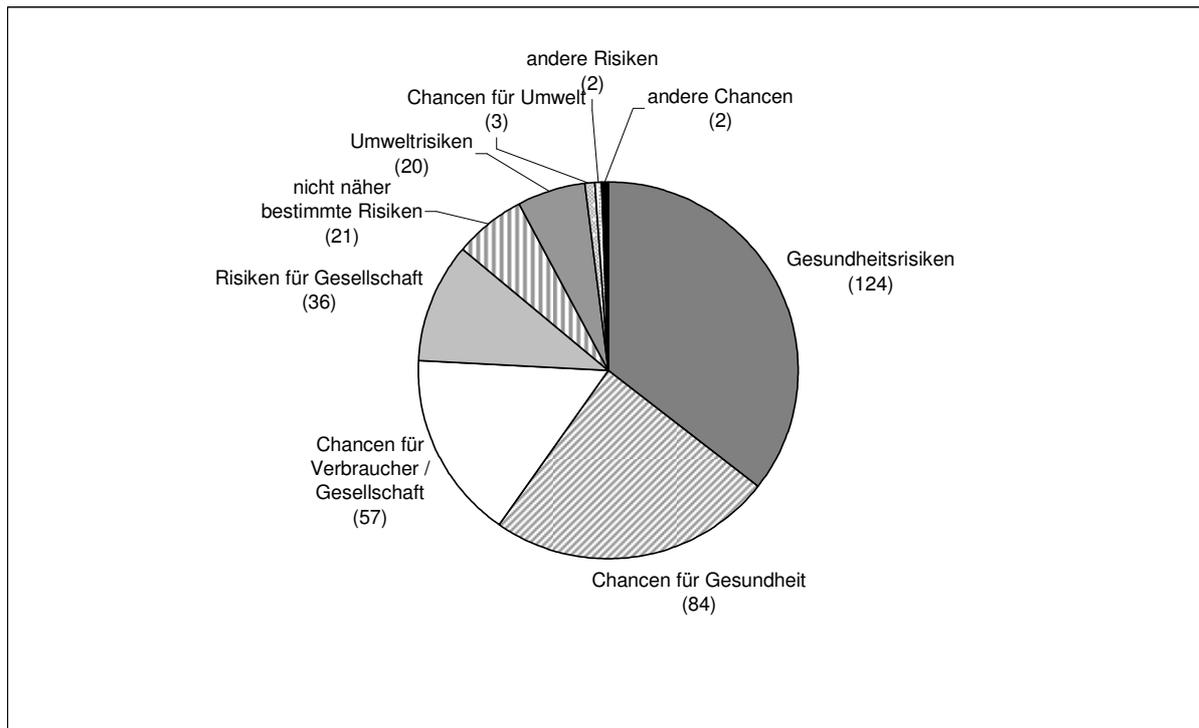
The question arises, as it did with regard to the general assessment of nanotechnology, of how the ascription of opportunities and risks differs according to the subject of the individual posts (coded as range). As can be expected given the differentiation of discourse that has already been observed, it is above all posts about applications and nanotechnology in general which ascribe opportunities and risks (in total 77 and 65%, respectively, of the posts); this is the case to a much lesser extent in posts concerned with actual nanoproducts. The perceived risks are most striking when it is a question of nanotechnology in general – the proportion in applications is somewhat lower. By contrast, opportunities are perceived in the majority of posts dealing with actual products. The discussion is most polarised here, with just three percent of posts ascribing both opportunities and risks to nanotechnology. Clearly, risks of the technology are more likely to be perceived the more abstract and the more general the discussion is. As far as actual products are concerned, however, there is more of a focus on the opportunities of the technology, yet such posts deal to an even greater extent with entirely different aspects that have nothing to do with the question of opportunities or risks.

**Figure 11: Perceived opportunities and risks by range of posts**

Explanatory note: Proportion of posts with the respective range which ascribe only opportunities, only risks, both opportunities and risks or neither opportunities nor risks to nanotechnology. Rounded percentages; listed according to the proportion of posts that associate nanotechnology with risks.

If one looks more closely at the types of opportunities and risks which are ascribed to nanotechnology in online discourse (see Figure 12), health aspects are clearly centre stage, raised in a total of 196 posts (with double mentions in twelve of these). Posts focusing on health risks significantly outweigh posts relating to opportunities for health. As far as opportunities and risks for society are concerned, however, the opportunities are represented more frequently, although it should be noted here that this also included opportunities for the consumers as a group. It is surprising that the environmental aspects that were strongly emphasised in political discourse in particular (cf., for example, NanoKommission 2008) do not play a greater role. If they arise at all, then only as environmental risks; even risks that are not specified in more detail are associated somewhat more often with nanotechnology. Opportunities for the environment are a similarly marginal topic as nanofuturistic healing and nightmare scenarios. It is likewise surprising that many posts ascribe several risks or opportunities to nanotechnology at the same time, or opportunities and risks (approx. 13% of posts).

Examining the detailed description of the associated opportunities and risks in the context of mentions of actual products and applications gives a clearer indication of which product areas are associated with which opportunities and/or risks (see Table 14). The environmental risks, for example, are not associated with sunscreen products or surface treatments, but solely with foodstuffs and food packaging. This is no doubt due to the fact that nanoproducts are associated particularly frequently with several different risks in the foodstuffs category – six of the 27 posts associate two different risk types with nanotechnology, and one post even three.

**Figure 12: Detailed breakdown of perceived opportunities and risks**

Explanatory note: Absolute frequencies of specific opportunities and risks being ascribed to nanotechnology, proportions based on the total number of mentions (multiple mentions in 67 posts).

Besides foodstuffs and food packaging, cosmetics and dietary supplements are also associated with more risks than opportunities, although the latter are hardly perceived at all with respect to their risks or opportunities but with respect to their benefits (see below). As far as sunscreen products are concerned, it is surprising to note that they are associated with opportunities for health in just one post, yet are associated with health risks in several posts. There is clearly a strongly risk-based perception here; this is particularly remarkable in view of the fact that nanoparticles have already been in use in many sunscreen products for some time now.

By contrast, the opportunities ascribed to nanotechnology outweigh the risks in products for surface treatment, in other textile applications and, particularly noticeably, in the medical domain, especially with respect to cancer therapies. As far as nanoproducts for surface treatment and in the area of textiles are concerned, there are posts that associate nanotechnology with opportunities (generally opportunities for “the consumer”) and no small number of posts that point to the risks of these products (especially health risks posed by nanoparticles). It should be taken into consideration, however, that products in these categories are only perceived from an opportunities and/or risks point of view in a very small proportion of posts (87 and 80% of posts respectively do not relate to opportunities or risks).

In medical products and applications, on the other hand, there is very much a focus on opportunities for health; these far outweigh the risks ascribed to nanotechnology. Admittedly, six posts also associate risks – especially health risks – with nanotechnology in serious medical applications.

**Table 14: Perceived opportunities and risks for selected nanoproducts**

Product	Posts collected	Nanotechnology is associated with ...								
		environmental risks	health risks	risks for society	other risks	opportunities for the environment	opportunities for health	opportunities for society/consumers	other opportunities	neither risks nor opportunities)*
Dietary supplements, "wonder drugs"	9		1							8
Sunscreen products	16		10		2		1	1		4
Foodstuffs	27	4	13	4	4	1	1	8		7
Food packaging	5	2	4	1				2		0
Other cosmetics	27		3		1		2	1		21
Surface treatment (vehicles/textiles)	134		6	1			1	11		117
Other applications in textiles	15			1				2		12
Other serious medical applications	40		4	1	1		29			11
Cancer therapies	37		2		1		30			6

Explanatory note: In each case, the table shows the absolute incidence of risk and/or opportunity ascriptions in posts that deal with products from the respective category; multiple mentions are possible both in terms of the products and the risk and opportunity types; for the sake of clarity, fields with a zero were left blank; listed according to the ratio of risk to opportunity ascriptions overall; )\* the final column states the number of posts that ascribe neither opportunities nor risks to nanotechnology, not the number of mentions of the respective product category.

To assess the results of opportunities/risks discourse, it is helpful to examine more closely the relationship between the ascription of opportunities or risks and the assessment of nanotechnology. To this end, the individual categories were compared using a contingency table (see Figure 13). The table shows a clear – and statistically significant – relationship between the ascription of opportunities/risks and the assessment (Cramers  $V=0.69$ ; 1% significance level). Opportunity ascriptions are associated with positive assessments, risk ascriptions with negative assessments. Admittedly, the correlation is more pronounced in the case of risks: in 83% of all posts that mention only risks of nanotechnology, the technology is assessed negatively, while only 64% of posts that only mention opportunities give a positive assessment of nanotechnology. This can be seen as an indication that in the online discussions reviewed here, which on the whole are relatively consumer- and product-oriented, a blanket rejection of nanotechnology currently dominates risk discourse, while a certain reserve or at least distanced attitude towards the technology remains widespread in discourse of opportunities.

Because it can be shown at the same time that participants in the online discussions react strongly and, in many cases, in a nanotechnology-critical vein to risk discourse in mass media, science and organised civil society (cf. Chapter 4.4.2), a not inconsiderable potential for a change in the perception of the risks of nanotechnology can be expected – insofar as the general population is familiar with nanotechnology at all, it has so far assessed the technology in a mainly positive manner, without focusing on risks.

**Figure 13: Comparison of assessments and ascriptions of opportunities and risks**

positive	63 (30)	7 (11)	2 (37)	83 (77)	155
partly positive/ partly negative	6 (7)	11 (3)	9 (8)	9 (17)	35
negative	3 (36)	16 (14)	100 (45)	68 (92)	187
neutral/ neither pos nor neg	26 (25)	3 (9)	9 (30)	89 (63)	127
<i>total</i>	98	37	120	249	504
	opportunities	both opps and risks	risks	neither opps nor risks	<i>total</i>

Explanatory note: Observed absolute frequencies, with expected frequencies shown in brackets. Grey shading highlights the strength of correlation in the respective categories – in grey-shaded fields, the expected and observed frequencies correlate, white fields indicate fields that fall below uniform distribution values, while black fields indicate fields that exceed uniform distribution values.

To put these findings into perspective, two aspects need to be emphasised: first, the fact that risk perception was found to be more strongly represented overall must be seen in the context of the fact that the subject areas are represented in the sample with very different weightings, to the extent that the results of the research on the nano Internet public sphere (Chapter 1) are used as the basis. Second, it is important to remember the aforementioned fact that opportunities/risks discourse only plays a role at all in half of the reviewed online discussion contributions (cf. Chapter 4.3.1). The differences between the various application- and subject-related partial discourses on nanotechnology can only be identified when the benefits dimension is taken into account alongside the opportunities/risks dimension, as will be done in the following section.

#### 4.3.3 Perception from the benefits perspective

Future acceptance of nanotechnology is likely to depend on how actual first-generation nanoproducts are assessed by their users. This has less to do with the issue of risks and more to do with the question of whether the opportunities offered by nanotechnology are in fact viewed as being sufficiently great as to counterbalance any concerns that may emerge about its risks. In this context, the benefits perspective, especially with regard to actual and currently available nanoproducts, is of central importance.

In this regard, the fact that roughly 80% of the experience-based posts do not make any noticeable mention of opportunities or risks is of particular interest. This means that those people who report in their posts on their concrete experiences of nanotechnology and, above all, of nanoproducts, have little interest in discussing the future prospects of these or, in particular, their risks. This is especially true of the product-oriented discussions, above all those

about nanoproducts in the areas of vehicles and textiles (in which roughly half of the posts in each case are experience-based, see Section 4.3.1 above). Another interesting observation is that the perception of the benefits and non-benefits, and even of the harm of nanotechnology or nanoproducts is particularly noticeable in these highly experience-based areas. Posts in these areas very rarely fall into the category “ascription of both benefits and harm” (see Table 15). Obviously, experience helps people arrive at a clear verdict of the products, be it positive or negative.

If one looks only at those posts in which the aspect of benefits is raised, it can be noted initially that they account for 68% of all reviewed online discussion contributions. Of these, 47% see a benefit, 40% see no benefit or even harmful effects, while 13% see both benefits and harm. The highest relative proportion of perceived benefits can be found in the area of medicine, where 52% of posts ascribe benefits to nanotechnology as compared to 23% of posts that associate nanotechnology with harm. In the areas of vehicles and textiles too, the perceived benefits outweigh the perceived non-benefits or harm. The area of cosmetics is in the middle as regards perceived benefits and harms, while the perceived harm dominates in the areas of general discussion and foodstuffs.

This analysis, however, must take into account the differentiated nature of discourse as described above. If this is done, only the areas of vehicles and textiles show a clear focus on benefits and/or harm. The areas of medicine, foodstuffs and general discussion, on the other hand, are focused more on opportunities (medicine) or risks (general discussion, foodstuffs), with the area of cosmetics somewhere in the middle. In all of these latter areas, only around two thirds of posts relate in each case to questions of benefits – in the case of the general discussion, the proportion is only around half. In this sense, qualifying the discussions according to whether they associate benefits or harm with nanotechnology only applies to some of the categories.

**Table 15: Perceived benefits and harm by category**

Category	Posts collected	Nanotechnology is associated with ...			
		benefits (%)	harm (%)	both benefits and harm (%)	neither benefits nor harm (%)
Medicine	100	42	13	10	35
Vehicles	103	60	27	1	12
Textiles	45	47	22	7	24
Cosmetics	50	32	28	8	32
Gen. discussion	106	13	27	11	48
Foodstuffs	100	6	44	15	35
Total	504	32	27	9	32

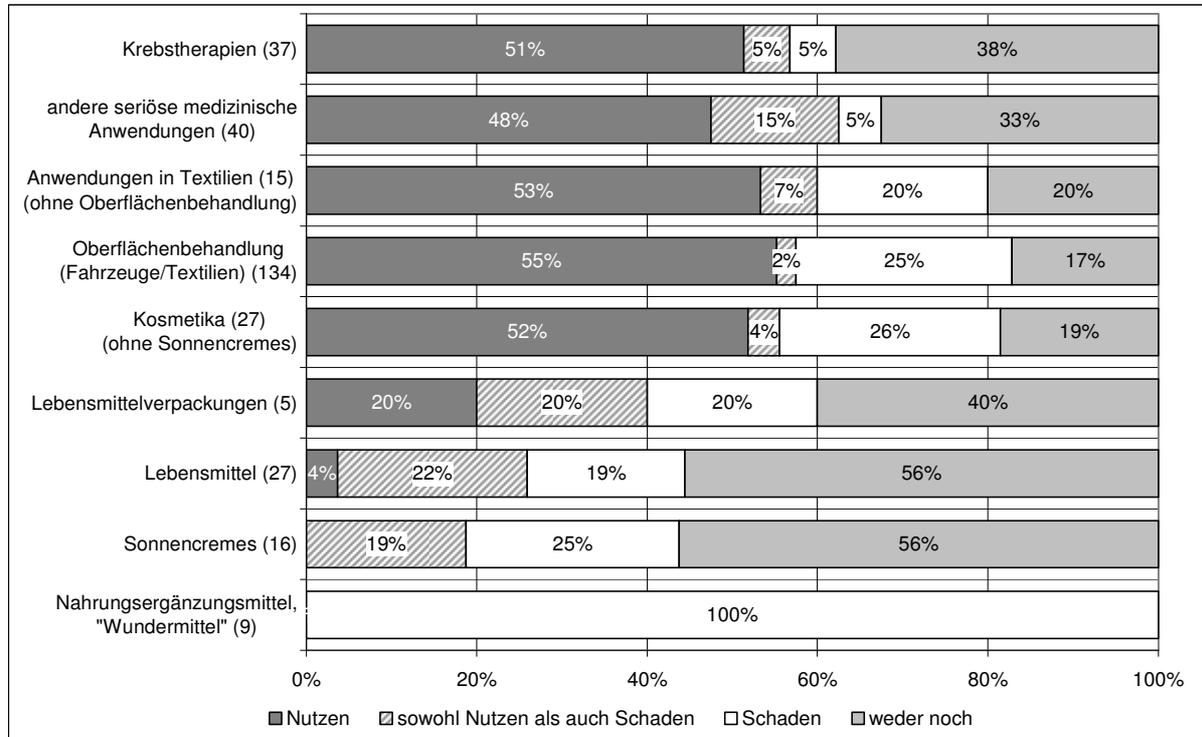
Explanatory note: Proportion of posts in the respective category that associate nanotechnology only with benefits or harm, both benefits and harm, or neither benefits nor harm; rounded percentages; listed according to the ratio of associated benefits to associated harm.

If one examines individual groups of products and applications separately (see Figure 14), these general findings can be specified even further. As one would expect, medical applications are characterised unanimously as beneficial, as are applications in textiles, surface treatment and cosmetics – so long as it is not a question of sunscreen products. Like applications in foodstuffs, food packaging and dietary supplements, and indeed the various “wonder drugs”, these are viewed by the majority of posts as being useless or harmful; this perception is unanimous in the latter product category.

This differentiated examination is useful for one thing because it allows a more precise distinction to be made in the area of cosmetics between applications that are more likely to be perceived as beneficial – such as creams and dental hygiene products – and applications

that are more likely to be perceived as harmful – such as sunscreen products (where the fear of nanoparticles, in the reviewed posts, outweighs the gain in sun protection that they can achieve).

**Figure 14: Assessment of different nanoproducts and applications by benefit and/or harm**



Explanatory note: The table shows the proportions of posts that associate nanoproducts in the respective category with benefits, harm, both benefits and harm or neither benefits nor harm; figures in brackets indicate the number of posts containing mentions of the respective product category (categories with fewer than five posts were left out); posts may be assigned to several different product categories; dietary supplements were not counted as foodstuffs when the authors of the posts portrayed them as a product group in their own right rather than as foodstuffs; rounded percentages; listed according to the ratio of ascriptions of benefit to ascriptions of harm.

For another thing, it shows clearly that the rejection of nanotechnology as a result of product assessments is by no means a marginal phenomenon. Leaving aside medical applications for nanotechnology and pseudo medical “wonder drugs”, the proportion of product-based posts that ascribe non-benefits or harm to nanotechnology is between roughly 20 and 25% in each case; only the proportion of cases in which benefits are ascribed varies. In other words, even if ascriptions of benefits predominate in the case of products in the areas of vehicles and textiles, the proportion of posts which believe nanotechnology has no benefits or even harmful effects remains comparable to product groups like nanofoods or sunscreen products, which tend to be viewed critically. This picture also reflects the observation made during the course of the research that discussions take place between nano-supporters and nano-opponents in many vehicle-related online forums: in some cases, these involve enthusiastic users of nano windscreen sealing agents arguing with people whose use of such agents has resulted in their windscreens being smeared, and who therefore see themselves as being literally at risk. Manufacturers are also regularly accused of attempting merely to drive up prices of vehicle care products through the (in some cases alleged) use of nanotechnology.

#### 4.3.4 Interim conclusion

To sum up, it can be noted that both perceived risks and opportunities, and the benefits aspect, constitute important factors in the assessment of nanotechnology in Internet discussions, albeit in different subject areas. While the discussion in the area of medicine revolves primarily around the opportunities offered by nanotechnology, there is a greater focus on risks in the areas of foodstuffs and general discussion. Furthermore, nanotechnology is perceived in one part of the general discussion (in roughly a quarter of the posts) in a more abstract manner, without any reference to opportunities, risks or benefits.

The benefits aspect, on the other hand, is the focus in the areas of vehicles and textiles, where the use of nanotechnology is predominantly perceived as bringing benefits; this reflects the mainly positive assessments in these areas. Finally, the area of cosmetics finds itself in an intermediate position: sunscreen products are mainly discussed in the context of risk aspects, while other cosmetic nanoproducts are largely perceived as being beneficial.

The finding that between 20 and 25 percent of product-based posts, depending on the subject area, assess the use of nanotechnology as non-beneficial or even harmful should not be ignored – it is striking that there are, among other things, many posts in which nanoproducts (and even nanotechnology as a whole) are polemically described as “hype” or a “rip-off”. Dietary supplements and “wonder drugs” are even perceived unanimously as being useless or harmful, yet nanotechnology is hardly perceived as harmful at all in the area of medicine.

In mass media and political academic discourse in recent years – following the discussions in the year 2000 and in the early part of the last decade, which tended to be somewhat excited and tied to far-reaching nightmare scenarios – a trend has taken place which has seen concrete risks coming to the fore in place of speculative scenarios, but above all which has focused on realistic opportunities. If by way of comparison one analyses the reviewed German-language online discussions of nanotechnology, this trend is not evident. It is true that speculative scenarios no longer play a part in these either; however, a focus on opportunities can only be found in the area of medicine, where the practical application of nanotechnology has not yet made much progress in consumer-oriented fields. Other areas, on the other hand, reveal primarily practical considerations of the technology’s usefulness or, particularly in the last few years, negative perceptions of nanotechnology as a result of fears about its risks.

Generally speaking, the findings relating to the different applications confirm the results of other acceptance and risk perception research on the subject, some of which also reflect the perception of other fields of technology such as biotechnology. First and foremost, this concerns the positive assessment of medical applications and the particularly high level of reserve shown towards novel foodstuffs. At the same time, all areas of application reveal a degree of scepticism towards or even open rejection of nanotechnology in Internet discussions which is surprising, at least in view of the results of population surveys. These include not only a number of new applications, but also nanoproducts that are already in widespread use. Moreover, these are discussions among sectors of the population who often at least claim to have relatively broad knowledge of nanotechnology or to have had experience of nanoproducts, although in the latter case a tendency towards more positive assessments and towards not mentioning risk aspects is evident.

In view of the correlation between society’s acceptance of nanotechnology and its further development, the fact that the nonetheless more negative overall perception of nanotechnology in Internet discussions is only in part attributable to perceived risks should not give the “all-clear”. On the contrary: if there should be increasing signs that first generation nanoproducts are meeting with considerable acceptance problems among a larger number of consumers on account of doubts about their benefits, this could prove more damaging to the

future of this field of research and development than largely unconfirmed fears about its risks.

Finally, it is worth mentioning that there are some signs that the online discussions of nanotechnology are polarised in terms of the perceived opportunities, risks and benefits. If the layman's online discourse on nanotechnology under review – which to a major extent is still in its infancy – is regarded as the potential harbinger of a future social discussion of the subject, these signs should be taken seriously, especially if they indicate a greater polarisation. However, it can be assumed that the polarisation is due to some extent to the interactive discursive communication format reviewed in the present study, yet the public character of these discussions means that they can influence society's perception of nanotechnology.

On the basis of the linguistic means (Chapter 4.4), argumentation patterns (Chapter 4.5), discourse characterisations (Chapter 4.6) and interpretative frames influenced by individual life-worlds (Chapter 4.7), further results of the content analysis will be presented in the following sections, with a more in-depth discussion also of some of the previously presented findings.

#### **4.4 Linguistic means**

The linguistic means used to pursue discourse on nanotechnology will be subjected to a more exacting qualitative analysis below.

##### **4.4.1 Comparisons**

In 16% of the reviewed posts, nanotechnology is compared with developments in other areas of technology or research. The posts containing comparisons are predominantly posts about nanotechnology in general and its applications (36 posts each), while posts about actual products only rarely contain comparisons (9 posts).

This linguistic means is used considerably more frequently in online discourse than in mass media discourse: according to a recent BfR study (Zimmer et al. 2008c), such comparisons were identified only in 4% of the press reports. It is true that the reference objects upon which the comparison is based are similar: comparisons with genetic engineering (17 mentions) and asbestos (eleven mentions) are most frequently found, and even the comparisons with thalidomide (four mentions), BSE and DDT (one mention each) that are present in media discourse can be found in online discourse, albeit only rarely.

There is, on the other hand, a series of other reference objects that are clearly specific to online discourse: comparisons are based comparatively frequently on particulate matter, "chemicals" (used as a generic and unspecified term) and various non-natural foodstuffs (see Table 16). This is noteworthy to the extent that they all have a negative connotation – risks or at least dubious benefits are the focus when it comes to chemicals and even novel foodstuffs. Two areas that are often cited in media discourse, however – nuclear power and the Internet – feature in online discourse only rarely (nuclear power with three mentions) or not at all (the Internet). Comparisons with mobile telephone radiation are not only to be found very rarely (two mentions), but even (in one case) are used to invalidate fears, pointing out that no proof that mobile phone radiation is harmful has ever been found.

**Table 16: Reference objects for nanotechnology**

Area of comparison	Number of mentions	Of which are posts about ...		
		nano-technology in general	applications	actual products
Asbestos	11	9	2	
Genetic engineering in general (excl. genetically modified foods)	10	3	7	
Specifically genetically modified foods	7	1	5	1
Particulate matter, dust, soot, smoke	9	4	4	1
Various scientific developments (e.g. particle acceleration experiment at CERN)	8	7		1
Chemicals in cosmetics / foodstuffs	7	1	4	2
Novel foods (including yoghurt cultures, isotonic drinks)	5	1	4	
Thalidomide	4	1	3	
Microelectronics, information and communication technology	4	4		
Nuclear technology	3	2	1	
Molecular gastronomy	3		3	
Biotechnology	2	2		
Mobile telephones	2	1	1	
Other comparisons	16	4	8	4
<b>Total number of mentions</b>	<b>91</b>	<b>40</b>	<b>42</b>	<b>9</b>

Explanatory note: Multiple codings possible (seven posts with multiple codings).

Examining the incidence of comparisons over time reveals a comparatively constant occurrence for all the reference objects listed in Table 17 and, overall, a rise in the use of comparisons (even taking into account the overall increase in numbers of posts). As in media discourse, comparisons with genetic engineering are to be found most early on, while asbestos and chemicals are more recent points of reference.

It is noticeable that there is an accumulation of comparisons with a mostly critical tenor in the first half of 2008. At this time, publications and press reports about them led to an intensification of comparative risk communication.

As regards the references to genetic engineering and, in particular, to genetically modified food, one of the contributing factors may have been a study on nanotechnology in food published in March 2008 by BUND, the German branch of Friends of the Earth (in three cases, a reference was also made to the BfR consumer survey on nanotechnology that had been published shortly before). The relative increase in asbestos comparisons is probably attributable to the results of research into the dangerousness of carbon nanotubes, which were published in "Nature Nanotechnology" in May 2008 and received wide press coverage. It is less easy to identify a catalyst for the comparisons with chemicals; among other things, a test report on sunscreen products published in the May 2008 edition of the magazine "Ökotest" may have contributed to the public's sensitisation.

**Table 17: Selected reference objects for nanotechnology over time**

Years	2001–2003	2004	2005	2006	2007	2008
Total	0	1	1	7	16	24
Genetic engineering, genetically modified food		1	1	2	3	5
Asbestos					2	4
Particulate matter etc.				2	2	1
Chemicals					1	4
Novel foods				1	2	1

Explanatory note: Half-yearly increments; multiple codings possible

#### 4.4.2 Linguistic images

What sets linguistic images apart from other linguistic elements in discourse is the fact that they allow complex matters to be depicted figuratively – in the form of an image (cf. Niehr/Böke 2003: 330). On the one hand, an image has a simplifying effect because it pares down a complex matter into a figurative entity; on the other hand, it has a connotative impact and can therefore make unknown and foreign issues appear more familiar, giving them, for example, an emotional charge that is evoked by the image. Images allow previously unnamed issues in (scientific and general social) discourse to be named.

As far as communication about nanotechnology as a technology visible only with considerable effort is concerned, Lösch (2006) in particular referred to the importance of images (illustrations). It can be assumed that both linguistic images and the material images he examined act as mediators between discourses pursued by scientists and experts on the one hand and the general population and consumers on the other. As such, they give the diverse expectations of nanotechnology a frame that at once reflects existing expectations and influences the emergence of expectations of nanotechnology (Lösch 2006).

Images are also used as indicators of how nanotechnology is perceived. A morphological-psychological study that was conducted within the framework of one of the recent BfR studies on the subject of nanotechnology (Zimmer et al. 2008b) reveals that the positive image nanotechnology enjoys among consumers is fed by images in which, among other things, the size aspect (“dwarf world”), progressiveness (“power of regeneration”) and indeed their own ignorance (“undreamed-of possibilities”) contribute to its image as a “future treasure”.

Finally, analyses of the image content of journalistic contributions on the subject of nanotechnology show that a quarter of the reviewed posts use images in order to explain nanotechnology and its future importance (Zimmer et al. 2008c). In this context, references to the size dimension play a particular role, as do – albeit to a lesser extent – references to the economic and technological importance of nanotechnology and its trendsetting character.

Against this background, the importance and semantic content of linguistic images in the contributions posted by Internet users are examined. A quantitative overview initially reveals that nearly 45% of the posts use linguistic images. Among these, images with negative connotations are identified most frequently (in 108 posts), while images with positive connotations or those without any identifiable judgement were found in 79 and 77 posts respectively (multiple codings of posts were possible). These figures prove that linguistic images are highly valued in online communication about nanotechnology. The more frequent use of negative images reflects the assessment of nanotechnology that was found overall.

On the basis of the semantic contexts of the linguistic images, they can be attributed to ten different “image worlds”.

### *Fascination*

Images that play on the fascinating impact of nanotechnology are used most frequently (69 identified images). These images express the fascination that is apparently provoked by applications for nanotechnology in all kinds of different areas. Although consumers know little about how this “simply sensational” “miracle stuff” works, they are fascinated by it and “would really like to try it out” themselves (all the quotations used in the following are taken from the material). The degree of abstraction ranges from comparatively concrete descriptions such as “nanotransporter” or “effective layer” to images such as the “lotus effect” or simply “nano-stuff” where the actual effects are completely ignored and the fascination is entirely associated with the first syllable “nano”. In the majority of cases the fascination is positive in connotation, yet there are also many negative connotations such as when doubts arise as to the actual effect, as in the case of comparisons of nanoproducts with dubious sales presentations (“where they light a fire on the bonnet and all that”) or when a nano-toothbrush is likened to “brushing your teeth with Domestos”.

### *Nanotechnology as actor*

The second most common image world is also effect-related but defines nanotechnology more as an actor (34 identified images). In this case, nanoparticles in particular are regarded as being capable of action: they are supposed to ensure “that the skin is well moisturised”, they “penetrate the cells”, “travel through our bodies” etc. There are images both with positive connotations (especially when it is a question of fighting cancer cells) and negative connotations, e.g. when a capability for action is associated with the notion of nanoparticles as intruders that could potentially be harmful to health.

### *Images with a reference to size*

The images that make reference to size, which are represented most prominently in the media analysis, appear only in third place in terms of frequency (29 images). The nano-dimension is compared with blood cells or human hair (“400 times thinner”) and only rarely with the pico-dimension (nano being a “huge 200 litre bottle” as compared with a piccolo bottle). Nano, like “tiny”, “mini” and “dwarf-sized”, is also used as a prefix to describe something that is very small in size (“nano power stations”). Purely visual clarifications are encountered more frequently than concrete comparisons (such as the well-known comparison between a football and planet earth). The images that make reference to size are mostly neutral, though in isolated cases they are used to play down an effect (the German word “Teilchen”, which literally means “little part”, is used more frequently in this context than “Partikel”, or “particle”) or are associated with a particular dangerousness (“shrunken substances” in contrast to the harmless “normal size”).

### *Secret, non-perceivable threat*

The latter aspect is more evident in another category of images which portray nanotechnology as a secret threat (26 images). At the core of this image world is the suspicion that, behind the scenes, as it were (or, as one post author puts it, “underground”), all kinds of quite different things could be being developed that consumers are unaware of and most of which, potentially, pose a threat. There are not only references to “Pandora’s box”; there are also suspicions that nanoproducts could be introduced “behind our backs” and negative information about them “kept secret from the public” – after all, “I cannot see what’s going on”. A particularly extreme form of this image world can be found in the idea that nanobombs could be developed, an example that shows to an extreme extent the fearful and critical tendency of images in this entire category: “You can’t smell it, you can’t taste it, you can’t see it and you can’t feel it. But the right mixture can kill you.”

### *Other image worlds*

Genuinely dystopian images such as the “grey goo” scenario are only rarely to be found, however (11 images). References to conventional risks, such as comparisons with “chemical assaults”, are also relatively rare (17 images). More common are positively connotated refer-

ences to science fiction in images of new worlds, such as the “dream world” or “nanocosmos” (19 images), although these are also used with an ironic negative connotation. References to future potential for nanotechnology are also fairly frequent (22 images); in these, nanotechnology promises “hope” (especially in the area of cancer therapy) but is still “in its infancy” and will not be “ready for series production until some time in the future”, with the result that the verdicts reached in these images are roughly balanced. Even more frequently, the images paint a picture of a near future for nanotechnology (24 images) which “is already in the starting blocks”, whose products are already “jostling for position on the market” and whose development is illustrated as a “nano-train” in which it may be necessary to “shift down a gear” but which cannot now be stopped completely. Although the connotations in the latter image world are essentially positive, it is also mixed with doubts about the usefulness of this development and the suspicion that it is all about “hype” without any real substance.

**Table 18: Linguistic images and their frequencies**

Category	Examples	Frequency
Fascinating effect	“great lotus blossom effect”; “super-duper magnetic molecule”; “rain simply rolls off”; “jazzed up with nano-additives”	69
Nano as actor	“penetrate cells”; “travel through our bodies”; “nanoparticles stress cells”	34
Reference to size	“tiny little balls”; “like a football compared to the earth”	29
Secret threat	“I cannot see what’s going on”; “kept secret from the public”	26
Near future	“already in the starting blocks”; “nanoproducts jostling for position on the market”	24
Future potential	“if the technological development is ever ready”; “a soup full of hope, fascination and vision”	22
(Reflexive) discourse reference	“it word” (buzz word); “alleged wonder drugs”	21
New worlds	“dream world”; “amazing surprise”	19
Conventional risks	“chemical assaults”; “like smoking”	17
Dystopian images	“grey goo”; “soylent green”; “resistance is futile”	11

Explanatory note: Multiple codings possible; other images occur in twelve posts

### *Conclusion*

The image worlds thus partly confirm the results of the morphological-psychological analysis in which the attitudes of consumers were investigated as part of a BfR study (Zimmer et al. 2008b). Among those Internet users who raise the topic of nanotechnology of their own accord, without any prior stimuli, the fascination and future-oriented nature of nanotechnology also account for a considerable proportion of the linguistic images assigned to them. There is a clear difference to mass media discourse in which explanatory images – such as the size comparison – are attributed greater importance.

The interpretation of the image worlds, as a particular feature of online discourse that sets it apart from the mentioned studies, initially points to the importance of the effects aspect of nanotechnology which is predominant in the two most frequently identified categories. This expresses a trust in the particular potential effect of nanotechnology despite the fact that this promise is not necessarily fulfilled by actual applications of nanotechnology in everyday life. Such images are to be found above all in application-oriented subject areas (vehicles, cosmetics, textiles). What provokes fascination in some, however, provides others with grounds for concern – negative connotations actually characterise the majority of the images used. The second particular feature of online discourse can be seen in the significance of critical image worlds. Their semantic content can be interpreted as follows: on the one hand, the effects of nanotechnology are regarded as a threat, while on the other hand the promises are not believed. Images depicting a secret threat assume that nanotechnology will have some sort of impact, but believe this impact to be uncontrollable and sinister. The lack of trust in actors who influence nanotechnology’s development is also evident in such images; they mistrust the promises of nanotechnology and portray them as insubstantial – the path from fascination (“super-duper”) to “nano disillusionment” and “marketing soap bubble” is short.

## 4.5 Arguments

When analysing the arguments put forward in the posts, it is not a question of assessing the quality of discourse in the sense of normative discourse theory (e.g. Habermas 1987). The aim is rather to identify typical patterns of argumentation and describe them within their respective contexts. The focus is on argumentation patterns that use argumentative means to position a specific perception of nanotechnology within discourse. This should be distinct from the analysis of concrete topoi of the argumentation (cf., for example, Niehr/Böke 2003, p. 334) that is to be described later on as part of the frame analysis of online discourse (see Chapter 4.6).

Overall, a majority of the reviewed posts contain argumentative expressions (63%); in turn, the majority of these are simple in structure, explaining, for example, a particular viewpoint or assessment. Only a minority of the argumentative posts use complex arguments such as weighing up pros and cons. The argumentation patterns will be studied below for posts that address a) opportunities, b) risks and c) both opportunities and risks of nanotechnology.

### 4.5.1 Exclusive reference to opportunities

The overwhelming majority of posts that raise the opportunities of nanotechnology point argumentatively to the benefits offered by the technology and/or individual products, referring both to concrete and more abstract benefits (36 mentions in all). This context should also include conclusions drawn by analogy: observation of one area of (nano) technology results in conclusions being drawn about developments in entirely different areas (three mentions, example: “if it is anything like nano-treatment for cars, it must be something pretty fantastic!”). A total of five posts relativise the opportunities of nanotechnology in their argumentation by pointing to the limits to the possibilities or expressing disillusionment. All these posts but one discuss the application of nanotechnology in cancer therapy.

By contrast, there are five posts that argue specifically against any speculation that nanotechnology might pose risks. They address concrete fears, such as the fear that particles could penetrate the skin or that nanostructured surfaces could bring about dangerous reactions. Their argumentation is based less on verifiable facts and more on convictions, as is shown particularly clearly by the following example: “there are no negative reports of nanosilicon on the web, and if there is anything negative to report you can always find it on the web...”. A further four posts discuss the opportunities in the light of the distinction between genuine and merely alleged nanotechnology – only genuine nanotechnology is ascribed opportunities, and doubts are expressed about the nano-character of certain products. Those posts that argue with the development of nanotechnology in mind also relativise the opportunities offered by nanotechnology, emphasising in particular the fact that these opportunities will only be realised in the distant future.

### 4.5.2 Exclusive reference to risks

Posts that raise the risks of nanotechnology use arguments even more often than those that refer to opportunities (73% vs. 60%). In this segment of the sample too, arguments refer particularly frequently to the dangers and/or risks posed by concrete applications of nanotechnology (22 mentions). These are followed by arguments that draw analogies with other areas of technology (twelve mentions, including three references to asbestos) and by arguments containing general fears of risks posed by technologies (three mentions). A general rejection of new technologies is thus to be found comparatively rarely; consumers' fears are associated far more often with concrete risks. It can be noted in this context that references to me-

dia reports and the results (published by them) of academic research are a common feature of such arguments.

The lion's share of the risk discussion, however, is made up of arguments (in 23 posts) which deduce potential hazards from the authors' limited knowledge of nanotechnology and of the consequences of its application. In this context, a comparison with the analysis of the image worlds is an obvious one; here too, ignorance plays a major role in connection with the perception of risks (see Chapter 4.3 above).

In the context of the limited knowledge of the risks of nanotechnology, there are also repeated calls for labelling of such products to be introduced. In seven posts in all, the authors explicitly address the problem of the lack of labelling in their argumentation, as in the following example: "What I think is the real scandal is the fact that these nanoparticles are not declared. Of course everyone can eat whatever they choose, but I'd like to decide for myself." The call for labelling is always associated with a strengthening of the consumer's position.

Linked to this is another argumentation pattern that occurs in a total of 14 posts; it believes that businesses (and their assumed desire for profits) are responsible for driving nanotechnology forward, and portrays the technology's overall development as unstoppable and/or not controllable by the consumer (example: "Scepticism is called for once again, especially given that the business world is yelling "onwards" before there is even the slightest knowledge of the risks to health."). This argumentation pattern also includes posts that depict nanoproducts as a "rip-off", that is to say those which believe that the benefits genuinely offered by such products are scant as compared with the promises made by the manufacturers.

In contrast, several posts believe there is a disproportionate exaggeration of risks (three posts) or relativise the possible dangers (seven posts), for example by referring to the inevitability of the development, something others see too (example: "I have now ordered titanium dioxide to lighten my soap. It is also in toothpaste, however, and in medication, so I don't think it matters if it's in soap. I will keep an eye on it, alongside my personal enemy (E102)"). As was also noted during the analysis of linguistic images, hardly any role at all is played in the reviewed sample by dystopian arguments that stress the serious consequences nanotechnology will have for society (three posts). The focus is not on scenarios of doom (e.g. "grey goo") but on human enhancement or on the invisible risks to civilisation posed, for example, by new types of bombs.

#### 4.5.3 Posts that mention opportunities and risks

Those posts that address both opportunities and risks of nanotechnology tend to use argumentation patterns from one of the two aforementioned groups. The argument of insufficient knowledge of the risks is put forward most frequently (13 mentions); a reference to concrete benefits (eleven mentions) or risks of the technology can also often be found (nine mentions; for the other argumentation patterns, see Table 19).

**Table 19: Argumentation patterns and their incidences**

Category	Description	Incidence
Argumentation patterns in posts that raise opportunities of nanotechnology		
Concrete benefits	Reasons for opportunities are given by referring to concrete benefits of nanotechnology (often in comparison to conventional products)	20
Abstract benefits	Reasons for opportunities are given by pointing to the benefits of nanotechnology in general (these are often potential benefits in the future)	16
Disappointed expectations	Opportunities are mentioned but are relativised by referring to disappointed hopes	5
Relativisation of risks	Reasons for opportunities are given by referring to the lack of grounds to fear risks	5
Genuine vs. non-genuine	Opportunities are only ascribed to "genuine" nanotechnology, the word is often used only for advertising purposes	4
Development perspective	Opportunities are believed to be offered by the long-term development of nanotechnology, with references to the distant future	4
Conclusions about opportunities by analogy	Reasons for opportunities are given by referring to comparable technological developments (e.g. semiconductor research) or applications (e.g.. surface treatment for cars)	3
Other		2
Argumentation patterns in posts that raise risks of nanotechnology		
Insufficient knowledge about risks	Effects of nanotechnology are not known, risks are insufficiently researched, nanoproductions impossible to identify	23
Risks posed by actual applications of nanotechnology	Reasons for risks are given by referring to experiences with actual products or to research reports on negative effects	22
Business as driver of development	Reasons for risks are given by referring to a mistrust of industry wishing merely to increase profits with nanotechnology	14
Conclusions about risks by analogy	Reasons for risks are given by referring to negative effects of other products or technologies (e.g. asbestos, particulate matter)	12
Empowerment of consumers	Based on the possibility of nanotechnology posing risks, there are calls for labelling to increase the power of consumers	7
Relativisation of risks	Nanotechnology may be associated with risks, but the risks are "not so bad" (because they are being officially investigated, because nano is everywhere etc.)	7
Dangers are exaggerated	Dystopian scenarios (e.g. nanomachines, nanoplastic fibres which flood the body) are cited to illustrate the absurdity of risk fears	3
General risk awareness	Caution is generally advised, "one doesn't have to do everything just because one can"	3
Serious consequences for society	Reasons for risks are given by referring to negative effects of nanotechnology on society (e.g. new class of human being, invisible weapons)	3
Other		2

**Continuation of Table 19: Argumentation patterns and their incidences**

Category	Description	Incidence
Argumentation patterns in posts that raise both opportunities and risks of nanotechnology		
Insufficient knowledge about risks	See "Risks" above	13
Concrete benefits	See "Opportunities" above	11
Risks posed by actual products	See "Risks" above	9
Business as driver of development	See "Risks" above	3
Abstract benefits	See "Opportunities" above	2
Relativisation of risks	See "Risks" above	2
Conclusions about risks by analogy	See "Risks" above	1
Dangers are exaggerated	See "Risks" above	1
Conclusions about opportunities by analogy	See "Opportunities" above	1
Dependence on area of application	Opportunities and risks of nanotechnology cannot be determined in general and can only be determined according to the respective application	1

Explanatory note: Multiple codings possible.

Only one post reveals an entirely new pattern of argumentation, explaining that the opportunities and risks of nanotechnology cannot be determined in general and can only be determined within the respective area of application: "there is no such thing as safe or unsafe nanotechnology. Nano simply means working with particles that are no more than 1000 nm = 1 micrometre in size. In powder form that can pose a hazard purely on account of the particulate matter; in liquid form, however, e.g. in the case of flavours where the flavour carrier is present in nanoparticles (usually embedded in fat), it is not dangerous because the fat dissolves when heated and only then releases the flavour, and the flavour is then incorporated into the food."

#### 4.5.4 Conclusion

Overall, the identified argumentation patterns show a similar structure to the image worlds. Depending on the author's viewpoint, concrete effects stand for either opportunities or risks of nanotechnology. A low level of knowledge is associated with risk ascriptions in the argumentation, and classic discourse patterns, e.g. a dystopian perspective, are only rarely to be found.

One independent characteristic of the argumentation patterns is the role ascribed to business as being the driving force behind nanotechnology development – coupled with references to the risks of the technology and the powerlessness of consumers. This argumentation pattern can be found above all in the foodstuffs category (ten mentions), but also in the general discussion (four mentions), medicine (two mentions) and cosmetics categories (one mention). As one would expect, it very often goes hand in hand with mistrust of private companies (eleven mentions), and in two cases also with mistrust of government institutions. Another study showed that mistrust of companies – especially large multinationals – can influence the perception of nanotechnology risks (Schütz/Wiedemann 2008).

## 4.6 Characterisations of discourse on nanotechnology

One feature of online discourse on nanotechnology and nanoproducts is that societal discourse on nanotechnology is often reflexively characterised – incidentally, so to speak – in the posts, either explicitly or implicitly. Such references were found for nearly half of the posts (approx. 46%) in our sample, with the numbers rising slightly over time. This is noteworthy to the extent that no wider societal discourse is yet taking place in Germany. Online discourse, according to the research conducted here, also does not achieve the quality of society-wide discourse – instead, it appears dispersed. Clearly, the discussion participants tend to have a stronger perception of the discussion of nanotechnology as clearly outlined discourse than is the case in the population as a whole.

### 4.6.1 Characteristic complexes

On the basis of this observation, the present study investigated how the discourse was described. The following eight characteristic complexes were identified as central indicators of the characterisation of nano-discourse:

- Progress discourse: nanotechnology offers concrete or future benefits and is described as a promising future technology whose potential has to some extent not yet been recognised  
*Example statement relating to the results of nanoresearch: “one of the fascinating results of cutting-edge research that may bring genuine progress (...)”*
- Fears of progress, negative science fiction, dystopias: nanotechnology is associated with visions of distant futures that often have negative connotations  
*Example statement: “What is more dangerous are nanomachines, often known as nanites in science fiction (Star Trek also uses the term to describe the Borg) – let’s just stick with it.”*
- Risk technology: nanotechnology is perceived and discussed as being fraught with risks  
*Example statement: “What is more, I would be careful with nano stuff in spray cans. The effect on health is scientifically very controversial, and it is almost impossible to avoid inhaling it (unlike with other nanoproducts).”*
- Risks/opportunities discourse: discourse sees a confrontation between proponents and opponents, and there is dispute over the meaning of nanotechnology  
*Example statement: “I am somewhat cautious as regards nanotechnology. The problem, as is unfortunately so often the case, is that industry develops a new product and only realises much later when it is used on people (in a field trial) how harmful it actually is (asbestos, timber protection agents, formaldehyde).”*
- Hysteria/scaremongering: discourse is perceived as being one-sided and risk-focused, and is criticised as “scaremongering” and/or “hysteria”  
*Example statement: “Finally we are being overtaken by the latest hysteria concerning the new unknown and unresearched danger: NANO. – An appeal to research and for more calm.”*
- Trend/hype: nanotechnology is a hype word that is used a great deal without there always being actual important developments in the background  
*Example statement: “Generally, I ask myself whether this so-called nanocosmetics really does “penetrate better” or whether it is just hype”*
- Misuse of the term: the term nanotechnology is used wrongly, regardless of the actual application of nanotechnology or its actual benefit. Typical reproaches are that it is a “rip-off”, an “advertising gimmick” or a “confidence trick” etc.

*Example statement: "... the salesman at the trade fair presents it as the very latest from the company XYZ with additional nano-osmosis protection. In my view, that's another of those nano miracles ..."*

- Rumour mill: although information about nanotechnology is shared in discourse, it is impossible to verify the validity or range of this information – it has more the status of rumours and hearsay. Accordingly, there are complaints of confusion among consumers in this context.

*Example statement: "I read somewhere that these products which \"produce\" the lotus effect also reduce icing up of the windscreen and windows, or at least make it easier to scrape the ice off. Does anyone have any experience of this, and where can you get hold of this stuff???"*

What is interesting about these characterisations is not so much how they relate to the assessment of nanotechnology or the perception of opportunities and risks (which is as one would expect), but particularly their development over time (for an overview, see Table 16). This is how three groups of characterisations can be recognised, each of which shape different phases of the societal discussion about nanotechnology.

#### 4.6.2 Characterisations over time

In the early phase of the period under review (2001 to 2008), the following three characterisations of nano-discourse are mainly used in the reviewed posts: the characterisations "rumour mill" and "fears of progress/dystopias" appear particularly early on, and are joined from 2005 on by the suspicion or reproach of "misuse of the term". What these characterisations have in common is the fact that they are only used to a minor extent in the last two years of the review period, although this only applies to the characterisations "fears about progress/dystopias" relative to the general development. Common to these early discourse characterisations is that they present a vague and/or exaggerated picture of nanotechnology that can be contrasted with a clear and concretely tangible one.

The characterisations as "trend/hype" and "progress discourse" are to be found in an intermediate phase; both start in 2004 and are used, with increasing incidence, right up to 2008. It is true that both exhibit a weaker rate of increase for the year 2008, measured against the total number of characterisations; the consistency of their use, however, indicates that they have not yet necessarily exceeded their peak importance. These two characterisations can also be related to one another in terms of their content: they stress the topical nature of the nanotechnology debate and point to an even greater importance of the field in future. The characterisation as "trend/hype" also contains doubts about the content and sustainability of the discourse in its nuances, whereas "progress discourse" includes a more positive perspective and assessment.

Finally, the most recent phase of the discussion (from 2007) is shaped by three characterisations that view "nanotechnology as a risk technology", point to "risks-opportunities discourse" and warn against "hysteria/scaremongering". The view of nanotechnology as a risk technology occupies an intermediate position here because it could also be assigned to the intermediate phase on account of the declining relative proportion of posts, although the proportion in 2008 is much higher than for the characterisations of the intermediate phase. The last-mentioned characterisation reflects the trend – noted in the present study – towards a perception of nanotechnology that is characterised to a greater extent by risk aspects. Linked to this, albeit with a slight delay, is the characterisation of the discussion as "risks-opportunities discourse". This is where both perspectives – nanotechnology as a future technology and as a risk technology – are brought together in the perception of discourse in which the opportunities have to be weighed up against the risks. The warnings against "hys-

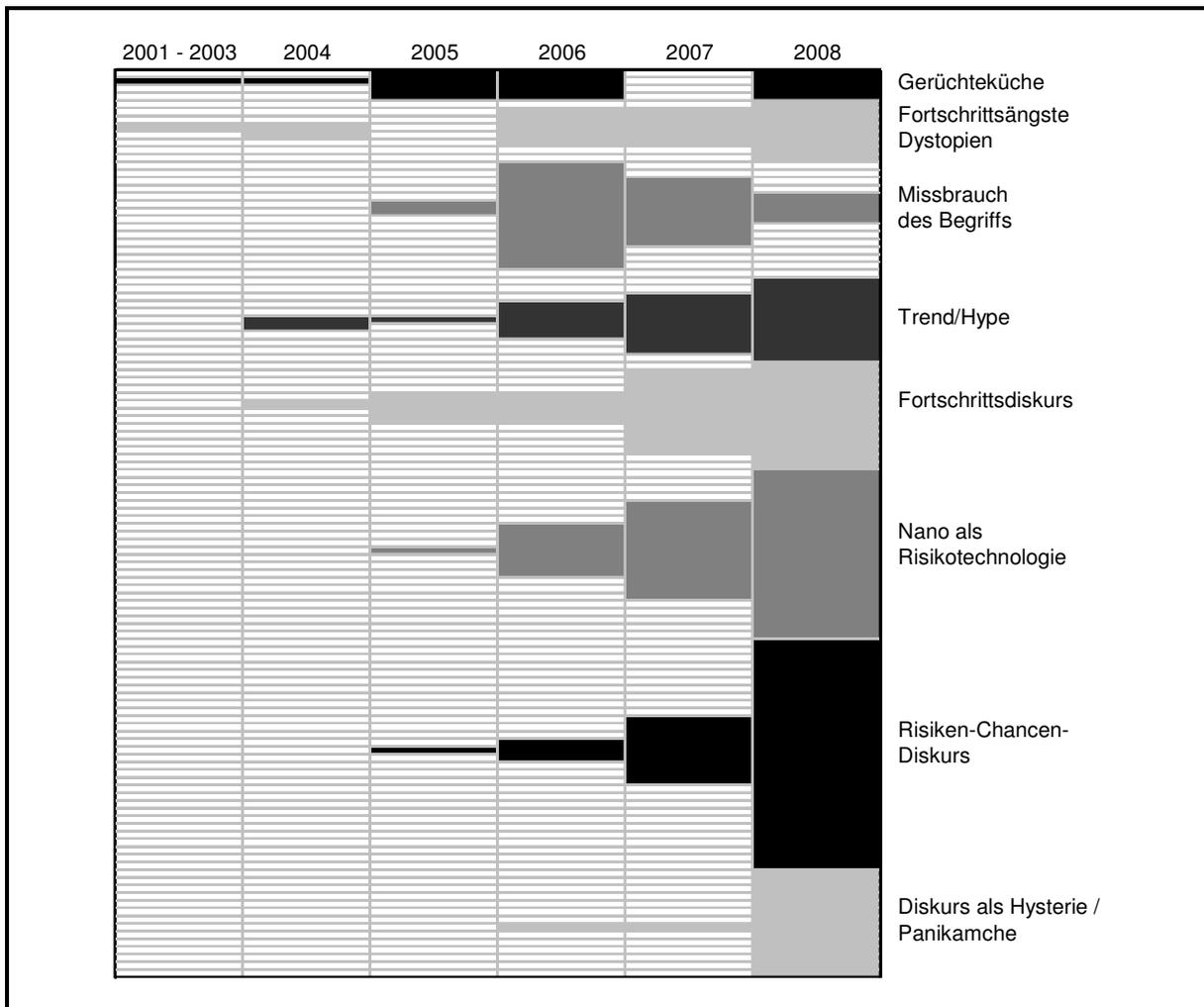
teria/scaremongering”, on the other hand, can be interpreted as a different reaction to risk discourse; a significant number of such warnings only began to appear in the last year, and represent an opposite view to the risk discussion, partly by discrediting the risk fears and partly by appealing for the discussion to become more objective.

**Table 20: Characterisations of the nano-discourse over time**

Characterisation/years	2001–2003	2004	2005	2006	2007	2008
Rumour mill	1 50%	1 17%	4 31%	4 9%		4 4%
Fears of progress/dystopia	1 50%	2 33%		5 12%	5 9%	8 7%
Misuse of term			2 15%	14 33%	9 16%	4 4%
Trend/hype		2 33%	1 8%	5 12%	8 14%	11 10%
Progress discourse		1 17%	4 31%	4 9%	11 20%	14 13%
Nano as risk technology			1 8%	7 16%	13 23%	22 21%
Risks-opportunities discourse			1 8%	3 7%	9 16%	30 28%
Hysteria/scaremongering				1 2%	1 2%	14 13%
<b>Total</b>	<b>2</b>	<b>6</b>	<b>13</b>	<b>43</b>	<b>56</b>	<b>107</b>

Explanatory note: Multiple codings possible; the total relates to the number of posts that can be clearly assigned to a category of discourse characterisations. It is stated merely for the purposes of comparing the development over time in the individual categories. The percentages relate to the total number of posts in the respective year.

Figure 15: Characterisations of nano-discourse over time



Explanatory note: The graph shows the absolute frequencies of posts containing the corresponding characterisation of nanotechnology discourse (cf. Table 20). Each shaded field represents on post. The time period covered is 2001-2008. Multiple codings of posts possible.

#### 4.6.3 Conclusion

In conclusion, it can be noted that a shift takes place over time as regards the assessments of societal discourse in the online discussions; this shift is from vague and predominantly negative discourse characterisations via more positive and future-oriented characterisations to a dual-track situation in which there is progress discourse and risk discourse. The latter discourse increasingly takes the form of an active debate of perceived risks and opportunities.

It should be remembered, however, that this self-reflection reflects the perception of the online discussion participants and cannot claim any objectivity. The discrepancy between the uniformity of a nano-discourse that is suggested by the characterisations and the dispersed nature of the online discourse found by the research conducted for the purposes of this study makes it clear that the reflexive characterisations should be interpreted with overall caution and do not necessarily permit conclusions to be drawn about the status of societal discourse.

## 4.7 Life-world backgrounds and interpretative frames

The social situation and semantic context of nanotechnology are defined within the online discussions themselves. A process of framing takes place that can be examined using Goffman's frame analysis (1977). Such analyses (e.g. Gamson 1988, Gamson/Modigliani 1989, Iyengar 1991) assume that the manner of framing both reveals something about the underlying knowledge and overall attitude of the communicator, and already implicitly predetermines the pathways the person concerned will follow in handling and assessing the topic.

As far as the following frame-based analysis is concerned, this means tackling two tasks. First, the milieus or life-worlds upon which the frames are based need to be outlined. A life-world encompasses the entire symbolically structured knowledge background of those taking part in the communication. Every communicative utterance tells us something about a segment of these underlying life-worlds. Correspondingly, it is assumed here that the frames open up a window, as it were, onto specific life-worlds. The different life-worlds of the online discussion participants can thus be partly reconstructed from their own remarks. Having considered this relationship between the life-world background and the current framing activity, the second task consists in investigating the consequences for an evaluation of nanotechnology. The starting hypothesis here is that the various different frames pave the way, so to speak, for particular forms of criticism or positive endorsement of this technology.

Three distinct frames were identified in the course of this study, and it was possible to assign to them all posts but one. The most common frame was "pragmatic and keen to experiment" (237 posts), followed by the frames "critical and political" (151 posts) and "scientific and progressive" (115 posts). What lies behind these somewhat abstract-seeming frames is most strikingly expressed by the participants themselves when they use images and key words to describe nanotechnology and place it within certain social discourses.

### 4.7.1 "Scientific and progressive"

In the frame "scientific and progressive", the basic assumption expressed by the authors of the Internet posts is that the application of innovative technologies can achieve social progress. Throughout history, humankind has attained ever new heights thanks to technology. Terms associated with technology include "future", "enlightenment" and technological "revolution". Accordingly, nano is often seen in a positive light as being a "key technology" or a "future technology". As far as possible, it is supposed to result in advantages such as greater comfort, new jobs or higher profits. This frame by no means rules out on principle any negative assessment of nanotechnology, but does make it less likely. The underlying question in this context is always the extent to which this technology has the potential to be put on an equal footing with previous successful technologies. These Internet authors have little time for a fundamentally sceptical view of nanotechnology. As one post puts it: "We must become more technology-friendly again." General political discourse in this regard is often criticised, claiming that there is a lack of scientific approach and optimism. The example of the "grey goo" scenario is used to explain that too much hysteria is incited.

### 4.7.2 "Critical and political"

By contrast, the basic tenor in the frame "critical and political" is sceptical of technology. Whereas the extreme end of the frame "scientific and progressive" imagines nanofuturistic utopias of a technology-optimised society, the critical and political view potentially sees a "mega disaster". One user said that his spontaneous association was "soylent green" when he heard about foodstuffs optimised by means of nanotechnology. This was an allusion to a film from the 1970s in which people are turned into food in a totalitarian and technocratic

future. Although this individual viewpoint is by no means representative, it does nonetheless indicate the general direction.

Nanotechnology is interpreted as a potential “Pandora’s box”. Technology is not seen as a solution to a problem here, but as an instrument of disenfranchisement, as a source of moral evil or as a symptom of cultural decline. There are warnings against allowing us to become the “guinea pigs of industry”. The authors’ own criticism is therefore linked to general socio-political discourse, e.g. on “consumer sovereignty” or risk technologies.

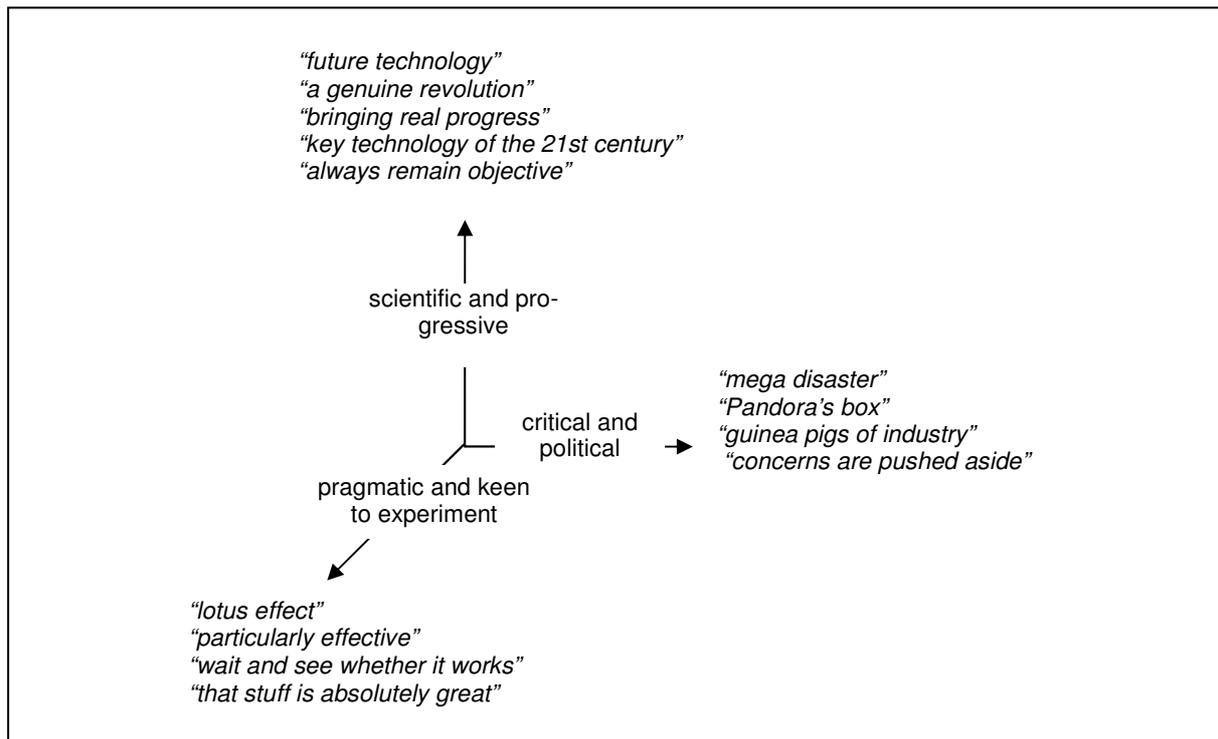
The sociopolitical horizon of these two frames is very broad. They contain certain teleological interpretations of history – at times utopian, at times dystopian. These frames also tend to imply basic assumptions about the relationship of man and technology, and as a rule go hand in hand with general notions about what is sociopolitically desirable.

#### 4.7.3 “Pragmatic and keen to experiment”

The group of online discussion participants whose viewpoint extends hardly beyond their own backyard is roughly the same size as all the representatives of the frames discussed in the previous section put together. They approach nanotechnology not from the perspective of the common good but in order to satisfy an individual interest. The only reason they are focusing on nanotechnology is because it appears to be a useful tool or an obstacle in everyday life. Furthermore, this frame has been described as “keen to experiment” because this mentality contains a strong desire to find a practical solution. This prompts everyday experiments in order to test the suitability for purpose of products treated by means of nanotechnology. In extreme cases, people have even embarked on their own experiments, using an (alleged) nanoparticle to treat their own clothing, car or skin and then reporting meticulously on their success or failure on the Internet.

Unlike those in the frame “scientific and progressive”, these users actually know little about the research background, which is why they often talk simply of “nano stuff”. Admittedly, their level of knowledge is high when it comes to all the possible practical applications. Terms such as “lotus blossom effect” and “roll-off effect” are commonly used. The discussion participants also develop a highly accurate applicational knowledge about how nanotechnology works in connection with cancer therapies, and do not hold back with their criticism when the nanoparticle in question does not live up to its manufacturer’s promise. Contrary to the frame “critical and political”, however, the assessment yardstick in this context is entirely non-political. While the former are interested in voicing generally recurring criticism of the thoughtless use of technology, the essential features of which can also be found in areas such as “genetic food”, organic food or asbestos protection, the latter tend to assess the usefulness of nanotechnology more from the perspective of the “sensible housewife”. This raises general discourses that could also be found in practical everyday advisory publications. On a positive level, nanotechnology is welcomed as a “wonder drug” that is “great” and “all the rage”. In a negative sense, on the other hand, these authors advise not falling for these overpriced products and the “advertising promises”, “hype” and “daylight robbery” that “nano” represents in reality. All that counts is practical experience; abstract and general explanations are mistrusted.

**Figure 16: Illustration of the different frames and their typical statements**



Explanatory note: Example statements relating to the individual frames were taken from the text corpus of the content analysis.

#### 4.7.4 Frames and assessments of nanotechnology

The different frames and orientations are also reflected in the assessments (see Table 21). Nearly half (48%) of the posts in the frame “scientific and progressive” rate nanotechnology positively. Only 8% express an ambivalent and 10% a problematic attitude towards nanotechnology. A good third abstain and do not explicitly assess the issue. This happens only rarely (13%) in the frame “critical and political”, where roughly four out of five posts (79%) take a negative view of nanotechnology, while the advantages and disadvantages – and above all the positive aspects – of this innovation are seen only very rarely (7% and 2% respectively). The field among those keen to experiment, on the other hand, is divided: two fifths (41%) sympathise with nanotechnology, yet roughly a quarter (24%) reject it. A further 29% have no opinion and 7% see both good and bad aspects of the new technology. In other words, there is a clear correlation between the type of frame and the orientation of the assessment. Critical and political posts generally reject nanotechnology, while scientific and progressive contributions tend to have a positive or neutral view of these innovations. In the pragmatic posts, by contrast, a mixed but generally more positive picture is painted. Accordingly, Cramers V indicates a comparatively strong correlation – at 0.42 – that is significant at the 1% level.

**Table 21: Interpretative frames and assessments of nanotechnology**

Frame	Posts collected	Assessment of nanotechnology ...			
		positive (%)	negative (%)	partly pos, partly neg (%)	neutral/neither pos nor neg (%)
Scientific and progressive	115	48	10	8	34
Critical and political	151	2	79	7	13
Pragmatic and keen to experiment	237	41	24	7	29
Total	503	31	37	7	25

Explanatory note: Rounded percentages; statistical analysis of the relationship between frame and assessment by means of chi-square test with Cramers  $V=0.42$ , sign.>99%; one post could not be assigned to a frame; the overview does not take into account any distortions due to the sample having been put together according to subject areas.

Quite different areas are assessed. While around a third of technology-optimistic posts focus on the technology in general, another third on areas of application and the final third on actual products, over 80% of everyday-oriented posts are only really interested in actual products and processes. Among the critical and political posts, half address nanotechnology's application in a particular area (e.g. foodstuffs); actual products are raised more rarely (in about a fifth of posts) and general questions are raised frequently (in around one third of posts).

This already indicates that the online discussion participants encounter nanotechnology in very different areas of life. The underlying "life-worlds" or milieus exhibit certain domains, as can be seen from the reviewed subject areas. The domain of the progressive and scientific life-world lies in the area of medicine (40%), whereas the critical and political life-world is primarily to be found in the area of foodstuffs (nearly half of all posts). Both share a further domain, namely general discussion, which is dealt with by 37% of the technology-optimistic and 30% of the technology-sceptical posts.

The structure of the pragmatic and keen to experiment life-worlds is different. Because they focus on trying out nanotechnology in everyday situations, they are hardly interested at all in the general discussion (7%). Instead, these posts are divided up into individual life-world sub-categories. As already explained, their frequencies tend to be based on the type of sampling rather than making any sort of representative statement: the car is the central focus of 41% of the posts, while the areas of cosmetics, medicine and textiles each account for roughly a seventh of the posts. Foodstuffs are only rarely addressed in the frame "pragmatic and keen to experiment" (6%).

If one considers these different underlying life-worlds it is possible to understand why a more precise assessment of the risks and opportunities or benefits and harm of nanotechnology is strongly related to the way in which this technology is framed. The life-worlds that come to light in the frame "pragmatic and keen to experiment" search for a concrete benefit in their respective everyday situation. As far as cars are concerned, it is usually a question of finding the most efficient cleaning and care products – what counts here is to achieve high-gloss paintwork. The situation is similar in the areas of cosmetics and textiles, although here the focus is then on the aesthetic appearance of one's own skin or clothing. Contributors in the area of medicine are a special case: they are usually seeking a remedy to an annoying or even life-threatening disease (e.g. cancer).

Because these life-world needs form the basis for the pragmatic and keen to experiment frames, 40% of the posts here ascribe a concrete benefit to nanotechnology rather than merely the chance of a benefit. Accordingly, 20% of posts warn against harm (not against risks). It is all about finding quick practical remedies and solving real-life problems, which is

why questions of potential risks or opportunities are of lesser interest. Just 8% of the posts exclusively discuss opportunities or risks.

The situation is different in life-worlds with a scientific and progressive frame, which are predominantly interested in nanotechnology as a promising future. 17% of posts deal with opportunities; regardless of whether a concrete benefit is already evident today. A further 30% talk both of benefits and opportunities, and the two frequently merge. The portrayal of nanotechnology in critical and political life-worlds is more or less the exact opposite: while some 13% of these posts talk mainly of concrete harm, just under 23% see only risks, and a further 34% see risks and harm.

Overall, there is also a clear correlation, in other words, between the frames and the different assessment of this technology's harm/risks and benefits/opportunities (Cramers V: 0.56, 1% significance level). The life-world background of these three frames has an even greater influence on the types of opportunities and risks. People whose life-worlds can be described as pragmatic and keen to experiment apparently give little thought to the environmental opportunities or risks. They also appear to have little interest in the consequences for society – what counts, rather, is potential harm to health or benefits for health. By contrast, the main fear expressed by critical and politically-oriented life-worlds concerns health risks, although they also frequently raise social risks (e.g. loss of culinary culture brought about by functional food) and environmental risks. Environmental risks tend not to be specifically named, but are expressed in a more formulaic manner (risks to “humankind and the environment”). Finally, the scientific and progressive life-worlds see above all the health benefits. Unlike the other posts, they see clear opportunities for society, especially in the area of economic innovation and growth. Nonetheless, they share – albeit on a comparatively lower level than the posts in the frame “critical and political” – typical risk perceptions for health and social conditions. Environmental hazards are largely absent from the frame “scientific and progressive”.

The way nanotechnology is associated with other risk discourses also shows clearly that these life-world backgrounds have very specific characteristics. In the frame “pragmatic and keen to experiment”, nanotechnology is something relatively new. The horizon of the discussion participants here is so limited that virtually no comparisons are made at all. Parallels are drawn only rarely, and only then when it is a question of objects related to their own experience (e.g. Teflon or pesticides in fruit). By contrast, the posts that most like to make comparisons are the critical and political ones; life-world experiences from previous risk discourses are brought up-to-date and equated with nanotechnology. They warn that “old mistakes” that were made with “genetically modified food”, asbestos, thalidomide, chemicals and nuclear power are being repeated. It is clear that the discourse sphere is being shared in this context with the scientific and progressive life-worlds from the fact that the latter likewise repeatedly cite the example of genetic engineering. Nonetheless, the posts warn that the communication mistakes that were made when this technology was introduced should as far as possible not be repeated with nanotechnology.

#### 4.7.5 Conclusion with focus on political positions on nanotechnology

The frame-based analysis has also brought about a typical and well-known conflict situation between three political-cultural milieus, described here as life-worlds. On the one hand there are the proponents of nanotechnology, who have an affinity with technology, while on the other hand there are sceptics whose life-worlds are anchored more in civil society areas in which there is also widespread criticism of “genetically modified food”. In addition, there is a very large group of participants in online discourse who are not particularly interested in this political controversy – they are more interested in the everyday practical use of a new technology.

**Table 22: Characterisation of the frames in different categories**

	Progress	Criticism	Everyday
Assessment	48 % positive	79 % negative	41 % positive and 24 % negative
Range	37 % general	48 % application	82 % products
Category	40 % medicine	48 % foodstuffs	41 % car
Benefits/harm and opportunities/risks	30 % both benefits and opportunities	34 % both harm and risks	41 % concrete benefit and 20 % useless or harmful

Explanatory note: Summary of key results using meaningful maximum categories.

Bearing in mind how topics, interests, motives and opinions relate, as presented above, to nanotechnology on the one hand and to the three frames on the other, it is easy to understand why their political positions differ. The only group that has any real political confidence – namely in science, above all – is the scientific and progressive-oriented life-world. The critical and political milieu is the group that is most mistrusting, especially of industry. The pragmatists with their everyday attitudes are largely indifferent, which is why they also make hardly any political demands. This is more the domain of the critical group; they call for labeling, more research into risks, more information about the risks and more political intervention in general. By contrast, the posts with a scientific or progressive tenor want more information to promote nanotechnology and more research to help it advance.



## 5 Summary and overarching assessment

The particular features of the object of study – online discussions – and of the sample for the content analysis have already been discussed a number of times in this study. This chapter, when discussing criteria for the perception of risks, opportunities and benefits of nanotechnology, will once again examine these particular features and classify the results in accordance with the current state of research (cf. Chapter 5.2). First, however, the key results of the study will be briefly summarised below.

### 5.1 Key study results

Overall, it can be noted, if one considers the entire breadth of this field of research and development, that a discursive German-language Internet public sphere relating to nanotechnology is still in its infancy. Nonetheless, the online discussions that were found certainly permit a general appraisal and a number of in-depth analyses. As with the assessment of nanotechnology and its opportunities and risks, considerable differences are noticeable here with respect to the different areas of application. All in all, the picture is of diverse and wide-ranging online discourse on nanotechnology by laypersons, and one which exhibits some significant differences to the picture of public perception of nanotechnology evident from population surveys and scientific and political discourse. Some of the findings obtained in other empirical research, however, are confirmed by examining the online discussions.

#### 5.1.1 Online discussions are wide-ranging but unequally distributed

In areas which are important from a consumer perspective, that is to say cosmetics, foodstuffs or textiles, there are only few online discussions of nanotechnology despite there having apparently been a considerable increase very recently in the area of nanofood. At the same time, however, significant online discussion activities can be noted in certain areas: not only discussions that are ignored or only mentioned in passing in this study such as those about shares and investment opportunities in the nano sector or about futuristic nanotechnology in computer games, but also and particularly in the vehicles category, where the main subject of discussion is surface sealing.

The research results relating to the discursive Internet public sphere covered a very broad spectrum of topics and product groups, reflecting the multifaceted character of nanotechnology as an interdisciplinary technology. It could not necessarily be expected that this diversity would also be reflected and detectable in online communication. Conversely, this finding supports the assumption that guides the entire study, namely that online communication has become so widespread in society that it represents a relevant area for monitoring risk communication and perception.

Despite this variety, however, considerable differences are evident between the various topics (see table in the annex): as regards the number of arenas and, no doubt, the number of posts, the vehicle forums stand out, especially those concerned with surface treatment in vehicle care. (This assessment disregards forums in which very extensive discussions, whose contents are hardly relevant, take place about shares or computer games with nano-futuristic elements.) It should generally be noted that the character of a website or forum, and indeed the topic of a thread, says nothing in itself about the contents and quality of the discussions. Only few chats were found, though some are of interest from the risk perception point of view. Conversely, there was a surprising number of blogs containing posts about nanotechnology, though only few of these conducted a continuous discussion of these topics. There was also little use of the comments function in the blogs that were found, to the extent that this could be determined on this level of research. There was only evidence in

individual cases of nano-discourse in the sense of consecutive and interlinked postings. Overall, a large number of arenas exists, yet the discussions in them – as far as this can be determined – are largely single-stranded.

The search results that were obtained give the impression that discussions about nanotechnology have arisen in recent years in numerous places on the Internet and in various thematic contexts. In these discussions, conflicting interpretations of nanotechnology and perceptions of their risks are made public. The dominant impression is one of largely unconnected specialist discourses on areas of application, existing side by side, which in turn are hardly linked at all to the general online discussions of nanotechnology.

#### 5.1.2 Ambivalent assessment, yet more negative and risk-centred

If one examines the quantitative results of the content analysis, which should be treated with particular caution, probably the most remarkable finding is that the assessment of nanotechnology in the reviewed online discussions is more negative overall than one would have presumed from the general population's appraisal as recorded in surveys. Nanotechnology is associated here more frequently with risks than with opportunities. Furthermore, in each of the years from 2006 to 2008, the number of posts that focus only on risks outweighs those that raise only the opportunities offered by nanotechnology, and this trend is increasing. These findings are all the more surprising given that the reviewed discussions predominantly deal with consumer-relevant applications and nanoproducts where it had been presumed that the level of nanotechnology acceptance would be relatively high.

Apart from the particular features of online communication, to be discussed below, and the specific selection of discussions, two qualifications have to be made here: first, both as regards the overall assessment of nanotechnology and in view of the assessment of its opportunities and risks, it can be noted that a large number of posts remain neutral in their assessment and/or raise neither opportunities nor risks. Second, it is evident from all reviewed aspects of risk, opportunity and benefit perception, and from the nuanced analysis of application areas, that knowledge about nanotechnology and, in particular, experience of nanoproducts often result in a positive assessment of this field of research and development.

A general discussion about "nanotechnology" and entire areas of application thus exists in which there is a clearly negative assessment of the field of research and development and in which risks are the central focus. Alongside this general discussion is a product-oriented discourse in which nanotechnology is seen more positively overall.

#### 5.1.3 Benefits assessment positive if anything, but ambivalent overall

The findings mentioned above probably indicate that discourse is split into opportunities/risks discourse and benefits/non-benefits discourse. 173 posts raise only benefits or non-benefits and harm, while 86 focus solely on opportunities or risks, 171 discuss aspects both of benefits/non-benefits and of opportunities/risks discourse, and 74 address neither. This is also revealed if an analysis of the results relating to the opportunities/risks aspect is carried out by category: in the areas of vehicles and textiles, the neither-nor codings predominate – that is to say there are hardly any references to opportunities or risks – and over 50% also belong in this category when it comes to cosmetics. Opportunities or risks are by far the greatest focus in foodstuffs, medicine and (albeit to a much lesser extent) the general discussion about nanotechnology; opportunities dominate the discussion in the area of medicine, while risks tend to be the focus in the area of foodstuffs and in the general discussion. The assessment of nanotechnology is also significant in this respect: in the area of vehicles, and even more noticeably in the areas of textiles and medicine, there are more positive and fewer negative

assessments. Conversely, more negative than positive assessments are to be found in the foodstuffs category. In line with these findings, four out of five posts which report on the authors' own experiences with actual nanoproducts and processes do not make any reference to opportunities or risks.

If one examines discourse on benefits, non-benefits and harm more closely, an ambivalent picture likewise emerges. It is evident, for one thing, that posts that address solely the benefits, above all of actual nanoproducts, account for a considerable proportion of the total number of posts in which nanotechnology is assessed positively. For another thing, however, it can also be noted that nearly a third of all negative assessments of nanotechnology is due to the fact that the authors of the posts do not see any benefits, or have even had negative experiences of nanoproducts.

It becomes clear, especially when one looks at individual groups of products and processes, that the rejection of nanotechnology on the basis of product experiences or perceptions is by no means a marginal phenomenon. Among posts dealing with surface treatments, for example, which are generally fairly unproblematic from a risk perspective (especially in the area of vehicles and textiles), approximately 46% contain positive assessments, but roughly 22% contain negative assessments of nanotechnology. When it comes to cosmetics, negative assessments predominate, mainly due to the rejection of nano sunscreen products. In the area of foodstuffs, hardly any positive assessments of nanotechnology can be found. Only among posts dealing with nanomedical procedures are the negative assessments marginal, with over 50% containing positive assessments and only a good 6% containing negative ones. Posts that reject nanotechnology, in which the sole subject of discussion is actual nanoproducts (rather than entire areas of application or nanotechnology in general), account for more than 13% of all reviewed online discussion posts and nearly 18% of all posts that contain any assessment at all.

It can be noted that the benefits aspect, and in particular the assessment of actual products, represents an important factor when it comes to assessing nanotechnology. The positive influences of actual product experiences or references clearly predominate in the assessment, yet negative product experiences and perceptions are by no means of marginal importance. For one thing, positive benefit assessments play virtually no role at all in the area of foodstuffs, and are also less widespread than negative assessments in the area of cosmetics. They significantly influence the negative assessments of nanotechnology in other areas too: in the area of vehicles, for example, in which many positive product experiences are portrayed, many polemical statements can also be found in which nanoproducts (and even nanotechnology as a whole) are described as "hype" or a "rip-off".

#### 5.1.4 Signs of polarisation

If one examines the ambivalent picture that emerges when it comes to perceived risks, opportunities and benefits, there is evidence of polarisation in online discussions of nanotechnology. This applies, for one thing, to discourse on opportunities and risks, in which the posts address very predominantly either only risks or only opportunities, although the mention of risks is much more frequently accompanied by negative assessments of nanotechnology than the mention of opportunities is accompanied by positive assessments. For another thing, there are also indications of a polarisation in online discussions of the benefits, non-benefits and harm of nanotechnology and its products. This polarisation can be seen both between different applications and within certain applications. As far as the latter are concerned, the considerable numbers of negative user experiences of products that are deemed low-risk are particularly striking.

Despite the limitations due to the object of the investigation and the choice of sample for the content analysis, the quantitative results with their overall surprisingly negative assessment of nanotechnology are worthy of note for two main reasons: first, the negative assessments are also not inconsiderable in the much-discussed areas of application – in the general discussion of nanotechnology, above and beyond specialist discourse, these are even far more numerous than the positive posts. Second, the differentiated weighting was able to reveal a significant and even huge level of rejection in two emerging and as yet small specialist discourses on specific areas of application (cosmetics, especially sunscreen products, and foodstuffs).

#### 5.1.5 Acceptance varied, benefits aspect relevant

The findings relating to the various areas of application confirm other results obtained by acceptance and risk perception research on the subject; some of these related also to the perception of other fields of technology such as biotechnology.

This applies above all to the positive assessment of medical applications and the particularly high level of reserve shown towards modified foodstuffs. At the same time, a degree of scepticism towards and even open rejection of nanotechnology can be found across all areas of application that is surprising, at least in comparison with the results of population surveys. Even in areas in which there is already widespread use of nanoproducts that are generally regarded as unproblematic from a risk perspective, nanotechnology is negatively assessed in at least a fifth of posts in each case. This is apparently due less to perceived risks and more to considerations of benefits.

As regards establishing how consumers currently assess nanotechnology and might appraise it in future, however, this finding is no less relevant than the increased importance attributed to risk aspects and the clear rejection of nanoproducts in certain new applications evident in online discussions as a whole. The fact that the comparatively negative overall assessment of nanotechnology is only partly attributable to perceived risks is no reason to dismiss the finding as irrelevant.

#### 5.1.6 Comparisons largely negative

An examination of comparisons of nanotechnology and its opportunities and risks with other fields and their opportunities and risks shows that nearly all comparisons are negative in character and have the potential to provoke polarised discussions of risks, as in the case of genetic engineering. Genetic engineering itself (especially genetically modified food) and asbestos are at the top of the list of frequently used comparisons, followed by particulate matter.

The comparisons, in terms of when they appeared, can almost all be attributed to specific issues featured in the media, the mass media having received their primary information in turn from non-governmental organisations, governmental institutions and academia. In other words, information about nanotechnology has a clear impact on online discussions; this should be given greater attention as far as risk communication is concerned.

#### 5.1.7 Linguistic images focused on benefits and risks

The split in online discussions into opportunities/risks discourse and benefits discourse is also reflected in the linguistic images used. At the forefront are images whose point of reference is the effect of nanotechnology (in terms of either of fascination or the ascription of cer-

tain characteristics / qualities to actors), which corresponds to a pragmatic benefits discourse interested in actual applications. An analysis of the imagery also shows, however, that a fascination with effects is essentially closely linked to fears and concerns about nanotechnology at the level of associative perception. After all, it is specifically the perceived power of the technology's effects and its potential to get out of control that characterise risk discourse.

Taking this point a step further, it should be questioned which factors cause fascination to turn into fear. One theory is that this happens when people have no trust in the actors who develop or regulate the technology. The general characterisation of nano as "hype", the mistrust of advertising claims, the focus on the problem of observability ("secret threat") and negative benefit perceptions are also relevant in this context.

Essentially, the analysis of the image worlds shows that the old discourse on nanotechnology, in which considerable space was taken up by images relating to size aspects and "dystopian" and "utopian" scenarios, is being superseded by a discourse that revolves around the current concrete benefits of nanotechnology and around its risks, frequently ignoring the opportunities aspect that is prominent in political and mass media discourse.

#### 5.1.8 Argumentation generally simple and often critical of industry

A clear majority of the reviewed online discussion posts contain argumentative turns of phrase; the majority of these are simple in structure, merely explaining, for example, a certain point of view or evaluation. Only a minority of the argumentative posts use complex arguments such as weighing up pros and cons; this may also be due above all to the particular features of online communication and the discussion culture on the Internet.

Overall, the identified argumentation patterns show a similar structure to the image worlds. Depending on the author's viewpoint, concrete effects stand for either opportunities or risks of nanotechnology. A low level of knowledge is associated with risk ascriptions in the argumentation, and older discourse patterns, e.g. a "dystopian" perspective, are only rarely to be found.

One independent characteristic of the argumentation patterns is the perception of business as being the primary driving force behind the development; this is usually coupled with references to the risks of the technology and the powerlessness of consumers. As one would expect, it very often goes hand in hand with a mistrust of companies, and in isolated cases also with a mistrust of government institutions.

#### 5.1.9 Discourse increasingly perceived as polarised

When examining how the participants in online discussions view nanotechnology discourse in civil society, there is evidence not only of a great interest in characterising this discourse, but also of a remarkable shift over time. The view develops from diffuse and predominantly negative discourse characterisations via more positive and future-oriented characterisations to a current perception which often regards discourse as polarised, featuring one-sided risk and opportunity perceptions and proponents and opponents.

It should be noted, however, that this assessment of discourse in society represents a perception among online discussion participants that is often expressed in a highly generalised manner and as such cannot claim any objectivity. The discrepancy between this sort of picture of an overarching nanotechnology discourse and the disperse nature of online discourse found in this study is an indication that the characterisations should on the whole be interpreted with caution and do not necessarily allow conclusions to be drawn about the actual status of the nanotechnology discourse in society. Although the majority of posts relate to

scientific-political and mass media discourse, they may only reflect a polarisation specifically of online discourse.

#### 5.1.10 Life-world frames characterise positions

Analysing aspects related to the life-worlds of the participants and the corresponding nanotechnology frames in online discussions highlight a further differentiation within opportunities/risks discourse. It is particularly noticeable that the frames appear to depend on the subject areas. In medicine, scientific-progressive views predominate, while political-critical views are the norm in the area of nanofood and are still averagely represented in cosmetics. In the areas of vehicles, textiles and also cosmetics, however, pragmatic frameworks are over-represented in each case. These findings may be the result of differences in the respective life-worlds of the discussion participants.

Overall, a frame-based analysis reveals a quite typical and well-known conflict situation between three political and cultural life-worlds. On the one hand there are the proponents of nanotechnology, with their affinity with technology, while on the other are sceptics whose life-world is rooted more in those areas of civil society in which criticism of genetically modified food is also widespread. In addition, there is a large population group that has virtually no interest in this political controversy: they are more concerned with the everyday practicality of a new technology. The only group that has any real confidence – namely in science itself, above all – is the scientific and progressive life-world. The critical and political milieu is the group that is most mistrusting, especially of industry. The pragmatists, who focus purely on everyday issues, are largely indifferent, which is why they also make hardly any political demands. This is more the domain of the critical group; they call for labelling, more research into risks, more information and more political intervention in general. By contrast, the posts with a scientific or progressive tenor want more information to promote nanotechnology and more research to help it advance.

## 5.2 Classification of results and final remarks

The content analysis of online discussions, which focused on discussions of current nanotechnology applications and actual products, revealed the following central criteria as regards the perception of risks, opportunities and benefits:

- the individual life-world, cultural and political background of the participants,
- their knowledge level, that is to say their familiarity with the topic of nanotechnology or their experiences of nanoproductions,
- their appraisal of the level of knowledge of opportunities and risks of nanotechnology and, associated with this, the degree of confidence they show in science, politics, industry and mass media,
- comparisons with other technologies and risks,
- specific assessments with respect to certain applications or products; the perception of benefits plays a particular role in this context.

These central criteria will also be the focus of the following final discussion of the most relevant study results. This discussion, in view of the state of research, will concentrate on the most recent studies, and particularly on studies relating to Germany (above all Grobe et al. 2008, Zimmer et al. 2008b).

### **Assessment of nanotechnology in online discourse**

The most striking finding of the content analysis is probably the fact that the assessment of nanotechnology is generally more negative than positive in online discourse, though ambiguous or non-judgemental posts account for roughly a third of all posts.

To put this finding into context, the most recent figures relating to Germany should first be examined: the population surveyed conducted in September and October 2007 within the framework of a BfR project showed that 20% of respondents believed the benefits of nanotechnology to be far greater than its risks, while 46% believed its benefits to be somewhat greater than its risks. In comparison, 24% of respondents felt that the risks were somewhat greater, and just 9% were of the opinion that the risks are far greater than the benefits (Zimmer et al. 2008b, p. 20). Two thirds of the respondents tend to envisage advantages, in other words, while a third focus more on disadvantages. In 22% of respondents the “overall feeling about the subject of nanotechnology” is bad or (to an extremely low extent) very bad, and good or very good in 77% of respondents.

In the reviewed online discourse, there is in addition a noticeable rise in the number of negative assessments from 2005, especially to the detriment of the positive assessments. A glance at the years 2006 to 2008 shows that the endorsement of nanotechnology in online discourse is much lower than one would have presumed from the largely positive perception of nanotechnology in the population as a whole. It is particularly remarkable that a similar impression is gained, albeit generally to a much lesser extent, from an examination of online discussions of applications and products. Admittedly, the assessments of all non-medical applications and product groups tend to correspond to those in the population survey (for more on this, see Zimmer et al. 2008b, p. 17f.), yet unequivocally positive assessments of nanotechnology are relatively rare in online discourse.

### **Possible reasons for the assessment of nanotechnology in online discourse**

One obvious explanation of the frequently one-sidedly negative assessments of nanotechnology in online discussions may concern the particular features of discussions in general and of interactive online communication in particular. Generally speaking, views are often put forward in discussions without any weighing up of the respective pros and cons in an individual discussion contribution. Furthermore, short posts predominate as a rule in the reviewed online communication formats. Finally, the discussion culture on the Internet is seen, in some respects unjustly (cf. Chapter 1.4.2; Grunwald et al. 2006), as being rather confrontational and somewhat lacking in content.

Even if this obvious explanation should prove accurate, the findings would still not be irrelevant because the reviewed online discussions are based on genuine experiences and backgrounds and without doubt have the potential to influence and shape opinions.

In this context it is important first to remember that the examination of online discussions could not be expected to gain direct insights into the perception of risks among the population as a whole. Any attempt to learn more about the authors of posts in online discourse is doomed to failure on account of their heterogeneity. It is true that existing studies such as the ACTA (2008) can be used to build up a sociodemographic profile of the kind of Internet users who post contributions in forums or blogs;<sup>11</sup> as a glance at the gender distribution shows (see Section 4.1.3 above), however, the contents of the respective discussions clearly play such a major role in the decision to take part in specific discussions that it is impossible to draw any

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<sup>11</sup> It is noticeable that blog and forum users are younger on average than the general population (though only groups aged between 14 and 64 years can be compared). Among blog users, the 14 to 19 year-old age group is particularly overrepresented, while among forum users it is the 20 to 29 year-olds. When it comes to educational qualifications, there would appear at first glance to be an overrepresentation of people with a higher education entrance qualification, though a very large number have yet to acquire any qualification – there is likely to be a considerable interaction with the age variable here. For details of the gender distribution, see Section 4.1.3 above.

conclusions as yet from a global analysis of the users of such communication formats (for more on this, see also Albrecht 2006).

By selecting certain posts, the present study sought to examine a specific discourse whose participants had all signalled at least an initial interest in nanotechnology (by themselves choosing to take part in a discussion) or, as consumers, had even already consciously acquired experience of nanoproducts. Such interaction on the Internet can be compared to passing – though in some cases very intense – discussions “over the garden fence”; unlike such discussions, however, the results (in the case of forums and blogs) can remain accessible to any interested members of the general public over a considerable period of time.

For the purposes of the study, the character of this form of communication has the advantage that possible social trends can be detected in such conversations and, in this particular case, that a risk discourse and the emergence of lines of conflict can be observed. This also applies to the linguistic images, comparisons and other aspects. For nanotechnology discourse in society, and specifically for individuals interested in the subject as a whole or in particular applications and products, the discursive Internet public sphere relating to nanotechnology serves as an information resource and as a way to get involved in the discussion of the subject.

### **Few visionary aspects in the assessment of nanotechnology in online discourse**

Two aspects that are often discussed in the debate on the public perception and ethical and social evaluation of nanotechnology play no relevant role in the reviewed online discussions as criteria for the perception of risks, opportunities and benefits: first is the concern, expressed frequently at the beginning of the decade (Paschen et al. 2004) yet confirmed empirically in only very few cases (e.g. Cobb 2005), that nanofuturistic nightmare scenarios might have a considerable negative influence on public perception. This is not confirmed by the results of the content analysis (cf. corresponding results of the analysis of media reporting on nanotechnology, Zimmer et al. 2008c). This finding is in line with the current state of research, and is entirely to be expected given the specific nature of this study (with the content analysis focused on product- and application-relevant areas). As one would likewise expect, the topics of human enhancement and transhumanism, which are the subject of intensive discussion in ethical and political discourse (for a critical view of this, see Nordmann 2007a and 2007b), are also virtually absent from the reviewed online discussions. It is impossible to tell whether a greater focus on the general online discussions of nanotechnology (and on discussions of nano-applications in the area of information and communication technologies, which can be assumed to be highly technophile) would have shown a higher relevance of markedly visionary aspects for the perception of risks and opportunities (similar in some respects to the situation in the USA; cf., for example, Cobb et al. 2008; Scheufele et al. 2009). The results of the content analysis, however, suggest that nanotechnology in consumer- and product-related online discussions (including patient forums and other online discussions of serious medical applications) is raised in the great majority of cases quite separately from this specific imaginary and idea-historical background.

### **General aspects of online discourse on nanotechnology**

Online discourses help establish images and understandings of nanotechnology in society as a whole, and above all in certain groups. The Internet reflects the variety of specialist discourses in diverse modern societies and serves as a relatively extensive “archive” of such discussions (according to Carvalho/Pereira 2008 with respect to documents and press reports of organisations). Rodrigue (2001) argues that the Internet offers in some sense the long-awaited possibility for governments and professionals, and indeed lay activists, to get their messages concerning risks out to the general public, bypassing the mass media and reaching relatively large audiences. This raises the question, on the one hand, of the extent to which traditional sender-recipient models are dominant in the new technological form or in

interactive communication forms, and on the other raises the problem of a continuing split in the “general public” (see, for example, Grunwald et al. 2006). This latter potential problem is irrelevant, however, to an analysis of online discussions relating to a wide-ranging and highly diverse risk discourse such as that on nanotechnology. Given suitable methods of research and analysis, new spheres of discourse to discuss aspects of risk and benefit perception could be created. In addition to the “manual” scientific discourse analysis, technologies that allow large volumes of texts published on the Internet to be automatically identified, archived and classified are currently becoming increasingly important. Market research is increasingly taking advantage of web- and text-mining applications in order to monitor, for example, the distribution, connotation and popularity of product-relevant topics in customer forums.

Individual consumers can also use the Internet in a similar manner, and indeed have already long been doing so. Especially consumer online forums are used to find out about particular products and to learn about controversial appraisals of them (Sun et al. 2006). Even in areas such as medicine, where “providers” of services and products enjoy particular authority in society, patients contribute the knowledge and views they have acquired online to their discussions with doctors and pharmacists (see, for example, von Kardoff 2008). This development is furthered by the fact that communication and the highly personal sharing of experiences can often take place in a much more relaxed and honest manner than is the case in face-to-face situations. The advantages to be gained by disclosing or withholding information are also virtually irrelevant when people do not know one another. Moreover, interactions with consumers who already have concrete product experiences are relevant factors when it comes to making one’s own decisions, e.g. in the area of e-commerce (Ha 2002), but also in the days before the development of the World Wide Web (Sun et al. 2006). Generally speaking, communication between laypersons can have a decisive influence on attitudes towards the diffusion of innovations because it is often regarded as a more reliable source of information than mass media and marketing sources.

Regardless of how much importance one attaches to online discourse on nanotechnology with respect to the public perception of this field of research and development, the results of the content analysis can, in principle, shed new light on current discussions in the relevant research. After all, the authors of the posts represent a section of the population who have already expressed an interest in nanotechnology and, to a considerable extent, have also already had experience of nanoproducts.

### **Public perception of nanotechnology**

Reference can be made here to the recent developments in research into the public perception of nanotechnology (see Chapter 1.2.3). The massive criticism in this context of the “familiarity hypothesis” claims that knowledge of or familiarity in everyday life with an “objectively” practical and promising technological development with acceptable levels of risk diminishes or eliminates any initial concerns about it. The magazine “Nature Nanotechnology” published an article reminiscent of the old nanotechnology discourse – that is based predominantly on this hypothesis - (Currall et al. 2006) which became the target of criticism expressed in a letter to the publisher (Wintle et al. 2007). Its stance opposing the familiarity hypothesis was then picked up on and endorsed in a series of other articles in the magazine (see Nature Nanotechnology 2007).

In line with the mainstream attitudes in research in social sciences, cultural studies and humanities, there is broad consensus here that the perception of opportunities and risks, and the political assessment of new and as yet largely unknown technologies in particular – such as nanotechnology – is strongly influenced by fundamental cultural, political and world views among the general population (see Currall 2009, Kahan et al. 2009, Scheufele et al. 2009, Wintle et al. 2007; cf., for example, Smiley Smith et al. 2008). Precisely this cultural and life-world conditioning means that it cannot by any means be assumed that greater consumer

knowledge about a technology deemed useful in politics and science automatically results in more acceptance of it in the general population. The opposite is often the case (see, for example, Kahan et al. 2009). In such processes, the media have an important role to play as amplifiers of such influences and preliminary attitudes in risk perception in general (Rodrigue 2001).

### **Hypotheses from the analysis of online nanotechnology discourse**

Based on the results of the content analysis conducted for online discussions, simply opposing the familiarity hypothesis and the cultural cognition hypothesis certainly does not appear to help achieve the nuanced analysis of the perceived risks and benefits of nanotechnology that is, to a major extent, the study's goal. The following distinctions may be more promising:

- Complete lack of knowledge about the subject (and even of the term "nanotechnology")
- A low level of knowledge (including an initial interest)
- Familiarity with the subject and discourse in civil society (including wide-ranging familiarity but without concrete experience of products or processes)
- Experience of actual products (without there necessarily being any interest in the subject of nanotechnology)

The results of the content analysis then make the following assumptions appear plausible; these may serve as the hypotheses for further research:

- If a person has at least a low knowledge of nanotechnology, their cultural conditioning will be the most influential criterion in their perception of risks, opportunities and benefits; initial knowledge will be processed with the aid of the familiar interpretation patterns (cf. Smiley Smith et al. 2008)
- The same applies to discourse that is "detached" from concrete experiences, even if it is characterised by a high level of knowledge.
- If a person has concrete experience of products or processes, the risks and opportunities perspective becomes much less important, as benefits are increasingly weighed up (which in the majority of cases, though not in all areas of application, prove positive).

As far as the perception of risks is concerned, however, it is perhaps not the consumers' own knowledge of nanotechnology that is most important but how they assess the level of knowledge concerning risk among experts, politicians and businesses. One important criterion in risk perception is the extent of knowledge and ignorance about possible risks that is assumed to exist in society as a whole. This might suggest that a more traditional approach to risk and science communication should be followed, based on information and public understanding of science, although there is certainly a risk here that new findings in risk research could also generate new cause for concern (or might not break through society's cultural and political conditioning).

### **Influence of trustworthy institutions on nanotechnology perception**

If such an approach were to be chosen, it would make sense to take advantage of the differentiated methods and findings of more recent accompanying research and refrain from dismissing any consumer views that appear irrational as being due simply to a lack of knowledge. Another closely related success factor might be to increase the credibility of organisations in which consumers often have little trust, that is to say business enterprises and government institutions (cf. Siegrist et al. 2007b, Zimmer et al. 2008b). Pinning one's hopes in this context solely on the relatively good reputation of science is unlikely to suffice. The obvious approach would be to use, on the one hand, the often good reputation of consumer organisations, environmental groups etc. in the form of an even more participatory strategy of

risk communication (cf. NanoKommission 2008). On the other, greater emphasis should be placed in risk and science communication in politics and other domains on the findings and, no less importantly, on the basic approaches of the more recent accompanying research in social sciences, cultural studies and humanities. This concerns questions such as the relationship between expert and lay knowledge, the role of science in society and as a culturally embedded practice, and different notions of progress. In this respect, the present study, despite the observed signs of a polarised perception of the risks and indeed the benefits of nanotechnology, arrives at the same conclusion as Kahan et al. (2009, p. 89): “(N)othing in our study suggests that cultural polarisation over nanotechnology is inevitable. (...) The practical lesson of our study, then, is that those who favour informed public deliberations on nanotechnology should neither be sanguine nor bleak. Instead they should be psychologically realistic. If they are, they will see the urgent need for additional efforts to develop risk communication strategies that make it possible for culturally diverse citizens to converge on politics that promote their common interests.”

### **Classifying the results within current nano-discourse in Germany**

In view of the strong lifeworldly influences – and given also the cultural diversity of modern societies that is certainly desirable – this kind of approach towards promoting a policy which reflects common interests can of course never constitute a complete harmonisation of interests. Psychological realism should therefore go hand in hand with political realism. In the USA, nanotechnology was often communicated within a somewhat technophile and indeed technocratic framework (see, for example, Roco/Bainbridge 2002; cf. Coenen et al. 2004; Coenen 2009, TAB 2008). This is quite different to the German approach as represented by the NanoCommission of the German Federal Government. While stressing the precautionary principle and aspects of sustainability and the environment, this approach ties in with widely shared cultural and political influences without ignoring the innovation aspect (for more on this, see also Grunwald 2008). An examination of the situation in Germany, however, reveals a number of signs that further action is needed, even if the results of the content analysis are interpreted with caution. The fact that the latest population survey (Zimmer et al. 2008b), as well as other studies (e.g. Grobe et al. 2008), have produced very positive results with respect to the level of knowledge and general assessment of nanotechnology among the German public by international standards, should not allow one to overlook the potential that exists for confrontational risk discourse. Such potential is also evident from an analysis of the reviewed online discussions. Although the analysis results point in some cases only to slight deviations of online discourse from discourse in society as a whole, and although the former can by no means be seen necessarily as indicative of the emergence of a confrontational risk discourse, tendencies towards the development of a more nanotechnology-critical risk discourse in Internet discussions can nonetheless be observed.

### **Influence of proactive risk communication on nanotechnology online discourse**

If risk communication wished to become more involved in the multifunctional medium that is the Internet – seen as a highly interactively structured “sphere” of social, cultural and political practice (cf. Paschen et al. 2002; Grunwald et al. 2006) – supporting or indeed proactive and stimulating measures with respect to online discourse would be conceivable. In principle, there are two possible options here: first, active intervention in the discussion that is ongoing in diverse individual forums, in the form of an expert council in consumer forums, for example. In this respect it is important to remember, however, that the anonymous nature of and fundamental mistrust of self-attributions in online communication mean that communication can only take place on a “like-to-like” basis and that an external “expert status” will always remain precarious. The present study sporadically observed defensive reactions on the part of discussion participants when suspicion arose that certain information was being communicated not from the consumer’s point of view but from the strategic perspective of particular interests (especially by commercial companies). To this extent, a second alternative form of proactive risk communication on the Internet would appear more interesting, namely a spe-

cial online discourse on nanotechnology, organised basically in the same way as citizens' consultations. This type of discourse on the Internet would, on the one hand, bring together the scattered consumer discussions and put them in contact with expert discourse; on the other, the established discussions could be used to generate awareness of the online citizens' consultation (a successful example of proactive risk communication online is the "1000 Questions" project of the campaign Aktion Mensch – [www.1000fragen.de](http://www.1000fragen.de)).

### **Classifying the study results relating to online discourse on nanotechnology**

The results of the study indicate that online discussions have become increasingly important as a source and part of the information upon which target-oriented risk communication is based. In principle, there is a need for further research on interactive online communication – conducted first and foremost by consumers – concerning the risks, opportunities and benefits of nanotechnology. The results of the content analysis of online discussions correspond to the quantitative and qualitative results of the latest BfR study on the subject (Zimmer et al. 2008b) and of other studies (e.g. Pidgeon et al. 2009) in the sense that special attention should be paid to familiarisation with nanotechnology at the product level and to the question of its acceptance in the various areas of application. These are probably more important criteria for the perception of risks and benefits of nanotechnology than cultural conditioning or abstract knowledge (cf. also Pidgeon et al. 2009).

The present study has shown that analyses of interactive online communication can produce relevant contributions to research in this regard. Similar studies based on other countries or language areas could be used to verify the fundamental value of such analyses. The interactive Internet public sphere on nanotechnology provides the general public with a diverse and consumer-oriented information and knowledge resource – despite the volatile nature of information on the Internet – and with a "sphere" in which they can play their part in the social shaping of nanotechnology.

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## 9 Annex

### 9.1 Examples of posts in online forums and blogs on the subject of nanotechnology (from the sample material)

The screenshot shows the BMW E39-Forum website. The main navigation bar includes links for 'Registrieren', 'Mitglieder', 'User Map', 'Team', 'Suchen', 'FAQ', 'Userpage', 'Formel1 Tipp', 'Chat', 'Shop', 'Kalender 2010', 'E39 Wiki', and 'Regeln'. The forum title is 'Nano Versiegelung Frontscheibe'. The post is from a user named 'Neu hier' on 16.07.2008 at 18:23. The content of the post discusses the user's experience with nanotechnology for surface treatment on a Cadillac and a Mitsubishi 3000GT Spyder. The user mentions that the treatment was successful on the Cadillac but failed on the Mitsubishi, leading to a lawsuit against the company. The user asks for advice on how to proceed.

Example 1: Example of a forum post in the vehicles category relating to nanoproducts for surface treatment

The screenshot shows the Opel-Voting.de forum website. The main navigation bar includes links for 'Registrieren', 'Benutzer', 'Kalender', 'FAQ', 'Suchen', and 'Heut. Beiträge'. The forum title is 'Tuning allgemein'. The post is from a user named 'Neu hier' on 18.12.2005 at 10:48. The content of the post discusses the user's interest in nanotechnology as a fuel additive. The user asks for advice on how to proceed with the treatment and mentions that they have already contacted the manufacturer.

Example 2: Example of a forum post in the vehicles category relating to nanoproducts as a fuel additive

Version 2.0  
BETA

**gutefrage.net** Die Ratgeber-Community

powered by **Google**

STARTSEITE FRAGE STELLEN NEUE FRAGEN GUTE FRAGEN OFFENE FRAGEN NEUE ANTWORTEN TIPPS STÖßERN TOP NUTZER [Login](#) | [Forum](#) | [Richtlinien](#) | [FAQ](#)

---

**2** **Habt ihr schon mal was von Nano Food gehört und kommt sowas wirklich auf den Markt?**

gefragt von am 12.07.2008 um 13:15 Uhr

Ich habbe so etwas gelesen, dass Lebensmittel auf den Markt kommen sollen, die ganz komisch funktionieren. Zum Beispiel soll ein Milchshake je nach Stärke des Schüttelns dsnn nach Erdbeer oder Schokolade schmecken. Auch schon dann gehört, was haltet ihr davon? Gibts das überhaupt?

Weitere Fragen zu verwandten Themen finden Sie hier:

[Ernährung \(9336\)](#)   [Lebensmittel \(2111\)](#)   [Nano Food \(1\)](#)   [ähnliche Fragen](#)

---

**Antworten** [Kommentare ein-/ausblenden](#)

beantwortet von am 12. Juli 2008 13:17 2x

ja nach Stärke des Schütteln wird höchstens dein Geld mehr und mehr aus den Fingern entrollen

**Neu hier?**  
Jetzt [kostenlos registrieren](#) und gutefrage.net vollständig nutzen.  
**5 ANTWORTEN PRO MINUTE**  
Jetzt entdecken!

THEMEN ZU DIESER FRAGE

[Ernährung Lebensmittel](#)  
[Nano Food](#)

FRAGE VERFOLGEN

[RSS Feed](#)

[Frage bloggen](#)

DIESE SEITE BOOKMARKEN

Example 3: Example of a forum post in the foodstuffs category relating to nanoproducts in general

**RFID weblog**  
immer auf Sendung...

powered by **creativeweblogging**

Alle Blogs   Datenschutz   Hintergrund   Retail   Sponsored Post   Technik   Trends   Beste Artikel

---

« RFID-Kühlschrank bald auf... | [Hauptseite](#) | [RFID verdreifacht Zahl de...](#) »

**Nanonase meets RFID - Die Revolution im Supermarkt?**

abgelegt im Archiv News von am 05.01.07



Was machen Sie, wenn eine Ware in Ihrem Kühlschrank ein paar Tage über dem Verfallsdatum liegt? In den meisten Fällen lautet die Antwort wohl schlichtweg: Wegschmeissen, wengleich es sich doch um ein Mindest-Haltbarkeitsdatum handelt und die Waren meist noch tage-, wenn nicht wochenlang völlig genießbar sind. Experten schätzen, dass 30 Prozent aller Lebensmittel weggeworfen werden, nur, weil ihr Haltbarkeitsdatum überschritten wurde.

Die Lösung gegen dieses Problem lautet: Nanotechnologie plus RFID. Einem Bericht auf der Webseite des [Deutschlandsradios](#) zufolge, gibt es schon jetzt vielversprechende Versuche der niederländischen Aquamarin Micro Filtration BV, bei denen Nanodrähte auf bestimmte [chemikalien](#) reagieren:

*"Der Nanodraht reagiert auf eine Störung des ihn umgebenden elektrischen Feldes. Man muss natürlich eine sehr empfindliche Messmethode wie das 'Lock-In'-Verfahren verwenden: Man schickt einen Wechselstrom einer bestimmten Frequenz durch den Nanodraht und konzentriert sich auf die Widerstandsänderung bei dieser Frequenz; so kriegt man das Rauschen raus. Wenn jetzt eine Fremdsubstanz an den Draht andockt, ändert sich der Widerstand. Das Zeitintervall, in dem das stattfindet, ist ein weiteres Kriterium für die Qualität der Messung."*

RSS  | [Alle Abonnements sehen](#)

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Yahoo!

MEIN MSN

Bloglines

Newsletter

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---

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Benutzerdefinierte S

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kinkaa blog - das Blog zur Reiseschmaschine

blog.kinkaa

Kreuzfahrten

Das Mietwagen-Blog

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**BESTE ARTIKEL**

Example 4: Example of a blog post in the foodstuffs category relating to nanoproducts in packaging



Metis e.V. Forum Home Direktansicht Regeln Hilfe

Willkommen, Gast  
Bitte [anmelden](#) oder [registrieren](#). [Passwort vergessen?](#)

Metis e.V. Forum Metis e.V.- Forum Gesundheit nano-dynamic® Silberlösung  
Hepatitis B (1 Leser) (1) Gast

Die nano-dynamic®-Silberlösung wird in einem aufwendigen Produktionsprozess aus Hyper-nano-dynamic®-Wasser und kolloidalem Silberpulver hergestellt. Auch dieses Herstellungsverfahren ist ein speziell angepasster nano-dynamic®-Prozess. Der Erfolg des Herstellungsverfahrens und die Wirksamkeit der Silberlösung hängen wesentlich von der Reinheit und den subtilen Eigenschaften des Wassers ab, welches als Träger verwendet wird. Mit seiner hohen Aufnahmefähigkeit ist nano-dynamic®-Wasser dem zu Folge der ideale Träger für die hochwertige Silber-Substanz. Die Silberlösung ist unmittelbar beim Eintritt in den menschlichen Organismus extrem reaktionsfreudig, aufgrund ihrer großen Oberfläche hochwirksam. Bereits geringe Mengen können die erwünschte Wirkung hinsichtlich der Stimulation des Immunsystems und somit die Stärkung der Selbstheilungs- und Abwehrkräfte herbeiführen. Die nano-dynamic®-Silberlösung ist daher weitaus wirksamer als herkömmliche Silberpräparate und ein unspezifisch wirksames Nahrungsergänzungsmittel zur Modulation des Immunsystems und Förderung des allgemeinen Wohlbefindens.

Beliebt: 0

**Example 7: Example of a forum post relating to nanoproducts as dietary supplements.**

16.09.2006, 11:35 #33

 ?

 Beautyprofil

Registriert seit:   
Beiträge: 

weg 😊

☯ ☯

**AW: Nanopartikel Kosmetik**

Hallo Ihr Lieben,

hier ist ein Artikel zu DMS, Liposomen und Nanoparts:

<http://www.vitalsysteme.de/nanopartikel.html>  
<http://www.vitalsysteme.de/pdf/BF-05-03-Liposom.pdf>

DMS-Cremes sind ja eher einfache Basiscremes, die die Haut nicht reizen und die Hautfunktionen stabilisieren durch Phospholipide. Diese ähneln den natürlichen Hautfetten. Durch Liposomen und Nanoparts kann man gezielt Wirkstoffe zuführen. Man erreicht dadurch wohl die tieferen Schichten der Oberhaut (die Zwischenräume zwischen den Hautzellen).

Ich denke, dass DMS-Cremes mit den richtigen Wirkstoffen nicht austrocknen. Bei sehr trockener Haut sollte man nicht nur Feuchtigkeit, sondern auch kaltgepresste Öle ergänzen.

LG



**Example 8: Example of a forum post in the cosmetics category relating to nanoparticles in skin creams.**

nanoproducts.de  
nano products & technologies

MITGLIEDER    TEAM    SUCHEN    FAQ    FORUM

---

**Nanotechnologie Diskussionsforum für alle Themen rund um Nanotech, Nanoprodukte und Nanowissenschaften »** » Hallo Gast  
[anmelden] [registrieren]

Druckvorschau | An Freund senden | Thema zu Favoriten hinzufügen

Autor	Beitrag
	<p style="text-align: right;">« Vorheriges Thema   Nächstes Thema »</p> <p><b>Sonnenschutz</b> <input type="button" value="ZITAT"/> <input type="button" value="BEARBEITEN"/> <input type="button" value="MELDEN"/> <input type="button" value="IP"/> <input type="button" value="↓"/></p> <p>Hallo,</p> <p>ich habe auf einer anderen Webseite eine Sonnencreme bzw. ein Spray von der Firma  gesehen. Die sagen, es wären anorganische Titandioxid Nanopartikel als UV Schutz enthalten. Auf der  Webseite findet man allerdings nichts über Nanotechnologie. Hier in dieser Datenbank finde ich auch nichts zu den  Sonnenschutzmitteln. Hat die Sonnencreme was mit Nano zu tun? Was passiert eigentlich mit solchen Partikeln auf der Haut? Dringen die ein? Können die in die Blutbahn gelangen und anreichern?</p> <p>Danke</p>
28.07.2007 18:54	<p style="text-align: right;"><input type="button" value="ZITAT"/> <input type="button" value="BEARBEITEN"/> <input type="button" value="MELDEN"/> <input type="button" value="IP"/> <input type="button" value="↓"/></p> <p>Eine etwas ältere Nachricht. Hab ich von der taz.de</p> <p><i>Von wegen bedenkenlos bräunen: Titandioxid, wie es in Hightech-Sonnenschutzmitteln verwendet wird, steht im Verdacht, Nervenzellen zu schädigen. Dazu müssen die Nanopartikel allerdings erst einmal einen Weg durch die Haut finden</i> VON WOLFGANG LÖHR</p>

**Example 9: Example of a forum post in the cosmetics category relating to nanoproducts in sunscreen products.**

 <p><b>Lebt im Forum</b> Registriert seit:  Ort:  Beiträge:  <a href="#">Meine Fotos</a></p>	<p>11.03.2005, 18:40    <b>NANO Nässeblocker Imprägnierung - das neue Wunderspray?</b>    #1</p> <p><a href="#">Klick</a></p> <p>Testsieger bei Fit for Fun TV - klar, dass ich da zuschlagen musste. 🍀</p> <p>Lt. "Fit for fun" ist das Zeug schlicht sensationell und hält seine Wirkung auch noch außergewöhnlich lange aufrecht. NANO Nässeblocker hat das (zweitplazierte) Produkt von Granger´s klar hinter sich gelassen. Lt. Deichmann für alle Leder und Textilien zu verwenden. "Das neue Wunderspray schützt Schuhe und Bekleidung aus Leder und Textil monatelang gegen Schmutz und Feuchtigkeit. [...] Besonders wirksam bei sparsamer Anwendung" - klingt gut! 😊</p> <p>Hat das Zeug schon jemand ausprobiert? Ich bin sehr gespannt! 250ml kosten übrigens 7,95 EUR. (Granger´s XT: 300ml, 14,95 EUR)</p>
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**Example 10: Example of a forum post in the textiles category relating to nanoproducts for waterproofing.**

Suchbegriff 

[WISSEN](#)
[KAUFEN](#)
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**Neues aus Utopia.** Hier erfahren Sie die wichtigsten Nachrichten, die interessantesten Meldungen und green gossip aus der nachhaltigen Welt - und zwar tagesaktuell. Dazu Fakten, Hintergründe und Meinungen von unseren Utopia-Korrespondenten auf allen Kontinenten. **Bleiben Sie mit uns auf dem Laufenden.**

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Startseite / Wissen / Neuigkeiten / [27.03.08: Riskante Lebensmittel - BUND fordert Verkaufsstopp für Nano-Produkte](#)

**Log-In für Utopisten**

Benutzername:

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[Auf nach Utopia](#)

**27.03.08: Riskante Lebensmittel - BUND fordert Verkaufsstopp für Nano-Produkte** 27.03.2008



Redaktion

Gesamt: ●●●●● 5

**Obwohl es eine wachsende Zahl wissenschaftlicher Belege für mögliche Gesundheits- und**

[Reaktionen](#) [Auf dieser Seite einen neuen Kommentar hinzufügen.](#)

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Utopist

04.04.2008

**Vielleicht hat das Ganze ja ein Gutes...**

..., nämlich, dass wir uns bald selbst von diesem Planeten katapultieren.

Soweit der Sarkasmus.

Selbst als Bio-/ökologisch ausgerichteter Mensch haben wir doch keine Chance, diesem Wahnsinn zu entgehen, da keiner weiß, wo Nanopartikel verwendet werden. Die sind ja nicht deklarationspflichtig und auch sooo nützlich (und überwinden u.a. auch die Hirn-Blutschranke).

Vielleicht können wir aber Druck machen mit einer Petition o.ä., wie ja bereits vorgeschlagen - ich bekäme einige Unterschriften zusammen!

Trotzdem - freundliche Grüße,

Gesamtwertung ●●●●● 5

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Utopist

02.04.2008

**Wo ist die Petition?**

Während wir uns noch mit der Abwehr der Gentechnik beschäftigen, kommt uns nun hinterrücks auch noch die Nanotechnik auf den Teller.

Was erzählen uns die Befürworter der Nanotechnologie? Richtig, sie argumentieren mit dem Hunger in der Welt, versprechen höhere Ernteerträge + geringe Umweltbelastung. Ungeachtet der gesundheitlichen Risiken (Blutgerinnsel, Morbus Crohn, Krebs etc.) wächst der Weltmarkt für funktionelle Nahrung. Auf der einen Seite die Macht der Konzerne - auf der anderen immer mehr Menschen, die nicht von ihrer Hände Arbeit satt werden.

Wo, frage ich mich, ist die Möglichkeit einer Petition??? hier auf Utopia oder über den BUND, der das Ganze jetzt in die Öffentlichkeit bringt? Bis dahin und weiterhin können wir beim Einkaufen immer mit den Füßen abstimmen und Biokost kaufen

Gesamtwertung ●●●●● 5

**Example 11: Example of a blog post in the general discussion category relating to political demands with respect to nanoproducts.**

## 9.2 Researched websites and arenas relating to nanotechnology

### 9.2.1 Arenas with a particularly high profile in the nano Internet public sphere

Position	Website URL	Type of website	Characterisation of arenas
1	de.wikipedia.org	Wikipedia; relevant articles (e.g. "Nanotechnologie" (i.e. nanotechnology), "Nanobeschichtung" (i.e. nano-coating), "Molekulare Nanotechnologie" (i.e. molecular nanotechnology) and "Nanopartikel" (i.e. nanoparticle))	Discussion forum for each article, <20 relevant discussion posts in total
15	www.nanotechnologie-forum.de	Forum of the nanotechnology website www.nanoproducts.de	152 relevant posts in total
18	www.welt.de	Website of the German daily newspaper "Die Welt" with readers' comments about articles	1 article about risks of nanotechnology with 24 comments from readers
26	www.heise.de	Website of a publisher specialised in IT; blogs and forums of the online publications "Telepolis" and (German) "Technology Review"	Various articles and numerous blog posts about nano, each including comments
35	forum.golem.de/index.php?100	Forum of a website that specialises in IT but also addresses other fields of technology	Discussions in the forum, including about nanofuturism
98	www.focus.de	Weekly magazine; forums relating to individual articles, including on nano topics	Forum includes 1 medium-length thread about the risks
130	www.wallstreet-online.de	Forum about financial investment, stock exchange & shares	Nanotechnology sub-forum about "nano" shares, investment funds etc.; 864 "nano" threads with several thousand posts in total
211	www.motor-talk.de	Vehicle forum (especially cars; including chats and blogs)	At least 40 "nano" threads; focus on sealing

Explanatory note: The table lists all arenas to be found among the first 500 results of a Google search for the term "nanotechnology" (cf. Section 3.1) – and as such were particularly visible within the nano Internet public sphere – in order of their mention (see column "Position").

### 9.2.2 Other researched arenas relating to nanotechnology, listed in alphabetical order by URL

Website URL	Type	Type of website	Characterisation
anna.nzzcampus.ch	Blog	Diary; student life	6 posts
architektur.kaywa.ch	Blog	Mix; architecture and daily life	1 post about future vision, architecture
babble.antville.org/main	Blog	Diary; personally relevant issues	1 post about risk
blog.bruysten.com	Blog	Mix; focus on design topics	4 posts about convergence, future visions
blog.darkplasma.de	Blog	Diary; all kinds of issues	1 post about nanotechnology in general, risk, reference to BfR
blog.europadruck.com	Blog	PR blog; printing industry, graphic design industry	3 posts about paper, markings, safety technology
blog.handwerker-fair.eu	Blog	PR blog; services provided by companies to trade and construction	2 posts about hygiene, surface sealing
blog.hna.de	Blog	PR blog; blog accompanying Hessische/Niedersächsische Allg. newspaper	3 posts, including about nanoparticles, nanolithography, nanofiltration
blog.hotel-gastronomie-service.eu	Blog	PR blog; services provided by companies to hotels and catering industry	1 post about surface sealing, lotus effect
blog.jvm-neckar.de	Blog	PR blog; design	1 post about Nokia Morph
blog.kairaven.de	Blog	Diary; technology	4 posts, in 3 other posts only mention of nano's small size
blog.kooptech.de	Blog	Specialist blog; media/technology	1 post about Nokia Morph
blog.markt-studie.de	Blog	Specialist blog; advertising and marketing	3 posts, including about risk, products (textiles, cosmetics, car paints)
blog.maschinenmarkt.de/index.php	Blog	PR blog; industry news	2 posts about material research
blog.omc.ch	Blog	Suspected spamblog; all kinds of issues	1 post about nanosealing
blog.safog.com	Blog	Specialist blog; science	1 post about nanosilver
blog.sentinel-haus.eu	Blog	PR blog; building and home	1 post about risk, criticism, nanoparticles
blog.stif2.de	Blog	Mix; information for students of Pasing State Institute	1 post about nanocoating of yoghurt pots
blog.timehelp.ch	Blog	Diary; all kinds of issues	1 post about nanoparticles
blogs.pm-magazin.de/openscience	Blog	Specialist blog; science; science communication	6 posts, including about nano degree courses, risk communication, trade fairs, exhibitions, nanoparticles, nanomedicine
board.beauty24.de	Forum	Beauty forum	Among other things, 1 long thread about sunscreen products (with numerous mentions of nanoproducts and risks)
bonner-wirtschaftsgespraech.de	Blog	PR blog; business and culture in Bonn	29 posts, including about the research landscape
cipha.de	Blog	Magazine; sci-fi, future, technology	14 posts, including about risk, future visions
das-ist-drin.de/blog	Blog	Specialist blog; diet, health	2 posts, including about risk, nanofood, nanoparticles
didgeridu.dead-parrot.de	Forum	Musicians forum (about the didgeridoo)	1 short thread about nanocoating of didgeridoos
doktorsblog.de	Blog	Mix; technology, all kinds of issues	5 posts, including about risk
dortmund-blog.de	Blog	Mix; information, discussions about Dortmund	1 post about research

Website URL	Type	Type of website	Characterisation
elearningblog.tugraz.at	Blog	Specialist blog; e-learning and new technologies in general	1 post about Nokia Morph
etosha.weblog.co.at	Blog	Diary; personally relevant issues	2 posts, nano only as a synonym for progress
finanzblog.kaywa.com	Blog	PR blog; business and finance	20 posts, including about risk
fisch-blog.blog.de	Blog	Specialist blog; natural sciences	22 posts, including about risk (Morgelons theories)
forum.bmw-voten.de	Forum	Vehicle forum, cars (BMW)	At least 1 thread about hard wax
forum.boote-magazin.de	Forum	Vehicle forum, boats	At least 1 medium-length thread; about experiences of nanocoating (without risks)
forum.die-nanos.de	Forum	Forum for students of nano structural studies at a university	Discussions of study planning and the like
forum.digitalfernsehen.de	Forum	Forum about television	1 short thread about nanocoating of aerials
forum.finanzen.net	Forum	Stock exchange forum	1 short thread about nano shares
forum.garten-pur.de	Forum	Gardening forum	1 medium-length thread about risks of nanotechnology (though with many joking posts)
forum.geizhals.at	Forum	General consumer portal	1 short thread about nano cleaning agents (with an argument about advertising in the forum)
forum.gute-fahrt.de	Forum	Vehicle forum, cars (VW and Audi)	At least 1 short thread about nanosealing
forum.infokrieg.tv	Forum	Political forum	1 short thread about risks of nanotechnology (especially nanofood)
forum.kijiji.de	Forum	General forum portal	1 short thread about nano cleaning agents
forum.mini2ig.de	Forum	Vehicle forum, cars (Mini)	5 threads about nanosealing, one of medium length
forum.oekotest.de	Forum	Publisher's website (consumer advice)	At least 1 medium-length and 1 short thread relating to discussion about "neosino"
forum.outdoorseiten.net	Forum	Outdoor forum	1 medium-length thread about nano waterproofing for shoes
forum.spiegel.de	Forum	Forum of the German news magazine	65 threads with a reference to "nano", including about nanofood, nanotechnology in general, nanoparticles
forum.tagesschau.de	Forum	Forum of the German TV news programme	Fewer than 10 posts, including about economic policy
forum.team2hoernchen.de	Forum	General forum portal (local)	Car sealing, 1 question with 1 response
forum.yacht.de	Forum	Vehicle forum, boats (yachts)	6 threads with "nano" in the title, including several of medium length; a total of 67 posts containing the word "nano" (particularly fouling protection, but also motor additives)
forums-de.anarchy-online.com	Forum	Computer game forum (about a particular online role-playing game in a "nanofuturistic" science fiction world)	Several 100 threads with "nano" in the title
fuwatch.wordpress.com	Blog	Watchblog; development of the FU Berlin	1 post about research policy
govo.de/blog	Blog	Diary; personally relevant issues	2 posts, including note about events
grenzwissenschaft-aktuell.blogspot.com	Blog	Specialist blog; fringe and parascience	3 posts, including about risk
gruene-pest1.com	Forum	Political(?) forum	1 conspiracy theory post with 1 response

Website URL	Type	Type of website	Characterisation
hahn.blogkade.de	Blog	Diary; all kinds of issues	Clearly simply the reuse of articles by others...
infam.antville.org	Blog	Watchblog; satire of media	3 posts, including about economic policy
john-locke.blogspot.com	Blog	Diary; all kinds of issues	1 post, nanotechnology in general
kinder-psyche.blogspot.com	Blog	Specialist blog; psychotherapy, children, health	1 post about nanofiltration
kommentare.zeit.de	Forum	Comments by readers of the German weekly newspaper	7 finds, including about nanotechnology in general, economic policy, nanorobots
konsumblog.de	Blog	Specialist blog; consumer protection, criticism of consumerism	7 posts, including about risk, Magic Nano, sunscreen products, nanofood
leicht.ykom.de	Blog	Diary; personally relevant issues	1 post about risk, nanoparticles
nano0.at	Blog	Suspected spamblog; all kinds of issues	12 posts, including about nano paint; nanosealing; nano car care; lotus effect
nano-for-energy.de/nanoene	Blog	Suspected spamblog; nanotechnology; health and well-being	15 posts, including about powernano, glasses coating, additives
neuerdings.com	Blog	Specialist blog; electronic gadgets	5 posts, including about future visions; Nokia Morph; nano pad
omspace.org	Forum	Health forum (esoteric medicine)	1 post about nano toothpaste (hardly any response)
piratenblog.wordpress.com	Blog	Mix; posts about pirate party, science and technology	Approx. 50 posts, including links to research results
powerforen.de	Forum	General forum portal	1 medium-length thread about risks of nanofood
schriftstellerwerden.blogspot.com	Blog	Mix; literature and other topics	1 post, nano only as a sci-fi element
schweizerblog.ch	Blog	Specialist blog; Internet and technology	1 post about Nokia Morph
sieghai.wordpress.com	Blog	Mix; personally relevant issues	3 posts about nanotubes, nanobots
staycleaner.blogspot.com	Blog	PR blog; nanotechnology and sealing	3 posts about products (sealing), nanotechnology in general
suboptimales.wordpress.com	Blog	Diary; political issues, personally relevant issues	1 post about surveillance technology
trendtester.over-blog.com	Blog	Specialist blog; trends, lifestyle, products	1 post about nano pad
w3projekt.com	Blog	Specialist blog; computer technology, Mac news, NetzWelt and IT vacancies	2 posts about research, nanofibres
web558.webbox239.server-home.org/cpcii/wordpress	Blog	Specialist blog; cyberpunk	2 posts about research, textiles, nano conductors
webstyler.de/category/chronologisch	Blog	Specialist blog; product communication	1 post about economic policy
wir-2.spaces.live.com/blog	Blog	Diary; all kinds of issues	1 post about consumer protection, risk communication
wutzblog.wordpress.com	Blog	Diary; personally relevant issues	1 post about waterproofing spray
www.1000fragen	Forum	Ethics forum (of charity "Aktion Mensch")	The sub-forums of 2 (of a total of 1,000) questions focus on transhumanistic and other nanofuturistic visions.
www.7-forum.com/forum	Forum	Vehicle forum, cars (certain types of BMW)	Among others, 6 threads about nanosealing which have a total of 60 posts and include three medium-length threads
www.alfisti.net	Forum	Vehicle forum, cars (Alfa Romeo)	Several medium-length threads about nanosealing; one short thread about engine additives

Website URL	Type	Type of website	Characterisation
www.amazon.de	Forum	Online bookshop with reviews by users and forums	Several non-fiction books about nanotechnology received 1-4 reviews.
www.antifouling-shop.com	Forum	Vehicle forum, boats (website about fouling protection for boats)	1 question without any response
www.ariva.de	Forum	Stock exchange forum	Query about nano shares (from 2002)
www.autoextrem.de	Forum	Vehicle forum, cars	At least 1 short thread about nano paints (with deleted advertising)
www.auto-treff.com	Forum	Vehicle forum, cars	Among others, 2 medium-length threads about vehicle care; including risk aspects
www.basichinking.de/blog	Blog	Mix; computer scene, Web development	4 posts about future vision, human enhancement, nanoclothing
www.besserlackieren.de	Forum	Paints forum	1 short thread about nano paint
www.best-practice-business.de/blog	Blog	Specialist blog; business consultants	Approx. 20 posts, including about future visions, research, nanoparticles, nanosilver
www.biermann-web.de/fliesen-heimwerker-sanitaer	Blog	Specialist blog; DIY	3 posts about sealing, nanosilver
www.bio100.de	Forum	Organic products forum	1 short thread about risks of nanotechnology
www.blog.nano4home.de	Blog	PR blog; nanotechnology and nanoproducts	8 posts, including about nanosealing, building care, criticism; sees itself less as a blog and more as a forum for comments – though without any participation
www.bmbf.de	Chat	Chat on German Ministry website	1 chat with a “nano expert”; including about risks
www.bmw-syndikat.de	Forum	Vehicle forum, cars (BMW)	At least 1 medium-length thread about nanosealing; registration required to search
www.boote-forum.de	Forum	Vehicle forum, boats	At least 1 short thread about risks (“Magic Nano”)
www.boschblog.de	Blog	Diary; personally relevant issues	1 post about surveillance technology
www.ccfreunde.de	Forum	Vehicle forum, cars (Peugeot)	Including 4 threads of medium length about nanosealing
www.chefkoch.de	Forum	Cookery forum	A sub-forum about a kitchen exhibition includes 1 thread with “nano” in the title and 14 posts
www.ciao.de	Forum	Forum portal for product assessments	2 reports of experience of nanosealing
www.cthulhu-forum.de	Forum	Role-playing forum (based on literary fantasy world of the horror genre)	At least 1 long thread which includes, among many other things, some posts about nanotechnology reality and visions
www.daytrading.de/blog	Blog	Specialist blog; finance and investment	2 posts, Nokia Morph
www.die-ideenschmiede.de	Blog	Specialist blog; innovation, business	2 posts about innovation, nano paint, sealing, nano generators
www.dieweltistscheisse.de	Blog	Diary; all kinds of issues	3 posts about future visions, research, nanorobotics
www.duckhome.de/tb/index.php	Blog	Diary; personally relevant issues	1 post, about batteries
www.dyingeyes.de	Blog	Diary; personally relevant issues	1 post, nano only as sci-fi element
www.dzkgblog.de	Blog	Specialist blog; medicine, research	1 post about nanomedicine
www.e39-forum.de	Forum	Vehicle forum, cars (certain types of BMW)	Including 1 thread with 48 posts about nanosealing of the windscreen
www.ethlife.ethz.ch	Forum	University website	1 article about nanofood with 1 comment

Website URL	Type	Type of website	Characterisation
www.faz.net	Forum	Comments by readers of the German newspaper	5 readers' opinions of nanotechnology, including nanofiltration, memory chips, nano research
www.fiestast-forum.ch	Forum	Vehicle forum, cars (Ford); Switzerland	At least 1 medium-length thread about nanosealing
www.forum-chemie-macht-zukunft.de	Chat	Chats on chemistry website	2 chats, each with a nanoscientist, including about risks
www.frag-mutti.de	Forum	General forum portal (providing advice)	1 short thread about car care
www.ftd.de/debatte	Forum	Newspaper forum	13 threads relating to "nano", including about nano as a technology of the future
www.gesundheits-weblog.de	Blog	Specialist blog; health, medicine, research	9 posts, including about risk, research, nanomedicine
www.gnogongo.de	Blog	Diary; personally relevant issues	1 post, nano tubes as rat poison
www.gruendernet.de	Blog	Specialist blog; information for company founders	2 posts about innovation, grants
www.gutefrage.net	Forum	General forum portal (providing advice)	Including 1 medium-length thread about nanofood, including risks, 2 short threads about nano cleaning agents, and 1 short thread about what nanotechnology is
www.haufe.de	Forum	Publisher's website with forum	Occupational safety and health subforum contains 1 short thread about toner dust and risks of nanoparticles
www.hausgarten.net	Forum	Gardening forum	1 short thread about nano glasses cleaning agents
www.hdschellnack.de	Blog	Mix; design and other issues	11 posts, including about future visions, nanobots
www.healthexperiment.com	Blog	Specialist blog; medicine and health	3 posts about risk, nanoparticles (bilingual blog)
www.heise.de/tr/blog	Blog	Specialist blog; technology	Approx. 30 posts, including about risk, nano matter, nanofood, nanoparticles, human enhancement
www.ideenverteiler.de	Blog	Specialist blog; advertising and marketing	1 post about advertising means, nano printing
www.info-pause.de	Blog	Diary; personally relevant issues	1 post, nano as an indicator of economic development
www.julia-adriana.de	Blog	Diary; personally relevant issues	1 post about progressiveness, science fiction
www.kilo-leicht.de	Blog	Specialist blog; diet and healthy living	1 post about risk, nanofood
www.krebs-kompass.org	Forum	Health forum (clinical nano cancer therapies)	67 mentions of nano; 2 medium-length threads with "nano" in the title
www.leben-ohne-diaet.de/blog/index.html	Blog	Specialist blog; diet, health	1 post about risk, nanofood
www.lebensmittelallergie.info	Forum	Health forum (allergies)	1 short thread about nanofood
www.lifeline.de	Forum	Health forum	1 short thread about nanosilicon to combat fungal nail infection
www.lohas-blog.de	Blog	Specialist blog; sustainability, spirituality, appreciation	1 post about risk, nanoceramics, coating of pans
www.mc600.de	Forum	Health forum (clinical nano cancer therapies)	1 short thread about nano
www.med1.de	Forum	Health forum	1 medium-length thread about nanosilicon to combat vaginal thrush; also risks of nanoparticles
www.mediacoffee.de	Blog	Specialist blog; communication, PR, journalism	1 post about consumer conference on nanotechnology
www.mediauser.de	Blog	Diary; media, technology, gadgets	1 post about IT
www.metis-ev.eu	Forum	Product supplier website in the area of esoteric medicine with forum	No response

Website URL	Type	Type of website	Characterisation
www.mittelstandsblog.de	Blog	Specialist blog; business, small/medium-sized enterprises, company management	12 posts, including about economic policy, innovation, risk, nanomaterials
www.modulor.de/blog	Blog	PR blog; material and production, product design	7 posts, including about paper, textiles, coating, materials
www.musiker-board.de	Forum	Musicians' forum	At least 1 medium-length thread about guitar strings called "Nano Webs"
www.nano-forum-nrw.de	Forum	Product supplier website in textiles industry, with forum	Hardly any responses
www.nano-invests.de	Chat	Chat on stock exchange website	One chat, entitled "expert forum", with an expert in nano shares
www.nano-polis.de	Blog	Specialist blog; nanotechnology, innovation, technology design	16 posts, including about nanotechnology in general, risk discourse
www.nanoproducts.de	Blog	News service; nanotechnology in general	> 50 posts, including about innovation, products, risk
www.nanotechnik-forum.de	Forum	Nanotechnology website	Broad spectrum of topics but only 8 posts in total
www.nanowerk.com/phpscripts/n_news.php	Blog	News service; nanotechnology in general	> 50 posts, only some in Germany, covering various topics and products
www.nensch.de	Forum	Essay forum (covering broad range of topics)	1 medium-length thread about nanotechnology visions and reality
www.nikella.de	Forum	Vehicle forum, cars (only vehicle care)	306 posts in total about "nano"
www.nil4you.com/blog	Blog	Specialist blog; electronic gadgets	5 posts, only about iPod and nanosilver coating
www.oberlehrer.de	Blog	Diary; computer, personally relevant issues	1 post
www.opel-voting.de	Forum	Vehicle forum, cars (Opel)	At least 1 medium-length thread about nanosealing
www.passatforum.com	Forum	Vehicle forum, cars (VW)	At least 1 thread about nanosealing
www.pavatex.ch/weblog.aspx	Blog	PR blog; insulating materials, construction industry	1 post about risk, nanoparticles, environmental contamination
www.peugeotboard.de	Forum	Vehicle forum, cars (Peugeot)	At least 1 medium-length thread about nanosealing
www.portablegaming.de	Forum	Compute game forum	1 medium-length thread about nanosealing of Play Stations
www.rea51.de	Forum	Esoteric, mystery and conspiracy theory forum (declaredly)	1 medium-length thread about nanofood
www.readers-edition.de/index.php	Blog	Mix; all kinds of issues	7 posts, including about innovation, nano measurement technology, nano imprint
www.reinigungsforum.de	Forum	Cleaning forum	2 threads containing a total of 30 posts
www.rfidweblog.de	Blog	Specialist blog; RFID	2 posts about research, nano wires, sensors, nanosilver
www.risikodialog.at	Forum	Nanotechnology risks dialogue Austria	A total of 17 posts, no medium-length thread
www.roboternetz.de	Forum	Robotics forum	3 small threads about nanotechnology
www.sata.com	Forum	Product supplier website in the paints industry, with forum	Hardly any responses
www.scheidenpilz.com	Forum	Health forum, vaginal thrush	2 small threads about nanosilicon to combat vaginal thrush
www.schroeder-wendt.com/blog	Blog	Specialist blog; interface design, usability	2 posts about production technology, materials, Nokia Morph
www.schweizblog.hochparterre.ch	Blog	Specialist blog; architecture, design	2 posts, including about Swiss Re study
www.scienceblogs.de/deutsches-museum	Blog	Specialist blog; science and technology	6 posts, including about research results, knowledge communication, surface technology, nanophysics

Website URL	Type	Type of website	Characterisation
www.scienceblogs.de/nanojugend	Blog	Specialist blog; information about youth nanomedicine forum	7 posts, including about research, business, products (cleaning agents), criticism
www.scienceblogs.de/neurons	Blog	Specialist blog; science and research	4 posts about research, risk, materials, IT
www.scienceblogs.de/wissen-schafft-kommunikation	Blog	Specialist blog; science and research results	4 posts about risk, nanosealing, surface coating
www.scifinet.org	Forum	Science fiction forum (cyberpunk)	At least 1 medium-length thread about nanotechnology in general, risks and visions
www.seeblog.seelicht.ch	Blog	Diary; personally relevant issues	1 post about risk, nanoparticles, risk of progress
www.shopblogger.de/blog	Blog	Diary; events concerning a supermarket	1 post about risk (referring only to newspaper article)
www.slstalk.de/index.html	Blog	Specialist blog; second life	1 post, future vision
www.spiel-fans.de	Blog	Specialist blog; computer games	1 post, nano only as topic in computer games
www.spin.de	Forum	General forum portal	1 medium-length thread about risks and about nanotechnology in general
www.sueddeutsche.de	Forum	Daily newspaper; with sporadic posts about nano issues (risks, nanotechnology in general and nano-products for cars)	Articles contain <2 comments
www.tachoteam.de	Forum	Vehicle forum, cars	1 short thread about engine additives
www.tanzpartner.at	Forum	General forum portal; Austria	47 posts; one medium-length thread about window cleaning
www.tanzpartner.info	Forum	General forum portal	34 posts; one medium-length thread about why "nanoproducts" are still so expensive
www.taz.de/1/debatte/leserforen	Forum	Comments by readers of the newspaper	Comments relating only to one post about consumer protection issues
www.terraon.de	Forum	Terrarium forum	1 short thread about glass cleaning, including risks
www.thafaker.de	Blog	Diary; all kinds of issues	1 post about forgery scandal
www.trendbuero.de/index.php?f_categoryId=155	Blog	PR blog; trends, innovations	6 posts, including about research, innovation, cosmetics, health, energy, textiles, nanorobotics
www.tr-freun.de	Forum	Vehicle forum, cars	1 medium-length thread about engine additives
www.umweltdatenbank.de	Forum	Environmental forum	1 short thread about nanotechnology in general
www.uni-protokolle.de	Forum	General forum for students	Includes, among other things, 2 short threads about choice of degree course and 1 short thread about nanosilicon wonder drugs
www.ursispaltenstein.ch/blog	Blog	Diary; all kinds of issues	1 post, reference solely to other site
www.vectra-forum.de	Forum	Vehicle forum, cars (Opel)	A total of 20 posts containing "nano", with two threads among them
www.venture-lounge.de	Blog	PR blog; venture capital	2 posts about business, investment
www.webnews.de	Forum	General news portal (lay-journalistic) with comments option	1 article about nano and safety with 4 comments (but without any reference to nanotechnology)
www.webwelt.info	Blog	Diary; all kinds of issues	1 post about nanotechnology in general, risk
www.weltdergadgets.de	Blog	Specialist blog; gadgets, technology, curiosities, cars, mobile phones and more	2 posts about research, science, nanopaper, nanotubes
www.werbeblogger.de	Blog	Specialist blog; advertising and marketing	1 post about Nokia Morph

Website URL	Type	Type of website	Characterisation
www.wer-weiss-was.de	Forum	General forum portal	Includes 1 medium-length thread about environmental risks and nanotechnology in general, 1 short thread about nano coating for glasses and 1 medium-length thread about choice of degree course
www.wintergarten-ratgeber.de	Forum	Gardening forum	2 small threads about cleaning of conservatories
www.wissen.toppx.de	Blog	Specialist blog; science	2 posts about research, particles, nanomachines
www.wissenslogs.de/wblogs/summary.php	Blog	Specialist blog; science	10 posts, including about risk, research
www.wissenswerkstatt.net	Blog	Specialist blog; science	9 posts, including about risk communication, nanofood, research, materials, nanotubes, nanoparticles
www.wohl-bekomms.info	Blog	Specialist blog; nutrition, food, drink, luxury products	1 post about criticism, nano in foodstuffs
www.xing.com	Forum	Social network for business professionals	At least 1 short thread about nano projects and nano companies
www.z3-roadster-forum.de/phpBB2/home.php	Forum	Vehicle forum, cars (certain types of BMW)	2 medium-length threads about nanosealing
www.zahnimplantate-info.eu	Blog	Suspected spamblog; dental implants	4 posts
www.zentrale-der-macht.de	Blog	Diary; entertainment	1 post about nano invisibility cloak
xesier.de	Blog	Mix; art and literature, ideas	1 post, nano only as topic in computer games

### 9.3 Coding scheme

#### **Preliminary remark:**

The key question to be answered by the content analysis is which perceptions exist in the population (or, in this specific case, among users of arenas on the Internet) with respect to nanotechnology and its products. The analysis is concerned in particular with perceived benefits and risks in statements that communicate experiences, knowledge and beliefs or questions.

#### **Procedure:**

- The entity to be investigated is the entire post (including user name, date of publication etc.) in the form in which it appears online. The version saved in the database is used primarily for documentation and data back-up purposes, but may in some cases not be able to reproduce certain characteristics such as links, smileys etc.
- Within the post, it is first and foremost the individual statements relating to the subject of nanotechnology that are of interest, so the first step is to identify the central statement made by a post. "Central statement" refers in this context to the core statement relating to nanotechnology; there may be other statements that are central to the post but are not directly related to nanotechnology. To record the central statement, the coder puts the central statement of the post into his or her own words (paraphrasing). If one post contains several statements about nanotechnology, these should also be analysed providing the coding scheme permits this. In cases where only one single statement can be analysed, only the central statement should be used.
- In some cases, the statement may not be evident from the post alone, and may only become apparent when the post is viewed overall within the framework of a thread. If this is the case, the analysis must take into account not only the post itself, but also the other relevant posts that are needed to understand the statement.
- Unless specified otherwise, only the manifest contents of the post / statement are of interest, that is to say that which is explicitly mentioned rather than that which the coder may interpret with the benefit of his or her background knowledge.
- It makes no difference whether the statement / post is genuinely concerned with nanotechnology or whether it relates to an object that only apparently has to do with nanotechnology. The key factor is that a relevance to nanotechnology is established in the communication, either directly or indirectly, and not whether this genuinely reflects the truth. For example, "Magic Nano" was advertised as a nanotech product, but in actual fact had nothing to do with nanotechnology. This is nonetheless relevant to the present analysis.

#### **General coding instructions:**

- If a category is not relevant or applicable to the post / statement in question, a dot (".") is entered in the corresponding line.
- The categories of the revised scheme are fixed and should be applied in the form in which they are specified in the code book. Changes and/or extensions are only possible in the places where this is explicitly stated. As a rule, they should be marked as such (e.g. by adding the word "Other: ...").
- As far as possible, it is enough to use the corresponding numerical value during coding. Codes only need to be explained in words when this is explicitly requested (e.g. paraphrasing, naming etc.).
- The following scheme is used for all the coding instructions stated below:

No. of dimension	Title of dimension	
Description of dimension		
Category 1	<i>Designation</i>	<i>Explanation / example</i>
Category 2	<i>Designation</i>	<i>Explanation / example</i>
...	...	...
Application rules		

## Areas and dimensions:

### 1. Information about the speaker

1.1	Speaker	
What does the post reveal about the gender of the speaker?		
1	<i>Female</i>	<i>Example: "...on 23.11 my husband suddenly was very unwell ... Love Brigitte"</i>
2	<i>Male</i>	<i>Example: "... I'd better not get involved. Best wishes, Mark"</i>
3	<i>Not determinable</i>	
Application rules: The key to determining the gender of the speaker is, in particular, names that appear beneath the post and information within the post that allow direct conclusions to be drawn about the speaker's gender. In all cases in which no clear gender assignment is possible, category 3 should be selected.		

### 2. Coding of statement & subject

2.1	Central statement	
What is the post's central statement relating to nanotechnology?		
<i>No numerical code</i>	<i>Please paraphrase!</i>	
Application rules: The central statement relating to nanotechnology needs to be determined for the post as a whole. If several different statements are made, the most important should be chosen (e.g. the most frequent statement or the statement with the greatest relevance to nanotechnology etc.). The coder should briefly summarise the statement in his or her own words. This will then serve as the point of reference for the following codings that are concerned with individual statements.		

2.2	Range	
What is the range of the statement? Which level of aggregation is the central focus?		
1	<i>Nanotechnology in general</i>	<i>Example: "Wow!! Finally it's continuing!! Nanotechnology, then attotech-nology...just think what is happening underground, phew.. if so "much" is being shown already in public..."</i>
2	<i>Applications of nanotechnology</i>	<i>Example: "I guess this nano-food is possible, but as Harald already said, probably not so soon..."</i>
3	<i>Actual product/s</i>	<i>Example: "...I read in a report that nanosilicon in capsule or spray form can help combat neurodermatitis (unfortunately not how!). Has anyone heard of this or does anyone even have experience of it..."</i>
Application rules: It needs to be determined whether the statement contained in the post relates to nanotechnology in general, individual applications or actual products. Classification takes places on the basis of the explicitly communicating meaning. If several areas of application are mentioned, it needs to be checked whether nanotechnology in general is being addressed or whether the applications are the main focus.		

2.3	Actual products	
Which nanoproducts or processes are mentioned explicitly in the statement?		
1	<i>Surface treatment</i>	<i>e.g. coatings, waterproofing agents, wax, polish etc.</i>
2	<i>Material improvement</i>	<i>e.g. hardening in sports equipment</i>
3	<i>Applications in textiles</i>	<i>e.g. nanomaterials, caution: surface treatments come under textiles!</i>
4	<i>Fuel additives</i>	<i>e.g. ceramic engine additives</i>
5	<i>Sunscreen products/sun protection</i>	<i>e.g. those with nanoscale titanium dioxide</i>
6	<i>Other cosmetics</i>	<i>e.g. toothpaste, anti-aging cream etc.</i>
7	<i>Foodstuffs</i>	<i>Caution: in the case of dietary supplements, the coding "11" should be used if they are characterised in the post as dietary supplements, "wonder drugs" or the like!</i>
8	<i>Foodstuff packaging</i>	<i>e.g. application in plastic bottles etc.</i>

9	<i>Cancer therapies</i>	<i>e.g. experimental application in relation to hyperthermia therapies</i>
10	<i>Other serious medical applications</i>	<i>Caution: the coder should not assess the seriousness; this should be based on the characterisation in the post!</i>
11	<i>Dietary supplements, wonder drugs</i>	<i>Caution: in the case of dietary supplements, the coding "Foodstuffs" should be used if they are characterised as foodstuffs in the post!</i>
12	<i>Other</i>	<i>Please include in 2.3.1 which type of products are addressed!</i>
<p>Application rules:          These codings should only be used if the "actual product/s" coding was used in 2.2! The key factor is always the way the product is characterised in the post, even if this does not correspond to reality! Dietary supplements and "wonder drugs" must be recorded separately because there may be a deviation here between the scientific classification (=foodstuffs) and lay classification (=medicine).</p>		

2.4	<b>Subject area</b>	
To which of the following subject areas should be post be attributed on the basis of its statement?		
1	<i>Vehicles</i>	<i>e.g. applications in cars, boats</i>
2	<i>Foodstuffs</i>	<i>e.g. applications in foodstuffs and packaging</i>
3	<i>Medicine</i>	<i>e.g. cancer treatment, future therapies etc.</i>
4	<i>Cosmetics</i>	<i>e.g. sunscreen products, skin creams etc.</i>
5	<i>Textiles</i>	<i>e.g. nanomaterials, sealing of textiles etc.</i>
6	<i>Other applications</i>	<i>e.g. cleaning agents, electronics (not: posts on the subject of "Magic Nano"!)</i>
7	<i>General discussion</i>	<i>All posts which mention aspects of nanotechnology which cover several subject areas or are abstract in nature, including general risk discourse relating to individual products or applications of nanotechnology, e.g. posts on the subject of "Magic Nano"</i>
<p>Application rules:          Multiple codings should be avoided as far as possible! The key factor is always the subject area that is the central focus; if several subject areas are touched upon, it should be checked whether the "general discussion" coding should be used. As far as the definition of the subject areas is concerned, please refer additionally to the definition in the interim report "Selection strategy".</p>		

2.5	<b>Statement types</b>	
To which of the following statement types can the statement be assigned?		
1	<i>Description of experience</i>	<i>e.g. concrete product experience</i>
2	<i>Beliefs</i>	<i>If the statement includes assessments</i>
3	<i>Knowledge</i>	<i>If the statement contains factual descriptions</i>
4	<i>Question</i>	
.	<i>Other</i>	
<p>Application rules:          If several categories are applicable, preference should be given to low codes, that is to say a "1" should be assigned if the statement is based on concrete experience, even if general assessments are also given.</p>		

2.6	<b>Question types</b>	
What type of question is involved?		
1	<i>Question about experience</i>	<i>see dimension 2.5</i>
2	<i>Question about beliefs</i>	<i>see dimension 2.5</i>
3	<i>Question about knowledge</i>	<i>see dimension 2.5</i>
4	<i>Other question</i>	
.	<i>Not applicable</i>	<i>If the post does not involve a question</i>
<p>Application rules:          Only use these codes if the "Question" coding was used in 2.5!</p>		

2.7	<b>Assessment</b>	
What is the speaker's assessment of the subject of the statement?		
1	<i>Positive</i>	<i>Example of a "positive" assessment: "I've just been to see our painter; he recommended having the rims painted with nano clear varnish. This would cost roughly 70€ per rim."</i>
2	<i>Partly positive, partly negative</i>	<i>This coding should be used if both positive and negative assessments are mentioned and no clear decision in favour of one of the two categories can be made.</i>

3	Negative	Example of a "negative" assessment: "...Pollmer and his co-authors provide a clear and easily comprehensible introduction and explanation here, as well as their usual critical appraisal of the subject, which in this case is more than appropriate and by no means exaggerated. For this, high praise for Pollmer & Co!..."
.	Neutral / neither positive nor negative	This coding should be used if no clear assessment is evident and positive and negative assessments are not weighed up against each other.
Application rules: The key factor here is always the overall impression gained from the statement, in relation to the subject of the statement. The assessment can be made explicitly or implicitly.		

### 3. Benefits and risks

3.1	Benefit vs. risk dimension			
Are benefits or risks, or possibly combinations of the two, ascribed to nanotechnology in general, or to the subject of the statement?				
1	Benefits or opportunities	The post ascribes a concrete benefit or particular opportunities to nanotechnology in general or to the subject of the statement; there is no reference to uselessness/harm or risks.		
2	Harm or risks	The post ascribes uselessness or a harmful effect to nanotechnology in general or to the subject of the statement, or links it to particular risks but not to opportunities or benefits.		
3	Combination of dimensions	The post ascribes not only benefits or opportunities but also risks, uselessness or harm to nanotechnology in general or to the subject of the statement.		
4	Benefits, but not opportunities or risks	The post ascribes a concrete benefit but not uselessness or harmful effect to nanotechnology in general or to the subject of the statement, and ascribes no opportunities or risks to nanotechnology.		
5	Uselessness, but not opportunities or risks	The post ascribes concrete uselessness or harm but not benefits to nanotechnology in general or to the subject of the statement, without ascribing opportunities or risks to it.		
6	Opportunities, but not benefits or uselessness	The post ascribes opportunities but not risks to nanotechnology in general or to the subject of the statement, without ascribing a concrete benefit or harm to it.		
7	Risks, but not benefits or uselessness	The post ascribes risks but not opportunities to nanotechnology in general or the subject of the statement, and ascribes neither concrete benefits or harm to it.		
8	Neither benefits or uselessness nor opportunities or risks	The post ascribes neither benefits or opportunities nor risks, uselessness or harm to nanotechnology in general or the subject of the statement.		
.	Other combinations			
Application rules: These categories are designed to establish how the post relates nanotechnology to two interconnected dimensions: first, the dimension of benefits or uselessness or even harm, and second, the dimension of risks or opportunities. The first is concerned with concrete expectations for nanotechnology relating to the speakers themselves, while the latter is about abstract potential which affects a group of people that is not necessarily more closely defined. In each case it is a question of whether opportunities, risks, benefits or harm are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. See the descriptions given above for details of the individual categories; the following contingency table showing both dimensions provides an overview of the relationships between the categories:				
	Opportunities	Risks	Both opps and risks	Neither opps nor risks
useful	1	.	.	4
useless/ harmful	.	2	.	5
both useful and useless/harmful	.	.	3	.
neither useful nor useless/harmful	6	7	.	8

3.2	Opportunity / risk	
Are opportunities, risks or both associated with nanotechnology in general or with the subject of the statement?		
1	Opportunities	
2	Risks	

3	<i>Both opportunities and risks</i>	
.	<i>Neither opportunities nor risks</i>	
Application rules: This variable is not to be coded! It is calculated in detail on the basis of the opportunities and risks (3.3 and 3.4), depending on whether individual opportunities or risks were mentioned or not.		

3.3.1	Risks in detail: environment	
Are risks to the environment associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>e.g. negative effects on other living creatures, uncontrolled dissemination in waterways etc.</i>
2	No	
Application rules: In each case it is a question of whether risks are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding risks.		

3.3.2	Risks in detail: health	
Are risks to the health of consumers or of the general population associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>e.g. breaking through the blood-brain barrier, toxic effect on the human body etc.</i>
2	No	
Application rules: In each case it is a question of whether risks are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding risks.		

3.3.3	Risks in detail: society	
Are risks to society or to social development (including business, security etc.) associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>e.g. nano-weapons, increasing the power of large corporations etc.</i>
2	No	
Application rules: In each case it is a question of whether risks are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding risks.		

3.3.4	Risks in detail: other	
Are risks that do not fall under aspects 3.3.1 to 3.3.3 associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>Caution: please characterise the mentioned risks under 3.3.5!</i>
2	No	
Application rules: In each case it is a question of whether risks are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding risks.		

3.4.1	Opportunities in detail: environment	
Are opportunities for the environment associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>e.g. more efficient generation of electricity, less environmental pollution due to reduced use of cleaning agents etc.</i>
2	No	
Application rules: In each case it is a question of whether opportunities are mentioned <i>in relation to</i> nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding opportunities.		

3.4.2	Opportunities in detail: health	
Are opportunities for the health of consumers or of the general population associated with nanotechnology in general or with the subject of the statement?		
1	Yes	<i>e.g. improved treatments, medical nanorobots, nanoparticles as medicinal drugs etc.</i>
2	No	

## Application rules:

In each case it is a question of whether opportunities are mentioned *in relation to* nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding opportunities.

## 3.4.3 Opportunities in detail: society and consumers

Are opportunities for society or for consumers associated with nanotechnology in general or with the subject of the statement?

1	Yes	<i>e.g. innovative products, greater living comfort, economic development etc.</i>
2	No	

## Application rules:

In each case it is a question of whether opportunities are mentioned *in relation to* nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding opportunities.

## 3.4.4 Opportunities in detail: other

Are opportunities that do not fall under aspects 3.4.1 to 3.4.3 associated with nanotechnology in general or with the subject of the statement?

1	Yes	<i>Caution: please characterise the mentioned opportunities under 3.4.5!</i>
2	No	

## Application rules:

In each case it is a question of whether opportunities are mentioned *in relation to* nanotechnology or nanoproducts, that is to say of whether these aspects are ascribed to nanotechnology. There will not necessarily be any causal ascription, however; it may be that nanotechnology has linguistic connotations of corresponding opportunities.

## 3.5 Comparison of products

Are nanoproducts or processes compared with conventional products or processes? How do they rate by comparison?

1	<i>Yes, regarded as better</i>	<i>Example: "...The nano-dynamic® silver solution is therefore much more effective than conventional silver compounds..."</i>
2	<i>Yes, regarded as worse</i>	<i>Example: "We have been using only liquid glass for years, and my DAD decided he should give one of those nanosealing things a go. strangely enough, I get mine clean much more easily with 4 layers of LG than he does his NANO-sealed BMW ..."</i>
3	<i>Yes, no difference</i>	<i>Example (sunscreen product): "...Even if the mineral filter inside is not supposed to be nano, this product still has the well-known risks of chemical filters, doesn't it? (...) We now have a choice between the plague and cholera. I believe you can't have it all, so I'll just have to compromise..."</i>
4	<i>No</i>	<i>Post does not compare nanoproducts or processes with conventional products or processes</i>
.	<i>Not applicable</i>	<i>Post is not about products</i>

## Application rules:

This coding should only be used if the post is about nanoproducts or processes! The coding relates in each case to whether the nanoproduct or process is regarded as "better" or "worse".

## 3.6 Arguments

What reasons do the speakers give for their statements or assessment of the subject?

1	<i>No reasons evident</i>	
2	<i>Simple argumentation</i>	<i>While speakers attempt to explain their own position, no real argumentation, e.g. weighing up the pros and cons, takes place. Example: "What I would like to see as far as nanotechnology in everyday life is concerned is active and critical risk research capable of proving its safety. These nanoparticles, after all, do not always stay where they should. And what then? I do not have a clue, as I cannot see what's going on."</i>

3	<i>Complex argumen- tation</i>	<i>Speakers not only attempt to explain, but also to persuade others of their own position, e.g. by using more complex patterns of argumentation, weighing up pros and cons etc. Example: "[Quote] ,The only thing that bothered me was the fact that nothing negative has yet been mentioned for the simple reason that there are apparently no (or very few) negative aspects to nanotechnology.[End of quote] Don't worry, that will come ;-)</i> In my opinion, there are definitely some negative aspects. Simply look at the major issue of "abuse". How great would it be for certain persons/countries if they could build the "ultimate nano-bomb"?! You can't smell it, you can't taste it, you can't see it and you can't feel it. But the "right mixture" can kill you. What a dream... You can kill everyone and nobody will notice!"
Application rules: A search for arguments relating to the statement or assessment of the subject is conducted in the post. See the above information provided for the individual categories for help with coding decisions!		

3.7	Arguments in detail
Which argument/s is/are put forward to justify the statement or assessment of the subject?	
<i>No numeric code</i>	<i>Please paraphrase!</i>
Application rules: This coding should only be used if the coding "2" or "3" was used in 3.6!	

#### 4. Linguistic means

4.1	Linguistic images
Which linguistic images and topoi are used in the post (e.g. metaphorically) to describe nanotechnology, nano-products or their characteristics?	
<i>No numerical code</i>	<i>Please distinguish between the images mentioned according to whether the images are used with positive, negative or no clear connotations!</i>
Application rules: Possible images include spatial images (e.g. the cosmos, landscape, inner world, invasion, change, etc.), temporal images (e.g. dreams of the future, 21 <sup>st</sup> century etc.), images that refer to effects (e.g. sorcerer's apprentice, revolution etc.) or size (e.g. dwarves, tiny things, minute particles, invisible etc.). The connotation in which the images are used can be seen from the linguistic (e.g. adjectives) and argumentational context in which the images are used.	

4.2	Key words
Which key words are used in the post to characterise or assess nanotechnology in general or individual aspects of it?	
<i>No numerical code</i>	<i>Please distinguish between the key words mentioned according to whether the key words are used with positive, negative or no clear connotations!</i>
Application rules: Key words are rhetorical devices in the form of individual words or phrases which are used to succinctly sum up complex matters or viewpoints and which occupy a striking position within a post. Key words condense complex patterns of argumentation, explanatory models, evaluation processes or themes into catchy phrases. The mere mention of such a word is not enough for it to be classified as a key word; it must also be used pragmatically as such within the post! The connotation in which the key words are used can be seen from the linguistic (e.g. adjectives) and argumentational context in which the words are used.	

4.3 Interpretative frames	
Into which interpretative frame does the statement place nanotechnology / the nanoproduct?	
1	<p><i>Scientific and progressive</i></p> <p><i>Nanotechnology (or its application) is described from the perspective of scientific progress and social innovation. Key references are the progress of research, the knowledge of acknowledged experts (scientists, politicians) and a long-term orientation that is detached from everyday life, and also: utopia/dystopia, hopes of solutions to the major problems facing humankind, fears of the world's destruction etc.</i></p> <p><i>Example: "...It is of course a good thing when research comes up with something new that can bring mankind more advantages and comfort, new jobs etc. But is it really necessary to write nano all over the place and use it for advertising purposes?..."</i></p>
2	<p><i>Critical and political</i></p> <p><i>Nanotechnology (or its application) is described from a critical perspective, which also includes questions of political regulation. Key references are abstract reference to nanotechnology (irrespective of its practical functionality), its risks, political interests, human health or environmental aspects (including conservative justification such as the sanctity of nature, warning against human hubris etc.) and an abstract orientation that is characterised by detachment from everyday life.</i></p> <p><i>Example: "...To put it plainly, these tiny particles could cause us serious harm because they can get in everywhere unhindered. And nobody knows this so far! Once again, we have developed products whose consequences are completely unpredictable – this is definitely comparable to the Thalidomide scandal!..."</i></p>
3	<p><i>Pragmatic and keen to experiment</i></p> <p><i>Nanotechnology (or its application) is described from a pragmatic or application-oriented perspective. Key references are an openness towards nanotechnology, concrete benefits, suitability for use and practical experiences (positive or negative) of the technology and/or, typically, of individual products (e.g. by consumers). It is all about the advantages and disadvantages for individuals offered by nanotechnology applications in everyday life.</i></p> <p><i>Example: "...According to [German fitness magazine] 'Fit for fun', this stuff is simply sensational and also remains effective for an unusually long time. NANO Nässeblocker waterproofing agent has left the (second-placed) product from Granger's standing. According to Deichmann, it can be used on all leather and fabric types. 'The new miracle spray protects leather and fabric shoes for months against dirt and moisture. [...] Particularly effective if used sparingly' – sounds good!..."</i></p>
4	<p><i>Other frame</i></p> <p><i>Please describe frame in your own words if it cannot be assigned to any of the other categories!</i></p>
.	<p><i>No frame identifiable</i></p>
<p>Application rules:  A post should initially be coded on the basis of the text in the post itself, with the focus on statements about nanotechnology and on the terms associated with it. If it is not possible to clearly identify a frame on the basis of the post itself, the thread as a whole can be referred to, and especially posts to which the post directly refers.</p>	

## 5. Sources and knowledge

5.1 Sources		
Which media are used as a source of information and knowledge about nanotechnology, to the extent that this is communicated in the post?		
1	Online	<i>e.g. other forum and blog entries, online media, websites of the mass media etc.</i>
2	Print	<i>e.g. newspapers, magazines, journals, books etc.</i>
3	Broadcasting	<i>e.g. television, radio etc.</i>
4	Events	<i>e.g. trade fairs, congresses etc.</i>
5	Individual face-to-face communication	<i>To the extent that explicit mention is made of this!</i>
6	Other media	<i>Please explain in column 5.1.1!</i>
7	Several media	<i>Please list in column 5.1.1!</i>
Application rules: Coding should be carried out for references to media used as a source of information and/or knowledge about nanotechnology. In case of doubt, e.g. if only one media provider but not the channel is mentioned, this should be noted in column 5.1.1 and the category "6" should be chosen.		

5.2 References		
Which actors are referred to as a source in the post?		
1	Laypersons	<i>e.g. other consumers</i>
2	Scientists	
3	Practitioners/experts	<i>e.g. sales people, tradespeople etc., including doctors</i>
4	Mass media	
5	Companies	
6	Government institutions	<i>e.g. German government, Federal Environment Agency (UBA), BfR etc.</i>
7	Civil society/ NGOs	<i>e.g. ETC Group, Greenpeace, Friends of the Earth, BUND etc.</i>
8	Other actors	<i>Please explain in column 5.2.1!</i>
9	Several actors	<i>Please list in column 5.2.1!</i>
Application rules: Coding should be carried out for references to actors used as a source of information and/or knowledge about nanotechnology.		

5.3 Speaker's level of knowledge		
How does the speaker reveal, implicitly or explicitly, their own level of knowledge with respect to nanotechnology in general or the subject of the post?		
1	Speaker expresses knowledge	
2	Speaker express lack of complete knowledge	
3	Speaker expresses lack of knowledge	
.	Not applicable	<i>No reference to level of knowledge evident</i>
Application rules: It must be checked whether the post characterises, explicitly or implicitly, the speaker's level of knowledge. Knowledge is expressed, for example, in observations, claims etc., while a lack of knowledge is expressed in particular in questions or doubts. Incomplete knowledge is characterised by the expression of both knowledge and a lack of knowledge.		

5.4 Discourse		
How is public discourse on nanotechnology and/or on individual products characterised or assessed in the post?		
No numerical code	<i>Please characterise in your own words, e.g. as an overestimation/underestimation of nanotechnology; hysteria / hype / speech bubble; key word, misjudgement of potential etc.</i>	
Application rules: Explicit or implicit assessments of nanotechnology discourse must be paraphrased in your own words; if no assessments are identified, the code "." should be used.		

\* NGO=non-governmental organisation.

5.5	Comparisons
Is the development of nanotechnology compared in the post with one of the following areas: atomic/nuclear energy; "gene food"/GMO; particulate matter/aerosols; asbestos; red biotechnology (stem cells, cloning, diagnostics); human enhancement (including eugenics)?	
<i>No numerical code</i>	<i>Please state the area with which nanotechnology is compared!</i>
Application rules: It is not a question here of comparing individual products, but of comparing nanotechnology in general, and especially its development as a field of science and technology in its own right. If any other comparisons are noted, these should be listed accordingly.	

## 6. Scope for action

6.1	Scope for intervention	
Which actors are assumed by the post to have the potential to shape or select nanotechnology in terms of its opportunities and risks, that is to say scope for influencing its development?		
1	<i>Nobody</i>	<i>This coding should only be used if the post explicitly rules out the possibility that the development of nanotechnology could be influenced by any actors!</i>
2	<i>Society (incl. NGOs), individuals</i>	<i>Apart from the actors specified in the other categories!</i>
3	<i>Companies</i>	
4	<i>Science</i>	
5	<i>Politics/state</i>	
6	<i>Other</i>	<i>Please add to column 6.1.1!</i>
.	<i>Not applicable</i>	<i>If the topic of scope for intervention is not raised or the post is not part of the general discussion of nanotechnology</i>
Application rules: This coding should only be used if the post is concerned with a general discussion of nanotechnology (see 2.4). A search should be carried out to identify any scope for intervention that the post believes particular actors to have. If no scope for intervention is ascribed to a particular actor / group of actors, this should be recorded under "Other".		

6.2	Trust	
Is one of the following actors explicitly trusted in the post?		
1	<i>Nobody</i>	<i>This coding should only be used if nobody is explicitly trusted!</i>
2	<i>NGOs</i>	<i>e.g. BUND, Greenpeace, churches etc.</i>
3	<i>Companies</i>	
4	<i>Science</i>	
5	<i>Politics/state</i>	
6	<i>Other</i>	<i>Please add to column 6.2.1!</i>
.	<i>Not applicable</i>	<i>If the topic of trust is not raised or the post is not part of the general discussion of nanotechnology</i>
Application rules: This coding should only be used if the post is concerned with a general discussion of nanotechnology (see 2.4). This coding should only be used if there is explicit mention of trust in a particular actor / group of actors.		

6.3	Mistrust	
Is one of the following actors explicitly mistrusted in the post?		
1	<i>Nobody</i>	<i>This coding should only be used if nobody is explicitly mistrusted!</i>
2	<i>NGOs</i>	<i>e.g. BUND, Greenpeace, churches etc.</i>
3	<i>Companies</i>	
4	<i>Science</i>	
5	<i>Politics/state</i>	
6	<i>Other</i>	<i>Please add to column 6.3.1!</i>
.	<i>Not applicable</i>	<i>If the topic of mistrust is not raised or the post is not part of the general discussion of nanotechnology</i>
Application rules: This coding should only be used if the post is concerned with a general discussion of nanotechnology (see 2.4). This coding should only be used if there is explicit mention of mistrust in a particular actor / group of actors.		

6.4	Demands	
Which demands are derived in the post from the speaker's own perception of nanotechnology risks?		
1	<i>None</i>	
2	<i>More education and information</i>	
3	<i>Greater civic participation and measures for societal dialogue</i>	
4	<i>More risk research</i>	
5	<i>Product labelling</i>	
6	<i>Ban on nanoproducts and consumer-relevant nanoproducts</i>	
7	<i>Moratorium on nanotechnology development</i>	
8	<i>Other legal regulations</i>	
9	<i>Several of these demands at once</i>	<i>Please explain in column 6.4.1!</i>
10	<i>Other demands</i>	<i>Please add to column 6.4.1!</i>
.	<i>Not applicable</i>	<i>If the post is not part of the general discussion of nanotechnology</i>
<p>Application rules:  This coding should only be used if the post is concerned with a general discussion of nanotechnology (see 2.4). A search should be carried out to identify demands that speakers put forward themselves and that address the regulation of nanotechnology.</p>		

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