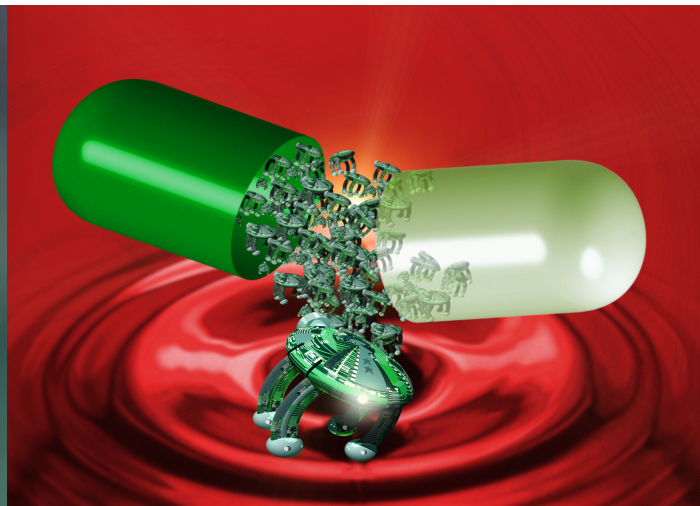
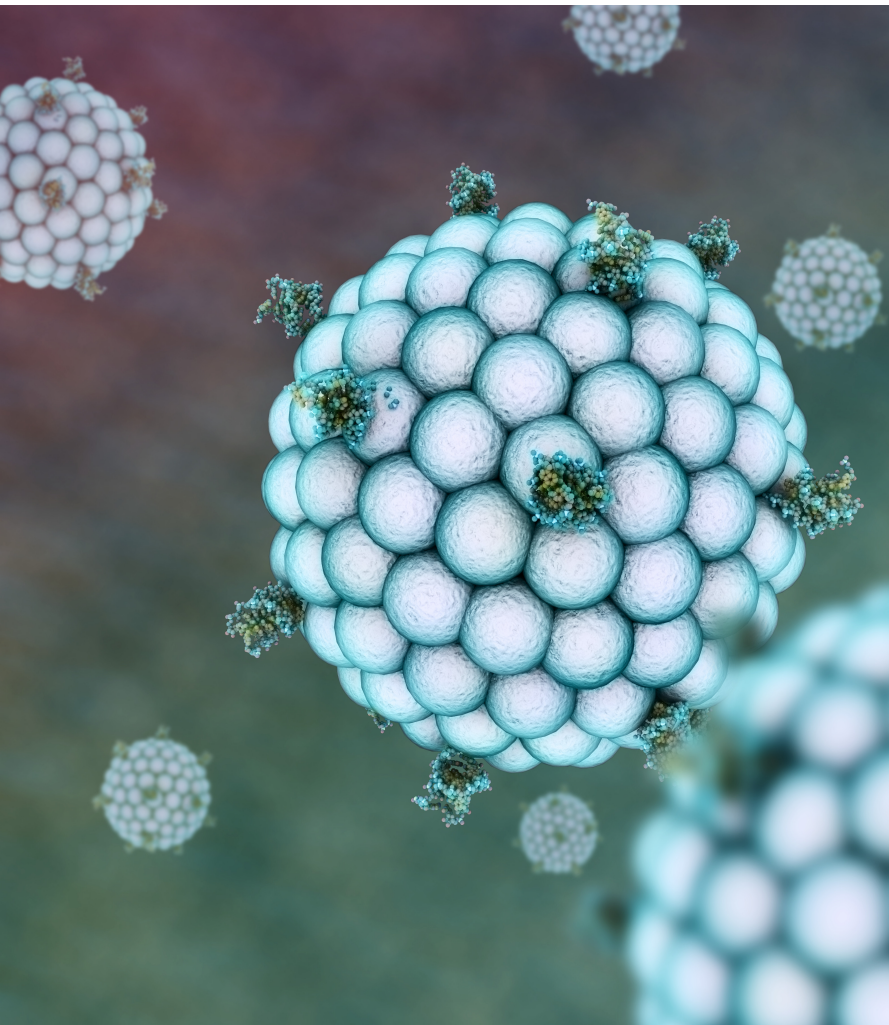


Austrian Nanotechnology Action Plan



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Austrian Nanotechnology Action Plan

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FEDERAL MINISTRY OF
LABOUR, SOCIAL AFFAIRS AND
CONSUMER PROTECTION



**FEDERAL MINISTRY
OF HEALTH**

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Austrian Federal Ministry of Science and Research

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ENVIRONMENT AGENCY AUSTRIA

This is an unofficial translation of the Austrian nanotechnology action plan. For interpretation purpose only the original German version has validity.

SUMMARY

The government programme for the 24th legislative period mentions the development of an Austrian nanotechnology action plan in two different instances. The chapter “Efficient Use of Resources / Waste” points out that the “the opportunities and risks of nanotechnology should be addressed by developing and implementing an Austrian action plan that allows an appropriate scope of action for risk research”. The chapter “Consumer Protection / Consumer Health” states that “an Austrian nanotechnology action plan should explore the risks and opportunities, especially those of nanotechnology procedures and nanomaterials, and develop fields of application and a national implementation strategy for this key technology”.

These challenges go hand in hand with other key fields of action in the government programme, especially in the chapters “Together for Austria”, “Regional Economic Policy and Jobs” as well “Research, Technology and Innovation”. The European Commission, too, published a corresponding press release entitled “Nanosciences and nanotechnologies: an action plan for Europe 2005-2009”, which is currently being revised in cooperation with the Member States.

The field of nanotechnology definitely involves a set of highly complex and multifarious topics. Nanotechnology is considered the key technology of the 21st century. It is expected to help push forward innovative developments in a diversity of technology fields and social applications. The potential uses of nanotechnology are manifold, ranging from electronics and automotive technology to consumer products and environmental technology. Austria, too, has decided to make nanotechnology one of its top priorities. It is anticipated that Austria will demonstrate special strength and potential in sensor technology, electronics, materials sciences, chemicals (e.g., paints) and environmental technology.

In order to benefit sustainably and over the long term from the opportunities offered by nanotechnology, a practical and transparent debate on the safety of nanotechnology applications is essential. There is thus unanimous agreement that due measure must be given to the identification of nanotechnology’s possible risks to health and the environment.

What is the best way for Austria to harness the opportunities in nanotechnology, for instance for the sake of environmental and energy technology, new resource-saving products or for small- or medium-sized enterprises? How can Austria contribute to ensuring the safety of nanotechnology applications? This Austrian Nanotechnology Action Plan addresses precisely these crucial issues.

The core of the Action Plan consists of 50 recommendations for specific Austrian measures to be taken at national, European and international level. These recommendations grew out of a consensus reached among the stakeholders involved and will be implemented by the end of 2012 at the latest. In the first half of 2012, a monitoring process will be launched to this end. Further specification of the measures - just as a focusing of the set priorities - will be part of this process.

Developing an overall strategic policy plan for the governance of nanotechnology and nanomaterials in Austria is considered to be of vital importance. Such a plan will satisfy the growing need for coordination among the various Austrian activities in the field while efficiently combining and coordinating the necessary deployment of resources. The Austrian Nanotechnology Action Plan provides both a starting point and inducement for such a concept.

The federal government's Research, Technology and Innovation Strategy (Forschungs-, Technologie- und Innovationsstrategie or FTI) shall not be determined by this.

Any financial effects resulting from the Action Plan shall be covered by the subdivisions of the responsible portfolios in keeping with the caps set by the Federal Budgetary Framework Law (Bundesfinanzrahmengesetz).

Individual measures with financial effects shall be implemented in keeping with the budgetary constraints.

A key package of measures in the Action Plan is devoted to **developing cooperation and reinforcing the dialogue and transparency** among all stakeholders, including the general public. This involves breaking down scientific knowledge, also with regard to the definition of nanotechnology, into generally understandable language, and strengthening cooperation with the media. In so doing, existing structures and best practices should be used as much as possible. The creation of an Austrian **Nanotechnology Information Platform (NIP)**, in particular, will bring together experts from a wide variety of fields, allowing synergies to be created and practical, high-quality, group-oriented knowledge for all stakeholders, including the general public, to be generated.

The **basic legal framework** needs to be examined and further developed where necessary, especially with a view to ensuring a high level of protection for the environment and human health. In this respect, the Austrian Action Plan also lays down the main lines of the Austrian position to be taken into account at European and international level.

One package of measures aims at strengthening **Austria's position as a high-tech powerhouse**. It includes measures intended to bring research and business more closely together, intensify international cooperation, step up basic research as a foundation for applied research, increase integration of technical aspects in the school curriculum and clarify the general requirements under patent law. Broad scope will also be given to measures intended to facilitate funding and enhance the incentives for investment and research activities. Such measures are also essential for Austria's **small- and medium-sized enterprises**.

A broad scope of action is devoted to **filling the knowledge gaps** in the evaluation of nanotechnology's safety. Recommended measures include the bundling of resources in order to evaluate environmental, health and safety risks (**EHS Programme**). The challenge for Austria consists in developing the necessary expertise in its own research system. In this regard, a need to intensify cooperation and coordination in the European and international context has been recognised, since no country alone can cover the whole range of EHS research in dealing with nanotechnology. The first concrete examples of where research is needed have already been identified by the individual stakeholders for their own specific field. Another priority is to steadily increase the knowledge base of the key stakeholders involved in employee safety, in order to ensure safety and health protection at the workplace when dealing with nanomaterials.

The creation of the Austrian Nanotechnology Action Plan is an excellent example of how stakeholders with different expectations and interests can work together to develop common measures for a very complex subject area. To develop the Action Plan, no fewer than 20 different organisations cooperated in one of four working groups: Health and Employee Protection, Environment, Business as well as Science, Research and Development. Ensuring the information flow between the various groups and stakeholders and facilitating cross-disciplinary and/or conflicting matters constituted a particular challenge. To draft the Action Plan, greatest possible transparency was ensured through a 3-week public online consultation process which was launched concurrently by the Austrian federal ministries, the Austrian

Federal Economic Chamber and the Federal Environment Agency Austria (Umweltbundesamt GmbH).

The path Austria has taken in the field of nanotechnology goes hand in hand with recommendations and developments at European and international level which clearly call for an improved dialogue and more cooperation among the decision-makers in public institutions, science, business and other stakeholders. Now that the present Nanotechnology Action Plan is available, Austria has taken an essential step towards achieving its objectives of taking optimal advantage of the opportunities nanotechnology has to offer and overcoming the associated challenges.

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PART 1 INTRODUCTION

The current Austrian government programme mentions the development of an Austrian nanotechnology action plan in several places: in the chapter “Climate and the Environment”, with an emphasis on “improving the quality of living and environmental protection”: “The opportunities and risks of nanotechnology should be addressed by developing and implementing an Austrian action plan that allows an appropriate scope of action for risk research”. The chapter “Consumer Protection / Consumer Health” formulates the issue as follows: “An Austrian nanotechnology action plan should explore the risks and opportunities, especially those of nanotechnology procedures and nanomaterials, and develop fields of application and a national implementation strategy for this key technology.” Comparable national plans of action have already been developed in Germany, Switzerland and the Netherlands, among others. The European Commission, too, published a corresponding press release entitled “Nanosciences and nanotechnologies: An action plan for Europe in 2005-2009”.¹

In light of the complexity of nanosciences and nanotechnologies and the wide variety of potential applications, a very broad approach is needed. The possible scientific and economic potential is definitely considered extremely high. At the same time, there is still an obvious lack of awareness of the potential risks or an adequate form of risk management. At present, one particular difficulty would appear to be obtaining knowledge about products that already exist. The numerous debates currently underway in other European countries and in the European institutions oscillate between these two poles – the diversity of possibilities and innovations versus the lack of certainty about health and environmental risks. That is precisely where the future challenges lie in connection with nanotechnologies: How can we make use of the possibilities for innovations, research and development, and economic prosperity? At the same time, how can we ensure protection of the environment, employees and consumers based on the precautionary principle? The present new Austrian nanotechnology action plan takes a first step towards this objective, providing the first precise survey of the Austrian situation and inferring specific recommendations for Austria while taking European and global developments into account.

The contents of the Austrian Nanotechnology Action Plan were developed between January 2009 and the autumn of 2009 in four different working groups: Health and Employee Protection, Environment, Business and, finally, Science, Research and Development. What singles out the Austrian approach is that the discussions were conducted on the broadest possible basis from the very beginning. The widest possible range of governmental authorities, interest groups and organisations worked together to analyse the current situation and to develop recommendations specific to Austria. All participating institutions are listed in Annex 1. A public consultation process followed that gave the various political, economic, social and scientific groups an opportunity to comment. The resulting feedback may be summarised as follows: suggestions to specify or add to the recommendations; suggestions regarding the structure of the Action Plan; expanding the group of actors involved; various suggestions involving the wording. All the comments received² were discussed by the team responsible for drafting the plan, which consisted of the working group leaders and the process managers; subsequently, they took into account the suggestions that were feasible without disregarding the broad-based consensus that had been achieved.

All of the process management was performed by the Federal Ministry of Agriculture and Forestry, Environment and Water Management with the assistance of an external company.

¹ <http://cordis.europa.eu/nanotechnology/actionplan.htm>

² See www.lebensministerium.at

To ensure the sustainability of the projects mentioned, the implementation of the recommendations formulated in the present Action Plan will be monitored in the first half of 2012. This monitoring process will also be carried out on the broadest possible basis, i.e., with the participation of the entire spectrum of stakeholders. Once completed, the intention is to draft a corresponding progress report.

Objectives of the Austrian Nanotechnology Action Plan

With the Austrian Nanotechnology Action Plan, all Austrian stakeholders involved with nanotechnology make a commitment to act responsibly and to cooperate in order to ensure that nanotechnologies develop favourably for Austria, as a member of the European Union, in terms of public health, safety and environment, while simultaneously generating economic benefits.

The Action Plan contains general principles as well as measures to be taken by Austrian stakeholders working with nanotechnology. The Action Plan is intended to support the programmes mentioned in the present and future European action plans (2005-2009 and 2010-2014), in connection with both regulatory and non-regulatory processes. Finally, the Action Plan is devised to improve utilisation of the existing instruments, structures and resources, and to help society deal better with scientific uncertainties.

The projects in this Action Plan focus on identifying the specific need for action in Austria, as well as the development of specific recommendations to various stakeholders, mainly policy-makers and interest groups.

The Action Plan was based on what are termed environmental analyses in Austria in the areas of health and employee protection, environment and business, as well as science and research & development. The present Action Plan for the first time examines and describes this current situation³ of nanotechnology and nanomaterials in detail.

This Nanotechnology Action Plan was created through successful cooperation among all the relevant portfolios, as well as employers and employees and other interested stakeholders at the initiative of the Federal Ministry of Agriculture, Forestry, Environment and Water Management. It constitutes a guidebook for a complex field of technology that serves to develop prospects in nanosciences and nanotechnologies, to identify opportunities and avoid duplication of efforts and undesirable developments in this broad field.

Working definition of nanotechnology

The terms nanotechnology and nanomaterials cover a very broad range of possible applications and products. An internationally authoritative definition is still lacking. To facilitate projects in this subject area, while simultaneously defining a common denominator for the work performed in the various working groups, the term “nanotechnology”, as used in the Austrian Nanotechnology Action Plan, is defined as follows:

- manufacturing or processing intentionally manufactured nanoscale materials, such as nanotubes or nanoplates
- including products made of such materials
- nanoscale means having at least one spatial dimension of 100 nm or less

³ The present Austrian Nanotechnology Action Plan represents the state of the art applicable in summer 2009.

The above definition includes three-dimensional nanoparticles or nanotubes as well as two-dimensional nanofibres or one-dimensional nanolayers. The central aspect of the definition is the deliberate manufacture of the nanoscale materials. As a result, nanoscale particles or other matter that result unintentionally, such as asbestos dust or diesel soot, are excluded from the present analysis. Nanoscale particles are also produced naturally, e.g., by forest fires, volcanic eruptions and sandstorms. This analysis does not cover such natural phenomena.

The definition developed for this Action Plan grew out of ongoing international discussions, with a particular focus on the results of the following EU or international working groups:

- EU: Working group on nanomaterials in REACH (CASG Nano)
- EU: Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)
- OECD (Organisation for Economic Co-Operation and Development): Working Party on Manufactured Nanomaterials, in cooperation with ISO (International Organization for Standardization)

All of the definitions developed by these bodies unanimously address "intentionally manufactured" nanomaterials. The OECD and ISO definitions include the order of magnitude "100 nm" and "sub-definitions" (e.g., what is meant by nanoscale, nano-object, nanostructured and nanomaterial).

Contents of the Austrian Nanotechnology Action Plan

Each environmental analysis (Part 3) focuses on a certain expert theme. The following areas, which are particularly relevant to nanotechnology in social and political terms, are analysed in detail: health, including employee protection, environment, business, as well as science, research & development.

In each of these sections, the main issues of the relevant theme are presented, the current situation in Austria is described, and the main stakeholders are enumerated. In addition, the knowledge gaps associated with nanotechnology applications are discussed, opportunities and their utilisation described, and the relevant risks and the degree of ignorance are analysed.

Finally, the analyses of the Austrian situation concerning the above-mentioned themes were used to develop the central section of the Nanotechnology Action Plan: Need for Action and Recommendations for Austria (Part 2). The latter are not presented as a separate theme but rather combined in five central fields of action. Each of the detailed formulations pursues a specific objective and addresses various stakeholders in Austria, especially policy-makers and interest representatives.

PART 2 NEED FOR ACTION and RECOMMENDATIONS

The environmental analyses in the areas of health and employee protection, environment, business or science, and research and development in Austria (see Part 3) form the basis of the need for action formulated here. This need and the resulting specific recommendations each pursue a clear objective and are addressed to a wide range of Austrian stakeholders, especially policymakers. In addition, a time frame is indicated for each recommendation.

The development of an overall strategic policy plan for dealing with nanotechnologies and nanomaterials is key. The Austrian Nanotechnology Action Plan is both the starting point and the driving force of such a plan. The Plan is intended to satisfy the growing need for coordination among the various Austrian activities in the nanotechnology sector and to bundle and harmonise the necessary use of resources. Such a strategy could be developed within the framework of an inter-ministerial committee involving social partners and other stakeholders. It might cover the following essential elements, defining focal subject areas that are sometimes interdisciplinary, establishing a precise determination of areas of responsibility, the coordinated supply of resources and measures to ensure a steady flow of information.

The core of the present Action Plan consists of the recommendations for specific Austrian measures at the national, European and international levels. They are based on a consensus among all the stakeholders involved. In formulating the recommendations it was essential to strike a balance between making use of the opportunities and potential, on the one hand, and dealing responsibly with the possible risks related to health and the environment, on the other.

Both the need for action and the numerous, often overlapping recommendations have been summarised in five fields of action:

- Verifying or guaranteeing an adequate legal framework, including support of voluntary business activities
- Information management, i.e., measures to inform consumers, employees, employers, and the general public, as well as inter-ministerial and inter-institutional networking
- Training and building the awareness in the professional world, of consumers, of the general public and in the educational system
- Creating a solid knowledge base for risk and assessment and selective risk management
- Research, need for research

A central package of measures in the Action Plan is devoted to further developing cooperation and reinforcing dialogue and transparency among all the stakeholders, including the public. This includes breaking down scientific findings, including the question of the definition of nanotechnology, into language understandable by non-specialists as well as increased cooperation with the media. Whenever possible, existing structures and examples of good practice should be used. In particular, the creation of an Austrian Nanotechnology Information Platform⁴ will bring together the knowledge of a wide variety of experts, making optimal use of synergies and generating practical, high-quality, group-oriented knowledge for all stakeholders, including the public.

The basic legal situation, especially with respect to securing a high level of protection of human health and the environment, should be examined and, where necessary, further developed. Accordingly, the Austrian Action Plan also defines guidelines for the Austrian position to be taken into account at European and international level.

⁴ See Annexe 5

One package of measures aims to strengthen Austria as a high-tech location. It includes measures to bring the world of research closer together with business, intensifying international cooperation, strengthening basic research as a basis for application-oriented research, increased integration of technical issues in the educational system and clarification of the basic situation in patent law. Broad scope is also given to measures aimed at facilitating funding and increasing the incentives for investments and research activities. Such measures are of essential importance for Austrian small- and medium-sized enterprises.

Another broad field of action focuses on filling the knowledge gaps in assessing the safety of nanotechnology. Recommendations for measures include the bundling of resources to assess possible environment, health and safety risks. Austria is faced with the challenge of building up the necessary level of expertise in its own research system. In this regard, it is acknowledged that cooperation and coordination in the European and international context should be promoted, since no country alone can cover the full range of EHS research in dealing with nanotechnology. In addition, several initial specific examples of possible needs for research will be mentioned that individual participants have identified in their own field. Another focus is the continuous strengthening of the knowledge base of the key stakeholders in the field of employee protection, in order to ensure safety and health protection at the workplace when dealing with nanomaterials.

The following table gives a detailed description of needs for action specific to Austria as well as the recommendations derived from these needs. They are broken down into the above-referenced fields of action.

In the table below, the timeframes associated with a recommendation are stated as follows:

Short-term: by the end of 2010

Medium-term: by the start of the initial monitoring process (see also p.6), approx. mid-2012

Long-term: after the middle/end of 2012

Need for action	Recommendation	Addressees	Objective	Timeframe
Field of Action -- Legal Matters (in the broadest sense)				
<p>Regarding the Austrian position on taking nanotechnologies and nanoscale materials into account in European legislation:</p> <p>The process of embedding nanotechnologies into the European regulations is in a state of flux. Austria should represent a uniform and coherent position on the individual committees. In this context, compliance with a high level of protection is particularly important.</p>	<p>In all proceedings that deal specifically with nanomaterials and nanotechnologies, it is important to insist on compliance with the precautionary or polluter-pays-principle. Solid documentation of the inherent properties as well as the risks resulting from the application should be a prerequisite for entering and remaining on the market.</p> <p>Austria advocates the quick development and interpretation of the existing legal provisions (such as REACH, CLP) in an appropriate form, in order to adequately describe and take into account the properties, risks and effects of nanomaterials.</p> <p>If the relevant legal provisions do not offer the level of protection needed to ensure safe use of nanomaterials, it remains legitimate to require that any nanomaterials in products be declared.</p>	<p>Ministries within whose remit instruments related to nanotechnology are processed</p>	<p>Introducing Austria's position effectively, taking into account especially the requirement of a high level of protection. Winning allies</p>	<p>Short to medium-term</p>
<p>Harmonised and coordinated European action</p>	<p>Embedding nanotechnology into the existing legal frameworks and harmonising them within the European Union</p>	<p>Policy makers, legislators</p>	<p>Uniform EU-wide rules on the use of existing instruments</p>	<p>Start: Short-term</p>

<p>Definition</p>	<p>An internationally harmonised, short and concise definition of nanomaterials, as generally valid as possible, would be very useful for public debates and legal certainty. Austrian delegates in international and EU committees should advocate incorporating such a working definition, which should be as uniform as possible and reflect the current state of scientific knowledge, into the various legal regulations (e.g., REACH, cosmetics, novel-food, and biocides).</p>	<p>Policymakers</p>	<p>Clear, meaningful definition of nanomaterials. To take the discussion of alternatives into account</p>	<p>Short-term</p>
<p>Stepping up activities to create norms and standards</p>	<p>Appropriate participation of Austria in national and international working groups, especially observation and, whenever possible, co-determination by the ON [Austrian Standards Institute] Committee 052 "Occupational health and safety technology"</p>	<p>Relevant ministries</p>	<p>Introducing the position of Austria and avoiding duplication of efforts</p>	<p>Start: short-term; ongoing</p>
<p>Voluntary measures</p>	<p>Promoting effective voluntary measures, such as a Code of Conduct, corporate certificates</p>	<p>Policymakers, legislators</p>	<p>Preventing excessive regulation and bureaucracy. Efficient use of resources</p>	<p>Start: short-term</p>
<p>REACH Regulation: Clearing up uncertainties in the legal framework. Interpreting the regulation and, where necessary, developing it further. References to nanomaterials currently still lacking. Filling information gaps for downstream users in the supply chain, especially SMEs</p>	<p>Basic clarifications, including registration and tonnage limits for nanomaterials. Specifications in a safety data sheet (SDS), specific SDS for nanoapplications (characterisation, exposure scenarios, risk management measures). Separate case files for bulk/naniform. Nanosubstance evaluations. Certain nanomaterials on the list of candidates. (REACH) guidelines for the drafting of SDS (for nanomaterials).</p>	<p>Austrian Federal Ministry of Agriculture, Forestry, Environment and Water European Chemicals Agency (ECHA). Industrial associations for guidelines</p>	<p>Securing a regulatory framework that enables responsible development of nanotechnologies and ensures an effective basis for risk management for users. Explicit duty to inform, knowledge of possible risks. SDS are easier to understand for users when the bulk form and naniform are separated.</p>	<p>Short-term</p>

<p>Examination of the legal framework in employee protection</p>	<p>Identifying and, when necessary, defining specific nanoregulations</p>	<p>Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate</p>	<p>To ensure a regulatory framework that enables responsible development of nanotechnologies; e.g., by clarifying whether reporting or replacement requirements are necessary for certain nanomaterials</p>	<p>Medium-term</p>
<p>Examination of the legal framework in consumer protection</p>	<p>Examining whether certain “nanospecific” provisions (e.g., labelling, notification, and registration) are necessary, taking exposure into account. If necessary: Initiatives at EU level</p>	<p>Policymakers with the involvement of the relevant institutions</p>	<p>To close any regulatory gaps regarding consumer protection</p>	<p>Medium-term</p>
<p>Field of Action in information management, networking</p>				
<p>Culture of communication</p>	<p>Open, dialogue-oriented and technically solid communication among all stakeholders and the public supports a dialogue on the opportunities and risks of nanotechnology</p>	<p>Stakeholders in the National Action Plan</p>	<p>Transparent, cooperative and technically solid dialogue</p>	<p>Start: short-term</p>

<p>Voluntary approaches/consumer information:</p> <p>Offering credible information suited to the target audience has great potential for securing social acceptance of nanotechnologies</p>	<p>Austria should support the structural and institutional approaches that promote maximising the social benefits of nanotechnology and the use of nanomaterials.</p> <p>This includes, in particular, the voluntary approaches by businesses to make information about nanomaterials available to interested parties, and to share such information especially with consumers, but also with scientists and researchers.</p> <p>Austria should ensure that the current state of nanotechnology and its effects on the environment and health are described in an accurate and understandable manner. The knowledge gaps and risks that cannot currently be assessed should also be presented in a manner suited to the target audience.</p> <p>In addition, Austria should make adequate information materials available and use cooperative efforts with the media in accordance with transparent and comprehensive information policy.</p>	<p>Stakeholders in the National Action Plan</p>	<p>High-quality services to build awareness and provide information that are easily accessible and developed in a participatory and transparent manner</p>	<p>Short-, medium-term</p>
<p>Coordinated communication. Creating an overview of the activities of the individual institutions</p>	<p>Coordinated public communication by all stakeholders in the Austrian Nanotechnology Action Plan (e.g., the NIP or Nanotechnology Information Platform) as well as a shared basic position on nanotechnology and presentation of their activities</p>	<p>Lead: Austrian Federal Ministry of Health as the initiator of the NIP; policymakers; stakeholders in the National Action Plan</p>	<p>Developing an information portal for inter-institutional communication and consumer information. Increasing the quality of the information communicated. Enabling dialogue & participation. Avoiding duplication of efforts, better use of resources</p>	<p>Start: short-term</p>

Using existing structures	The existing technically qualified institutions (e.g., NanoTrust Project, ITA) should become the technical pillars of a communication platform	Policy makers, ministries, social partners	Efficient use of resources	Starting immediately
Intensified cooperation among the various experts	Creating a pool of experts and regular exchanges of experiences	Policy makers	Coordination of expert knowledge	
Broadening the basis of participants in research projects in the business sector or initiating diffusion and transfer processes. Early analysis of entry barriers or setting up cooperative impulses.	Industry-wide discussions with industry members. Exhibition of all development projects coordinated as an event by the Austrian Federal Ministry of Transport, Innovation and Technology/Austrian Research Promotion Agency	Austrian Federal Ministry of Transport, Innovation and Technology/Austrian Research Promotion Agency (FFG)	Accelerating the economic use or technology transfer	Short-medium-term
Using the Europe-wide Innovation Relay Centre	Special info programme	Austrian Federal Ministry of Transport, Innovation and Technology/Austrian Research Promotion Agency (FFG)	Facilitating cross-border technology transfer, promoting of innovation at the local level	Long-term
Developing the science/economics interface	Promoting projects focused on a certain theme for a clearly limited time period, paying particular attention to SMEs	Austrian Federal Ministry of Transport, Innovation and Technology/Austrian Research Promotion Agency (FFG), Austrian Federal Ministry of Science and Research, Austrian Federal Ministry of Economy, Family and Youth	Broadening the basis of cooperation between science and economics. Strengthening the research expertise in fields of application relevant to businesses. Differentiating from other cooperation programmes. Promoting a certain vitality and openness in the research community	Long-term

<p>Intensification international cooperation:</p> <p>Improved access to know-how and cooperative partners abroad</p>	<p>Intensification of transnational project cooperation even outside of the EU framework programme (e.g., ERA net).</p> <p>National research programme in R&D as leverage for the EU framework programme.</p> <p>Developing strategies and potential for cooperative research with non-European countries, e.g., the USA, Korea, BRIC countries.</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research</p>	<p>Increased participation in European programmes, calls for tender, grants, projects</p>	<p>Long-term</p>
<p>Field of Action – Qualification, awareness building</p>				
<p>Informing the public</p>	<p>A short, concise definition of “nano” that is as generally valid as possible is particularly important for public discussions (cf. the Brundtland definition of the concept of sustainability as an example). This will create a basis for public discussion. An absolute scientific definition is not strictly necessary, but it is worth pointing out that such a definition is currently lacking.</p> <p>Utilisation of existing positive examples, such as the nanoTruck in Germany. It would also be a good idea to get universities much more involved in informing the public.</p> <p>For example, nationwide events could be held periodically concerning newsworthy events. This would ensure that nanotechnology is constantly in the public eye and generally raise the population’s level of knowledge</p>	<p>Policymakers, ministries, social partners, universities</p>	<p>Definition for public discussion. Specific public information campaigns. Creating a more uniform level of communication</p>	<p>Start: short-term</p>
<p>Specific information of companies (employers, employees) on nanotechnology and employee protection</p>	<p>Info events for the social partners and the AUVA (Austrian Social Insurance for Occupational Risks)</p>	<p>Social partners, AUVA, Environment Agency Austria, Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate</p>	<p>Awareness building at the company level</p>	<p>Short-, medium-term</p>

<p>Strengthening of the knowledge base on health and safety aspects among the main stakeholders in employee protection. Collecting expert opinions on nanomaterials</p>	<p>Developing educational services for labour and chemical inspectors, occupational physicians, safety experts, works council members, SVPs etc.</p>	<p>Social partners, AUVA, Environment Agency Austria, Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate</p>	<p>Ensuring the necessary qualifications to deal safely with nanotechnologies and nanomaterials. Availability of expert opinions when needed</p>	<p>Short-, medium-term</p>
<p>Increased transmission of knowledge about nanotechnology and its potential applications to consumers</p>	<p>Teaching basic knowledge in classroom education and through information campaigns</p>	<p>Policymakers</p>	<p>Information, awareness building, enabling consumers to choose products in an informed manner</p>	<p>Short-, medium-term</p>
<p>Gaps in knowledge and education</p>	<p>Technophobia due to ignorance is a well-known phenomenon based on the fear of the unknown. The only way to counteract such fear is through education and information. There are many fields of action, such as schools, universities, adult education, job training, public relations work, etc. Possibilities for specific steps should be discussed with the relevant ministries and institutions, e.g., ways of improved teaching about nanotechnology or the understanding of technology in general during initial training. The objective should be to train mature citizens who are capable of dealing critically with complex problems at a practical level. Existing job training and other forms of training (e.g., for safety engineers) should be adapted and brought up-to-date. In this connection, other aspects of nanotechnology could definitely be added or expanded upon as well, such as environmental protection and how to use substances safely.</p>	<p>Policymakers, social partners, ministries, educational institutions</p>	<p>Increased education and information for the general public, while getting the existing educational structures involved, such as general educational institutes, universities, training institutions, teachers, etc. Existing initiatives should be further developed</p>	<p>Medium-term</p>

	<p>Explanation: Dealing professionally with aspects of "innovation resistance" in the light of former neo-technologies. It is necessary to avoid polarising the debate, especially in the direction of "nanotechnology is fundamentally dangerous." The discussions need to be depersonalised in order to ensure that Austria remains attractive as a place of business, which may generally attract companies to relocate to Austria. The public debate must be conducted fairly, with a discussion of the opportunities as well as the risks. No secret should be made of the fact that "Nano" is nothing new in innumerable (natural) fields, but no secret should be made of the fact either, that there are still knowledge gaps in some areas. The objective should be to give a comprehensive and objective description of this field.</p>			Long-term
<p>Involving the social dimension: Dealing with expectations and fears: Anchoring nanotechnology in the public's perceptions, scientific communications and efforts to promote young players</p>	<p>Systematic public relations work, both inwards and outwards (Nanodiologue of the European Commission together with the Austrian Federal Ministry of Science and Research, Nanotechnology Award of the Austrian Federal Ministry of Transport, Innovation and Technology)</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research</p>	<p>Assuaging the population's doubts about nanosciences / nanotechnologies</p>	Long-term
<p>Intensification of human resources: Promoting education in the natural sciences</p>	<p>School children should be shown educational and career opportunities in the field of nanosciences / nanotechnologies. Dealing with the theme of nanosciences / nanotechnologies through existing human resource initiatives ("Innovation Generation", "Sparkling Science") or through the non-bureaucratic promoting of educational opportunities at the undergraduate and graduate levels.</p>	<p>Austrian Federal Ministry of Science and Research, Austrian Federal Ministry of Transport, Innovation and Technology</p>	<p>Motivation of young people to take up scientific studies</p>	Long-term
Field of Action - risk assessment, risk management				
<p>Evaluation of measures for nanorisk monitoring is expensive. Therefore: Create the foundations for measuring nano particles, especially in the atmosphere of contaminated workplaces</p>	<p>Determine methods, parameters and strategies for measurement at workplaces. Projects for exposure measurement at the workplace. Develop simple, inexpensive instruments of measurement.</p>	<p>Policy makers, relevant institutions</p>	<p>Enabling risk control through a basis for measurement and appropriate instruments. Improve the data and knowledge about exposure</p>	Medium-term

	<p>Create exposure scenarios for workplaces</p> <p>Prepare health-related (provisional) guide values /exposure concentration for (classes of) nanomaterials (workplace).</p> <p>Record-keeping obligations concerning nanoexposure in hazardous jobs (workplaces and exposed employees, accessible only to authorities).</p>	<p>Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate, ministries, relevant institutions, social partners</p>	<p>Effective risk-control through guide values: benchmarks, (evaluate risk management measures; decision-making support for personal protection equipment). Objective: workplace threshold values for nanomaterials (whenever possible in coordination with the EU or other EU countries)</p> <p>Ensure the traceability of employees' exposure at the workplace in case of job-related illness.</p>	<p>Short-, Medium-term</p>
<p>Overview of applications or types of workplaces where nanomaterials are used</p>	<p>List of industries and activity sectors concerned (regularly updated)</p>	<p>Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate, AUVA (Austrian Social Insurance for Occupational Risks)</p>	<p>Objective use of instruments for nanorisk management. Facilitating opportunities for objective consulting and control by authorities.</p>	<p>Short-term</p>

<p>Improvement of the current state of data/knowledge and risk management at the workplace (especially in SMEs)</p>	<p>Creating a guideline for (provisional) risk management for nanomaterials. Informing the employers, as well</p>	<p>Social partners, AUVA, Austrian Federal Ministry of Labour, Society and Consumer Protection/Central Labour Inspectorate</p>	<p>Developing a standard for "good practice" at European level. Means of assistance that are continually further developed pragmatically for implementing risk management in Austria</p>	<p>Short-term</p>
<p>Environmental toxicology/environmental behaviour issues – Austrian contribution to closing the knowledge gaps: There are gaps in our understanding of the eco-toxicology effects of nanomaterials and their environmental impact, with respect to both methods and the evaluation of individual cases. (Recommendations 1 and 2) The degree of networking is still insufficient; the ecotoxicology data is not sufficiently accessible (Recommendations 3 and 4)</p>	<ol style="list-style-type: none"> 1. Regarding methodology, Austria should focus on giving objective support to the development of methods at the international level, especially since the methods developed could be adopted directly by the European regulatory system 2. Regarding basic research on eco-toxicology and environmental fate with respect to nanomaterials, we should build on the existing structures and networks to avoid duplication of efforts and, while not neglecting international projects, support projects that are focused specifically on Austria 3. Austria, while respecting its duties of care and confidentiality, advocates improved networking and shared examination of data, which can be achieved through nanorelevant or nanospecific regulations: that should give scientists and the interested members of the general public access to relevant knowledge about (eco) toxicology and the environmental fate of nanomaterials. 4. Austria advocates that, both internationally and nationally, support for the development of nanotechnology should generally be linked with accompanying research or assessments of environmental risks 	<p>Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austrian Federal Ministry of Health, Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research</p>	<p>Generating and ensuring appropriate availability of data related to the environment, enabling a corresponding risk assessment</p>	<p>Short-, medium-term</p>

<p>EHS ("Environment, Health, Safety")</p>	<p>Intensification of Austria's participation in international EHS research projects (OECD, NanoImpactNet, FramingNano, ERA-Net Nano-Tox, etc.). Evaluation of themes relevant to Austria. Technological impact assessment as an accompanying measure</p>	<p>Ministries participating in the National Action Plan</p>	<p>Assuaging doubts related to EHS. Contributing to processes of international coordination, cooperating to establish basic legal conditions, cost-sharing among the Member States</p>	<p>Long-term</p>
<p>Examination and ex-ante or ex-post evaluation of the risk and safety aspects of the projects promoted by the Nano Initiative</p>	<p>Bundling of EHS fund⁵ from the ministries participating in the Nanotechnology Action Plan (including the Austrian Federal Ministry of the Economy, Family and Youth), voluntary participation of industry and other institutions</p>	<p>Ministries participating in the National Action Plan (including the Austrian Federal Ministry of the Economy, Family and Youth) with the involvement of the social partners. Lead: Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management</p>	<p>Pooling the resources available in Austria. Separating EHS research from the interests of industry.</p>	<p>Long-term</p>
<p>Examination and ex-ante or ex-post evaluation of the risk and safety aspects of the projects promoted by the Nano Initiative</p>	<p>Appointing appraisers on the suggestion of NanoTrust</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology/Austrian Research Promotion Agency (FFG)</p>	<p>To get the applicants to concern themselves with risk and safety issues. Developing strategies for dealing with them in each research project</p>	<p>Long-term</p>

⁵ This programme to be planned could, for example, integrate the specific themes listed as examples in Annex 4 into specific calls for projects.

<p>Further promoting of the NanoTrust project of the Austrian Federal Ministry of Transport, Innovation and Technology</p>	<p>NanoTrust should continue to play the role planned for it with respect to preparing information and interpretative summaries</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology</p>	<p>To objectivise a theme laden with emotions and anxieties and to present possible health and environment risks of nanotechnology by preparing scientific information</p>	<p>Long-term</p>
<p>Field of Action: Research, needs for research</p>				
<p>Austrian contribution to promoting nanotechnology in environmental protection: To identify fields of action and establish priorities. To use or create corresponding structures</p>	<p>Austria should promote those nanotechnology applications in particular that are able to make a positive contribution to environmental protection. Whenever possible, existing know-how should be built upon, and projects specifically relevant to Austria should be considered especially worth promoting</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austrian Federal Ministry of Science and Research, Austrian Federal Ministry of the Economy, Family and Youth, Austrian Federal Provinces</p>	<p>Nanotechnology in environmental protection should be embedded in the national and international support structures; nanotechnologies assessed as being positive and sustainable should be used</p>	<p>Short-, medium- and long-term</p>

<p>Intensification of research and development</p>	<p>Intensification and development of science and research and the necessary infrastructure of basic and applied research</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research</p>	<p>Creating the necessary basis for science & research for development of products and applications in nanosciences / nanotechnologies. Intensification of research expertise in fields of application that are relevant to Austria and offer great potential for innovation or for the use of nanotechnology in established industrial sectors (incremental development)</p>	<p>Long-term</p>
<p>Development of a space for European research or exploitation of synergies</p>	<p>Coordination of research & development programmes through promotional instruments of the European Commission (ERA-nets, JTI, Art 169)</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research</p>	<p>Avoiding duplication of efforts. Using synergies. Enabling transnational research projects</p>	<p>Long-term</p>
<p>Cooperating on European technology platforms</p>	<p>Active participation in and helping to shape existing structures (e.g., SUSKAM, Nanofuture)</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology</p>	<p>Developing a strategic research & development plan for nanosciences / nanotechnologies in order to improve competitiveness</p>	<p>Long-term</p>

Dealing responsibly with nanosciences / nanotechnologies in accordance with the European action plan	Conduct code for responsible research as a set of voluntary strategic guidelines	Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research	Responsible research in nanosciences and technologies, as well as dealing responsibly with innovative technologies	Long-term
Making use of European and national research infrastructures	Increased use of research infrastructures and implementation based on the ESFRI roadmap	Austrian Federal Ministry of Science and Research	Extending European competence in science and research	Long-term
Increasing national and international visibility	In the main fields relevant to Austria, it is important to take into account international R&TD policies, EU focal points and the strategic orientation of the European technology platforms	Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research	Coordination of national and international R&D policies in the area of nanosciences / nanotechnologies	Long-term
Key technology	Nanotechnology must be understood as a key technology in research & development as well as production	Policymakers, the general public, social partners	Intensify public relations work	Short-, medium-term
	<p>Explanation: The main problem for SMEs in nanoresearch is that research generally requires a long time and high initial investments. Main costs:</p> <p>Acquisition of know-how (e.g., research, research team, patents, licenses, etc.), research infrastructure and production equipment at the laboratory scale (analysis, production, etc.) as well as requirements imposed by government agencies (employee protection, monitoring exposure, etc.). The purchasing of pooled resources for multiple companies should be promoted.</p> <p>In light of these considerations, the government should try to alleviate such difficulties as much as possible. Applied research and development should be promoted more strongly in order to help lighten the heavy initial investments. It should also be investigated at European level whether the existing patent laws correspond to the long research periods (cf., the pharmaceutical sector).</p>			
Building up high-tech locations	Safeguarding and further developing Austrian and European high-tech locations	Policymakers	Recognition of the immense significance of nanotechnology by Austrian and European policymakers	Short-, medium-term

Supporting SMEs (small- and medium-sized enterprises)	In Austria, particular attention must be paid to the SME structure of the economy. In a European discussion, it is important to point out this fragile yet innovative structure. For these enterprises, improvements in support schemes and patent protection should be an effective catalyst to boost productivity and development. Austria therefore has a real chance of becoming established as a high-tech location.	Policy makers	Strengthening of Austrian SMEs and their power of innovation. Establishing Austria as a high-tech location	Medium-term, ongoing
Further development of funding programmes	In the support of nanoresearch, there should continue to be an emphasis on results that can be spun off to the business world. In any case, nanotechnologies should be a focal point of the national research and innovation strategy in development. It would be a useful step to recommend promoting SMEs and spin-offs at the Austrian and EU level.	Policy makers, Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research	Focus on nanotechnology in research funding (Austria and EU) with a further focus on SMEs and spin-offs	Short-term
Public relations work concerning the role of SMEs with respect to innovation	The importance of SMEs for structural change, the positive effects on employment and creation of value, as well as generally making the public more conscious of the international competitive position	Policy makers, ministries, social partners	Information campaigns and informative materials as well as positive communication to the public	Short-, medium-term
More flexible funding criteria Total project time for funded projects is often too short	In this respect, it is important to develop appropriate funding strategies and use appropriate promotional tools that allow for the long-term nature of nanoresearch	Policy makers, funding agencies, Austrian Federal Ministry of Transport, Innovation and Technology, BMWJF	More flexible research funding and promoting of "ideas on the drawing board"	Short-term, ongoing

	<p>A "milestone principle" might be conceivable in which a multi-year project is subdivided into several stages. In order to obtain further funding when moving on to the next stage, it is necessary to satisfy certain stipulated quality criteria. At the same time, it is necessary to be flexible in evaluating the intermediate and even the final results. Research not seldom leads to highly valuable "serendipitous results" that are very promising for the future. Such opportunities should not be missed as the result of an excessively rigid evaluation system.</p> <p>The funding criteria should be evaluated with due consideration for development in research. The type of projects that are funded should be thoroughly reassessed, as well. In particular, small projects of SMEs should be supported even if that may be very risky. It is precisely such projects that generally have an enormous power of innovation. Micro-funding for initial "ideas on the drawing board" would be especially suitable for such projects, as already mentioned above. A quick screening process could be used to identify numerous new potential projects. They could then be funded to a greater extent.</p>		<p>Creation of a basic situation in patent law that is especially advantageous to SMEs</p>	<p>Medium-term</p>
<p>Evaluation of patent laws and financial and practical support with patent law issues</p>	<p>Especially in light of the long duration of the projects, patent laws should be examined to see whether they sufficiently take into account the lengthy development periods. As with pharmaceuticals and plant protection products, guarantees should be provided for extended patent protection in certain areas of nanotechnology. Especially for SMEs, comprehensive support, including financial aid, advising and ongoing assistance should be provided for the purpose of applying for patents outside Austria. Austria should become actively involved in the process of reforming European patent laws.</p>	<p>Policymakers, social partners, patent office, ministries</p>		
<p>Balanced Health and-Environment (H&E) research with relevance to Austria</p>	<p>When giving research grants, it is important to make sure that H&E research costs are distributed equitably among all the participating countries. H&E research should therefore be planned internationally and with a fair division of labour.</p> <p>Although H&E research is not irrelevant to new technologies, we should avoid Austria making available a disproportionate amount of funding in that sector, since it is particularly difficult to reap economic benefits from such research. A balanced distribution of costs among all EU countries is a fair option. In principle, another objective should be to ensure that H&E research primarily takes place where it is relevant to Austria, too.</p>	<p>Ministries, policymakers</p>	<p>Fair and coordinated EU-wide distribution of R&D research funding and exploration of subject areas relevant to Austria</p>	<p>Starting immediately</p>

<p>Interfaces between science and economics</p>	<p>Recommendations of the Austrian Council for Research and Technology Development, for example, yield very interesting and solid approaches. According to them, the focus is not only on an interface between science and economics but already begins with the role of research institutions and universities as good breeding grounds for business activities. The existing instruments at universities, such as institutions for knowledge transfer, should be advertised more strongly and intensely</p>	<p>Universities, Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research, Austrian Federal Economic Chamber, Austrian Federal Ministry of the Economy, Family and Youth</p>	<p>Reinforcing and intensifying the knowledge transfer from scientists to entrepreneurs; improved use of innovations; Creating or enhancing the basic conditions necessary to that purpose</p>	<p>Medium-term</p>
<p>Basic research</p>	<p>It is precisely the link between technical scientific aspects and “entrepreneurship know-how” that is considered essential. Thereafter, it is important and useful to combine research with entrepreneurship in a professional manner, e.g., by making use of the general framework of patent law to optimise such cooperative efforts. The interdisciplinary factor is also of great importance</p>	<p>Developing Austrian basic nanotechnology research at universities and other relevant institutions as a priority</p>	<p>Intensification and improved funding of basic research</p>	<p>Medium-term</p>

<p>Venture Capital</p>	<p>Conditions for venture financing in Austria are not favourable. In areas like nanotechnology in which only long-term research & development can prove successful, it is important to distinguish clearly between publicly-financed basic research, on the one hand, and applied research and development based on venture capital and private equity (VC/PE), on the other. In this respect, it is very important to improve the basic conditions for VC/PE-funded enterprises.</p> <p>In comparison to the USA, for example, venture capital is not available to a sufficient extent even for commercial development projects with high growth potential. In contrast to the USA, where a significant part of research is situated in the sectors of military and space exploration, civilian use of nanotechnology takes precedence in Austria. This makes it all the more important for the government to get involved with seed and early-stage financing.</p>	<p>Policy-makers, Austrian Federal Ministry of the Economy, Family and Youth, Austrian Federal Ministry of Finance, Austrian Economic Chamber</p>	<p>Intensifying or facilitating venture capital financing. Creating incentives</p>	<p>Medium-term</p>
<p>Analysis of the control system</p>	<p>The option of further developing tax-based research funding (premium) should be examined.</p>	<p>Austrian Federal Ministry of Transport, Innovation and Technology, Austrian Federal Ministry of Science and Research, Austrian Federal Ministry of the Economy, Family and Youth, Austrian Federal Ministry of Finance, Austrian Economic Chamber</p>	<p>Increase corporate research spending</p>	<p>Medium-term</p>

The present Nanotechnology Action Plan, especially the need for action and recommendations formulated herein, will undergo monitoring in 2012. In order to observe the current launch and the implementation of these recommendations and, finally, to evaluate them for progress report, a steering committee should be formed from government agencies, social partners, and stakeholders in the Action Plan. This steering committee should be formed in the course of 2010.

PART 3 ENVIRONMENTAL ANALYSES

3.1 HEALTH AND EMPLOYEE PROTECTION

Nanotechnology is considered a promising area and often viewed as the technology of the future in the incipient 21st century. Potential fields of application are especially concentrated in the health and medical sector, but also in the food and packaging, environmental and energy sectors. The use of nanoscale substances is not absolutely new to certain fields of application but a growing number of people are coming into contact with nanomaterials thanks to new ranges of applications. Additional nano-jobs may possibly be created. The use of nanoscale materials or nanotechnology processes will no doubt have an impact on the Austrian workplaces in terms of occupational health and safety, and the general Austrian population will benefit from innovative products. The objective of the working group Health, including employee protection, was to shed more light on this impact. The guiding idea was preventive health protection.

The Situation in Austria

The current situation in Austria in nanotechnologies and health/employee protection is presented in greater detail below, based on the activities of individual institutions.

Federal Ministry of Health (BMG)

As part of their cooperation with the working groups of the European Council, BMG employees have been participating in the creation of the following EU regulations which deal explicitly with nanotechnology and nanomaterials: the Additives Regulation, the Novel Food Regulation and the Cosmetics Regulation. They are also involved in various national and European initiatives and projects, such as the Austrian nano-information platform “Nanotechnology risk:dialogue”, the European “Safety for Success Dialogue” (October 2008) and the “Exploratory meeting of bodies and experts involved in nanotechnology risk assessment” (March 2009). In addition, there is cooperation with the employees of AGES/PharmMed commissioned by the Federal Agency for Safety in Health Care; in particular in the “Quality”, “Biotechnology” and “Scientific Advice” working groups as well as the “Committee for Advanced Therapies”. In the medicinal product sector, there is cooperation with the EU working group “New and Emerging Technologies in Medical Devices”. In its activities, this group focused on identifying the main risks of nanotechnology and reviewing the existing regulations with respect to the risks associated with this technology.

Federal Ministry of Labour, Social Affairs and Consumer Protection (BMAK)

The BMAK is integrated into the Nanotechnology Platform Network at the national level through the employees of Division VII, the Central Labour Inspection Authority. BMAK also helps safeguard the interests of employee protection. In this role, the Central Labour Inspection Authority also participates in the creation of the Austrian Nanotechnology Action Plan. Nanotechnologies are also discussed in terms of employee protection at internal events of the Labour Inspection Authority and the corresponding competencies are strengthened. What is more, the Central Labour Inspection Authority participates in events discussing the use of nanomaterials in the occupational world, including the AUVA (Austrian Social Insurance for Occupational Risks) conference in the autumn of 2008. The Authority also attends relevant international conferences, such as the NANOSH Conference in Helsinki in 2007 and the follow-up conference in 2009. The government agencies of German-speaking countries also exchange information at events such as the “Behördendialog 2009” in Bern.

Austrian Agency for Health and Food Safety(AGES)

The tasks of AGES include ensuring the human, animal and plant health and continually improving the effectiveness of the related healthcare systems. AGES is also the Austrian focal point for the European Food Safety Agency. Other key tasks of AGES include preventive, and when necessary retrospective, risk assessment throughout the entire food chain, the development and use of statistical methods for efficient and scientific assessment of human, animal and plant health, as well as compiling risk databases. Since nanomaterials are also used in the food sector, relevant risk/benefit considerations need to be evaluated.

The activities of AGES related to the food chain and medicinal products and nanotechnologies include developing an internal cross-disciplinary nano-task force in AGES (the divisions Data, Statistics and Risk Assessment, Food, Agriculture, Analytical Competent Centres, PharmMed, and Communication). Moreover, AGES has organised or helped to organise several events on nanotechnology in food and medicine and participated in the “Nanotechnology risk:dialogue”. AGES also supports the Nanotechnology Information Platform.

Internationally, AGES, through its direct contacts with the European Food Safety Agency (EFSA), has access to the ongoing projects on food safety and nanotechnologies at the level of the European Commission and its advisory committees.

Federal Chancellery

The Bioethics Commission at the Federal Chancellery published an opinion on nanotechnology in June 2007.⁶

Austrian Social Insurance for Occupational Risks (AUVA)

AUVA has a statutory mandate in Austria to prevent occupational illnesses and accidents. Moreover, AUVA is also concerned with preventing job-related illnesses through various projects and other activities. For several years now, AUVA has shed light on the topic of “the health impact of ultrafine dust/nanomaterials at the workplace” by giving lectures at pertinent events, such as the annual conference of the Austrian Society of Occupational Medicine [ÖGA]. This subject has also been elaborated on in scientific publications.

A project launched in 2007 concerns exposure profiles in industrial sectors that process or manufacture nanoparticles and nanotubes and the effects on cells of the human body. Thanks to the Austrian Dust and Silicosis Control Office (ÖSBS⁷), AUVA also has expertise in measuring levels of exposure at the workplace. What is more, AUVA is represented in numerous international bodies, including the International Social Security Association (ISSA), one of whose focal points is nanotechnologies in connection with employee protection.

BioNanoNet Forschungsgesellschaft mbH

BioNanoNet is the trademark owner of the European Center for Nanotoxicology⁸, which is involved in the development, implementation and execution of standardised in-vitro and in-vivo procedures for the study of nanostructured material toxicity to humans. Nanostructured materials are systematically examined for potential toxicological effects, and mechanistic toxicity studies of these materials are also performed (see the website for further details). With numerous scientific publications on the safety of nanomaterials, with lectures at national and international events, and in advanced training on this subject matter, BioNanoNet plays an active role in the Austrian nanotechnology debate. BioNanoNet was one of the thematic partners in the “Nanotechnology risk:dialogue”. Finally, it served as co-coordinator in the project cluster on Nano-Health-Nanotechnologies and Human Toxicology.

⁶ www.bundeskanzleramt.at/DocView.axd?CobId=23987

⁷ www.oesbs-leoben@auva.at

⁸ www.euro-nanotox.at

Federal Chamber of Labour

The chambers of blue- and white-collar workers are the legal bodies representing the interests of three million employees. Under the Chamber of Labour Act [Arbeiterkammergesetz], the chambers of labour are tasked with representing and promoting the social, economic and cultural interests of employees. In order to ensure a high standard of health and safety at the workplace before and during the introduction of nanotechnology, the specialised departments that deal with nanotechnology are working at the national, European and international levels to ensure that working conditions as such are improved.

Austrian Academy of Sciences, Institute for Technological Assessment (ITA)

In the NanoTrust⁹ project, the ITA deals with potential health and environmental risks as well as social aspects of nanotechnologies. NanoTrust took part in the planning, organisation and implementation of various conferences on the possible risks of nanotechnologies, such as BioNanoMed 2009 and Viennano 2009. Moreover, NanoTrust has held three of its own conferences to date: NanoTrust conferences in the autumn of 2007, 2008 and 2009, which were devoted to “stock-taking” of the situation in nanotechnologies. Together with its partners, the ITA offers a publicly accessible database of literature on nanotechnologies and their impact, in the broadest sense of the term.¹⁰ NanoTrust continually publishes what are known as “dossiers” that can be downloaded from the website, providing short, easily understandable and scientifically reliable information on nanotechnologies and their impact.

PPM forschung + beratung

PPM forschung + beratung is an independent, interdisciplinary research and consulting institution involved with employee protection. In this context, PPM participates in national and international projects and is active in training prevention specialists (occupational physicians, security experts) in Austria.

In the field of nanotechnologies, PPM was the Austrian project partner in the EU-project NanoCap. The objective of this project was to build competence in trade unions and environmental NGOs, so as to advocate responsible use of nanotechnologies. In Austria, the Austrian Trade Union Federation (ÖGB) and the trade unions developed and established occupational health and safety as an aspect in the work with nanotechnologies. To provide access to information, an Austrian NanoCap website¹¹ has been set up (connection with the health portal of the ÖGB¹²). With the cooperation of NanoCap, a resolution of the European Trade Union Confederation (ETUC) on nanotechnologies and nanomaterials was drawn up and published.¹³

Nano-topics are also discussed at various union events and others, also at international level, as in a workshop of the 11th Conference of the European Work Hazards Networks (Bologna, October 2008) for instance. Continuing education activities are provided for safety officers (11/2007) and prevention specialists (course in occupational medicine at the Linz Academy of Occupational Medicine and Safety Engineering, 6/2008).

Umweltbundesamt GmbH (Environment Agency Austria)

Umweltbundesamt GmbH is nationally and internationally represented in projects and working groups concerning the critical support of nanotechnology development, among them, “Initiative risk:dialog”, “NanoImpactNet” (European Network on Health and Environmental Impact of Nanomaterials) or corresponding twinning projects. On behalf of the Ministry of Life, Umweltbundesamt GmbH also performs tasks within the scope of the EU-REACH Competent Authorities and is therefore involved with the further development of the REACH Regulation in the field of nanomaterials. In addition, the OECD Working Party on Manufactured Nanomaterial is developing test methods for nanomaterials, among other things.

⁹ www.NanoTrust.ac.at

¹⁰ <http://NanoTrust.ac.at/literatur>

¹¹ www.nanoinfo.at

¹² <http://netzwerke.oegb.at/gesundearbeit>

¹³ www.ppm.at/nanoinfo/inhalte/egb.htm

Consumer Information Association (VKI)

The work of VKI has two main thrusts: the first is protecting consumers, the second is providing consumers with information. With respect to nanotechnologies, there is need for action in both these areas and the need will no doubt continue in the years to come.

VKI activities range from publications on the cooperation of international consumer protection organisations (BEUC and TACD¹⁴) to publications on cooperation in specific projects (NanoRate - Evaluating Nanoproducts¹⁵). In future, nanomaterials will also be taken into consideration when developing (or revising) criteria for environmental labels.

Austrian Federal Economic Chamber (WKÖ)

WKÖ is the statutory representation of all the industrial and commercial enterprises in Austria. Its mission is to inform, assist and represent enterprises. The key objectives include ensuring equal conditions in the European Single Market, sustainable and resource-saving economic, technological and social development, as well as a self-determining, but fair and socially minded, market economy.

From these perspectives, nanotechnology is vital for Austria as a business location, and it represents an immense opportunity in many areas. WKÖ puts all its efforts into promoting nanotechnology as best possible and into helping enterprises understand it. It sheds light on the technical and applied possibilities as well as the need for safety with respect to the applications and products. These objectives are achieved by covering a range of relevant subject areas, such as electronics, cosmetics and laws governing chemicals. At the same time, specific services directly related to the topic of nanotechnology are offered too. Special emphasis is placed on the promotion of research and science, but attention is also paid to areas that require uniform European requirements for nanotechnology products. WKÖ does not advocate nano-specific legislation, since such legislation would not be expedient in light of the heterogeneity of nanotechnology products. Rather, it focuses on adapting existing laws and promoting voluntary measures. Particularly in relation to employee protection, this involves ongoing work on industrial guides for the safe use of nanoparticles, for instance. Moreover, WKÖ supports community efforts in various issues involving nanotechnology, since this is the only way to make optimal use of resources. It is not at all advisable for Austria to launch a solo venture as a nation, since that would weaken its positions as a business location.

With its specialised organisations, WKÖ is closely involved in discussions and projects in the relevant areas at European level. Within Austria, WKÖ is a partner in dialogue when it comes to the National Nanotechnology Action Plan and beyond that.

Statutory regulations

Specific requirements for nanomaterials in consumer products at national or European level are yet to be defined. No particle sizes have been stipulated for the approved food additives, such as titanium dioxide (E171) or silicon dioxide (E551), which are used in packaging materials, food supplements and cosmetics. Codes of conduct are already in place, however, including one issued by the European Commission, which give recommendations for voluntary compliance to authorities, enterprises, research institutions and organisations on responsible use of nanosciences and nanotechnologies.

Insofar as non-specific legislation is applicable, the aspects of consumer health protection in relation to nanomaterials contained in consumer products are subject to pertinent legal provisions.

¹⁴ BEUC: The European Consumer Organisation; TACD: Trans Atlantic Consumer Dialogue

¹⁵ <http://nenanet.at/index.php/article/articleview/1471/1/78>

Food

The placing on the market of food and food ingredients to which a production process not currently used has been applied and where that process gives rise to significant changes in the composition or structure of the foods or food ingredients is regulated in the European Community by Regulation (EC) No. 258/97 (Regulation on novel foods). These changes must affect the nutritional value, metabolism or level of undesirable substances in such food. This regulation in principle also covers novel food and food ingredients produced through nanotechnology processes. In addition, the authorisation of novel foods is subject to specific labelling requirements.

If nanomaterials in food are used solely for technological purposes, then they fall within the scope of Council Directive 89/107/EEC on food additives. The prerequisite for the lawful use of such additives is an authorisation process that includes safety aspects.

Cases not covered by the aforementioned legal instruments are regulated by Article 14 of the General Food Regulation 178/2002/EEC, according to which unsafe foods must not be placed on the market as a general principle. In this respect, it is the food company that is primarily responsible for the safety of its products.

Food packaging and contact materials

The use of nanomaterials in food packaging falls within the scope of the Regulation (EC) 1935/2004 on materials and articles intended to come into contact with food. For certain groups of materials and articles, and combinations thereof, what is known as 'specific measures' may be issued. Implementing rules concerning special requirements for active and intelligent materials and objectives will be issued shortly. Active materials and articles are intended to increase the shelf life of a packaged food or to preserve or improve its condition. Intelligent materials and articles, in contrast, are intended to monitor the condition of packaged food or the food's environment.

Cosmetics

According to the Ordinance on Control Measures for Cosmetics¹⁶, whenever nanoparticles are used in cosmetics, the manufacturer or importer must assess and document the safety of the product before placing such cosmetics on the market. Such assessments must take into account "the general toxicological profile of the ingredients, their chemical structure and degree of exposure". Such safety assessments are monitored in the course of market supervision.

Medicinal products

Nanotechnology in connection with medicinal products is surely not to be assessed in the same way as in applications related to food, cosmetics and articles of daily use or similar areas. The use of medicinal products (with the exception of self-medication using non-prescription preparations) generally requires a prior medical examination with the corresponding diagnosis and risk/benefit analysis. Medicinal products therefore involve a conscious and individual application rather than more or less haphazard, unintentional or unconscious exposure.

In principle, it should be noted that under Community Law, medicinal products containing ingredients manufactured or processed using nanotechnology must undergo a central authorisation process.¹⁷ What is more, the authorising agencies constantly verify and require proof of quality, efficacy and safety in the authorisation process for each medicinal product. As a result, the potential risks of using nanotechnology must be presented and evaluated in the course of such an authorisation process.

¹⁶ Federal Law Gazette 1996/168 as amended and Federal Law Gazette II 2005/92, implementing Directive 76/768/EEC

¹⁷ Regulation (EC) No. 726/2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency

Medical devices

The placing on the market and authorisation of medical devices are uniformly regulated throughout Europe by three EU Directives for medical devices: Directive 90/385/EEC on active implantable medical devices; Directive 93/42/EEC on medical devices, and Directive 98/79/EC on in-vitro diagnostics. These Directives have been transposed into Austrian national law by virtue of the Medical Devices Act (Medizinproduktegesetz¹⁸).

New developments at EU level

Cosmetics

The new EU Cosmetics Regulation, which the European institutions agreed on in the spring of 2009, for the first time defines engineered nanomaterials: "Nanomaterial" means an insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, at a scale from 1 to 100 nm." This definition will be updated along with future scientific developments and technical progress.

Cosmetics containing nanomaterials are subject to compulsory notification by the responsible person to the European Commission at least six months before the planned market launch. They cannot be placed on the market unless there are no health concerns. The Regulation will enter into force 42 months after its publication in the European Official Journal, which is planned for late 2009 or early 2010. Products that were launched on the market within the six-month period preceding that publication date must also be reported to the European Commission. If there are any health concerns, their continued marketing will be prohibited. All ingredients in the form of nanomaterials must be clearly indicated in the list of ingredients, with word "nano" inserted in brackets after the name of the ingredient.

The Commission will also publish a catalogue of all nanomaterials used in cosmetics 48 months after the effective date of the Regulation. A separate section of this catalogue will list all the nanomaterials placed on the market in the form of dyes, UV filters and preservatives, along with the categories of the cosmetics and reasonably foreseeable conditions of exposure. This catalogue must be updated on a regular basis and then made available to the public. The European Commission will submit to the European Parliament and Council an annual progress report containing information about the developments in the use of nanomaterials in cosmetics, including those used as dyes, UV filters and preservatives. The updated report will include, in particular, new notified nanomaterials in new product categories, the number of notifications, the progress achieved in the development of specific evaluation procedures for nanomaterials, safety assessment guidelines and information on international cooperation programmes. The European Commission will regularly review the relevant provisions of this Regulation in light of scientific progress and suggest amendments to the provisions as appropriate.

Food additives

The new Regulation (EC) No. 1333/2008 on food additives was published in the European Official Gazette on 16 December 2008. According to this Regulation, food additives must not be placed on the market or used in food under specified conditions unless they are included in the lists of approved ingredients standardised throughout Europe. If the production process, initial ingredients or particle size of a food additive that is already listed in the Community list is altered (e.g., by using nanotechnology), then the relevant food additive requires a new entry in the list before it can be placed on the market.

¹⁸ Medical Devices Act (Medizinproduktegesetz) Federal Law Gazette no. 675/1996, as amended

Novel food

The Community institutions were unable to reach an agreement on the first reading of the Proposal for a Regulation of the European Parliament and Council on Novel Food. The current Compromise Proposal (version of 30 May 2009) presented by the Czech Council Presidency at the initiative of the European Parliament and Austria consists of the following elements: the definition of terms in the Regulation will incorporate a definition of “*engineered nanomaterials*”, which is to be internationally coordinated and updated on a regular basis. Food that consists of or contains engineered nanomaterials will be subject to specific requirements for authorisation.

Employee protection

The statutory provisions for employee protection are intended to protect the life and health of employees in their professional activities. Employee protection provisions regulate such areas as the treatment of hazardous substances (e.g., toxic chemicals), the use of hazardous machines and tools, pollution created through working procedures or other effects such as noise, as well as instruction and examinations by occupational physicians. The objective of modern employee protection is prevention. Measures intended to prevent/reduce the probability of injury to human health or accidents are therefore a central concern of employee protection.

The obligations in this respect are primarily incumbent on the employer. Employers are required to watch over every aspect that is liable to affect their employees' activity in order to ensure their health and safety. To ensure that their efforts are effective and sustainable, the employer is required to establish a suitable employee protection organisation. Prevention experts (occupational physicians and safety engineers) assist employers by providing their expertise.

The following section includes an excerpt from the statutory provisions relevant to safe use of nanomaterials:

The Employee Protection Act (AschG) applies to the activities of all employees (all persons employed or undergoing training). It lays down the fundamentals regarding health and safety at the workplace. Section IV of this Act focuses on the use of hazardous materials. The Employee Protection Act is also applicable for the handling of nanomaterials at the workplace.

The Austrian Limit Value Ordinance (Grenzwertverordnung) stipulates the maximum concentrations of hazardous materials allowed at the workplace. No specific limit values have yet been defined for nanomaterials. To the extent that sufficient data is available in toxicology and occupational medicine, however, limit values could be established in this context.

The Austrian Explosive Atmosphere Ordinance (Verordnung explosionsfähige Atmosphären) regulates the protection against explosions at the workplace. Working with flammable nanomaterials dispersed in dust-like form in sufficient quantities may also lead to a risk of explosion that should be taken into account.

Implementation of EU laws governing chemicals, particularly the REACH Regulation¹⁹, will have an impact on the practice of employee protection in Austria. REACH governs the registration, assessment, authorisation and restriction of chemical substances and therefore also covers these substances in their nanoform. Manufacturers and importers of nanomaterials are therefore subject to all the obligations set out by REACH. In particular, they are required to register of substances. As part of the registration process, it is necessary to ascertain specific information about safe use of hazardous substances at the workplace and to pass this information along to the users in the form of safety data sheets. Article 32 of the REACH Regulation introduced an additional communication instrument that could be used for

¹⁹ See also page 44

nanoscale particles, among other things. The duty to provide information applies to substances or mixtures that, although not classified as hazardous, nevertheless make risk management measures necessary. In future, this instrument will be used to ensure improved communication regarding employee protection and environmental protection.

Opportunities for using nanotechnologies

Consumer applications

Generally, most applications and products could be improved by using nanomaterials or nanoparticles. Apart from electronics, important fields of application include composite materials strengthened by embedded nanoparticles or cosmetics and medicinal products, where nanoscale capsules enable improved transportation of active substances. Another broad field of application is surface treatment, e.g., detergents and sealants for textiles, wood and metal.

Food

It might be possible to use nanotechnology to improve the stability and shelf life of food, enhance the bioavailability of key ingredients and alter the appearance, taste and consistency of food.

Food packaging and contact materials

Packaging optimised through nanotechnology could help protect food better against spoiling and determine the degree of freshness. Such intelligent packaging materials could indicate whether the cold chain has been interrupted or the best-before date has been exceeded, for instance. What is more, nanomaterials could be used to make surfaces stronger, lighter, cleaner and “smarter”. For instance, such materials could be used in kitchen appliances, paints and dyes, and in products used to seal and clean surfaces. Nanoparticles of silver are used for surface coatings, since they are germicidal.

Cosmetics

In cosmetics, nanomaterials are already being used as UV filters in sunscreen lotions. Nanoparticles of titanium dioxide or zinc oxide, which are so small that they are transparent, prevent sunscreens from leaving a white film on the skin. At the same time, they offer a high degree of protection against ultraviolet radiation. In skincare products, nano-capsules are used to protect and transport active substances and make skincare more effective.

Medicinal products

In the field of medicinal products, nanotechnology is used to help improve possible treatments of diseases involving tumours, metabolic disorders and enzyme deficiencies. In the organism, the active substances are distributed to the target organs/tissues with greater precision, thereby increasing efficacy and decreasing the frequency and severity of undesirable side effects.

Medical devices

There are many possible uses of nanotechnology in medical devices. They range from coating surgical instruments with nanoparticles, using nanomaterials in cancer therapy to developing nanosensors. In imaging procedures, nanoparticles are used as contrast agents. Orthopaedic and dental implants are coated with nanomaterials in order to facilitate their acceptance by the surrounding tissue. Nanosensors built into DNA/protein microarrays and lab-on-a-chip devices are used in molecular in-vitro diagnostics. Dressing materials and textiles contain nanocrystalline particles with antibacterial and fungicidal effects.

Employee protection

In employee protection, nanotechnologies are especially promising when it comes to improving work clothing, industrial garments and personal protection gear. In functionalising

textile materials they can already be made water- and stain-resistant while remaining just as comfortable or becoming even more comfortable to wear. For protection against hazardous microbial contamination or aggressive inorganic chemicals, disposable outfits with special “nanocoatings” offer improved protection and comfort. In future, protective clothing that shields against electromagnetism, infrared or ultraviolet radiation, for example, may be made lighter, more durable and more efficient.

Current knowledge gaps

General

- Characterisation of nanoparticles with respect to chemical or physical parameters
- Standardised test methods²⁰, reference materials and methods of measurement for nanoparticles in food or consumer products should be improved
- Effect of nanoparticles on absorption of other substances of concern
- Applicability of existing *in-vivo* and *in-vitro* toxicity studies to nanoparticles
- Identification of nanomaterials used in consumer products such as food, cosmetics and articles of everyday use
- Assessment of exposure for the general population
- Possible health impact on employees and consumers

Austria-specific

- Lack of an overview of the nanomaterials produced/used in Austria
- Lack of an overview of consumer products in Austria that contain nanoparticles and the resulting (oral/dermal) exposure of the general population
- Lack of adequate data for risk assessment/risk management in Austrian industrial operations (primarily small- and medium-sized enterprises) or knowledge of the efficiency of standard protective measures for employees (masks, filter properties, etc.)
- Lack of an overview of ongoing research projects and results in Austria and their implementation

Food

- Standard methods for the determination of nanoparticles in food
- Studies of the ADME behaviour²¹ of nanoparticles after oral exposure
- Studies on bioaccumulation of nanoparticles within the food chain
- Studies of the release of bound nanoparticles from the matrix
- Detection and development of biomarkers for nanoparticles after oral intake
- Development of a specific risk assessment for nanoparticles in food

Cosmetics

- *In-vivo* studies of skin penetration by nanomaterials from cosmetics (especially in the case of damaged skin)
- Standard measurement methods for the determination of nanoparticles in cosmetics

Articles of everyday use

- Migration of nanoparticles from packaging/surface coating
- Standard measurement methods for nanoparticles in articles of everyday use
- Studies on the release of bound nanoparticles

²⁰ Methods of testing the various forms of penetration of nanostructured materials into humans and for the chronic effects of nanostructured materials

²¹ Absorption, distribution, metabolism, excretion; describes the main kinetic processes in the human body

Risk management at the workplace

- Standards, strategies and processes of measurement (esp. suitable for routine measurement)
- Exposure scenarios at the workplace and overview of the current situation of the industry with respect to nanotechnologies (enterprises, workplaces, risk management, risk control)
- Disclosure of information in the supply chain (practicability, quality, quantity)
- Findings of occupational medicine and toxicology regarding the effects of nanomaterials

Summary

In Austria, numerous activities concerning safety in nanotechnologies, in particular employee protection, consumer protection or chemicals policy, are already underway. Such activities include public events, exchanges of scientific or practical experience, international cooperative projects (EU, OECD), participation in (regional) networks, projects & project membership (incl. toxicology, risks and social aspects of nanotechnologies, corresponding twinning projects). In addition, the participating ministries carry out specific activities in legislative processes, international cooperation and information.

All of these existing activities could be made more visible and better networked.

In health protection at work, this theme is already being covered in the training of prevention specialists. The trend should be further strengthened.

Methods and instruments for measuring exposure at the workplace are available but robust instruments/methods still need to be developed for routine measurements. In projects such as NanoTrust or NanoCap, ascertaining the potential social, economic and environmental impact of nanotechnologies is essential.

The primary opportunities are considered to be in the improvement of product characteristics. By and large, however, the focus, when examining nanomaterials in the working world, should be on the insufficiently clarified risks to human health and the resulting uncertainties relative to the potential opportunities.

There are currently considerable knowledge gaps regarding the safe use of nanotechnologies in Austria. Once again, here is a summary of the most important ones:

- Lack of an overview of the existing nanotechnology applications and products
- Lack of knowledge about realistic exposure scenarios at the workplace and within the general population
- Lack of scientific and technical bases for risk assessment (workplaces and products)
- Lack of adequate (provisional) information about the safe use of nanomaterials and lack of knowledge about risk management measures in industrial practices (particularly in small- and medium-sized enterprises)
- Lack of information for the general population about nanotechnologies and its application to food and other consumer products,
- Lack of information about the implementation and applicability of research findings.

3.2 ENVIRONMENT

The utilisation of nanoscale materials and nanotechnology processes will undoubtedly have effects on the Austrian environmental situation. This chapter focuses on appraising both the potential positive and negative aspects of those effects. Whenever possible, it will explore the economic, structural and ecological aspects specific to Austria.

The uncontested objective is to maximise the potential positive effects for Austria while minimising the possible negative consequences. The entire life cycle of a product must be taken into account in order to ascertain the actual environmental consequences. Specific needs for action and specific recommendations will depend on the specific patterns of use, product categories and types of nanotechnology applications. Such recommendations should describe how the basic conditions in Austria should be adapted or created in order to achieve the desired effect. The aim is to determine which instruments are suitable, which levels of authority are appropriate for developing such instruments and – if measures at European or international level are shown to be appropriate – what a specific Austrian contribution might look like in that context.

Statutory regulations

Various legal instruments currently regulate the manufacture, importation, marketing, use and disposal of substances, including nanomaterials. Other regulations relevant to the environment (which are not discussed here), such as the Water Framework Directive or the Waste Management Directive, contain no nanospecific provisions.

Chemicals - nanomaterials and REACH

REACH²², a European regulation concerning chemicals, regulates the safe use of chemical substances.²³ It does not contain a specific definition of nanoscale substances.

Depending on whether registration is required in the nanoform of a substance or of the substance in general, different quantities will probably be involved. That does not mean, however, that registration of a substance in its nanoform requires less information just because the volume is less. The European Commission assumes that the total quantity (the nanoform plus the non-nanoform) must be registered. That is true, in particular, for nanomaterials that satisfy the criteria for what is termed “phase-in substances”²⁴ under REACH. In the case of nanosubstances that do not have a non-nanoform and are produced in small quantities, the problem of inadequate information requirements during registration may arise.

According to REACH, the creation of a safety data sheet (SDS) is obligatory for nanomaterials or nanomaterials in mixtures if the nanomaterial or mixture containing the nanomaterial is classified as “hazardous”. An SDS is also required if the nanomaterial satisfies the criteria for “Persistent/Bioaccumulative/Toxic” or “Very Bioaccumulative/Very Persistent” or figures on the list of candidate substances that give rise to serious concerns. If a substance in its nanoform or a mixture containing a nanomaterial presents additional dangers besides those for which it is classified as hazardous, they must be specified in the SDS.

According to REACH, a chemical safety report is necessary whenever the quantity of the relevant chemical produced or imported annually is 10 tonnes or more per registrant. The

²² REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals

²³ Also see page 40

²⁴ Generally substances that have been placed on the market for a long time already without requiring prior notification under chemicals laws

European Commission is also of the opinion that such reports must include all sizes, forms and morphologies of a substance.

In the case of certain products, such as textiles, toys and electronic appliances, special regulations apply: if a product contains a nanosubstance contained in the candidate list for substances of very high concern in a concentration > 0.1% by weight, then the commercial recipient of the product must be given “sufficient information” to allow “safe use” of the product. That means at least the name of the relevant substance. Consumers are also entitled to demand such information from the supplier, who is then required to supply it free of charge within 45 days thereafter.

For substance evaluation, substances that have already been registered are selected according to specific criteria and submitted to the government agencies of a Member State for evaluation. Substance evaluation could be particularly relevant to nanomaterials. It must be determined, for example, whether the underlying test methods were appropriate to ascertain the specific nanocharacteristics or whether all possible routes of exposure have been taken into account. The results of the current review of the OECD test methods will be particularly relevant in this respect (see below).

According to REACH, nanomaterials may be subjected to certain restrictive measures. For a restrictive measure to be proposed by the authorities, an EU-wide risk must be demonstrated. The instrument of restriction already proved effective for the “old” chemicals system. Restrictions can effectively regulate the use, manufacture or marketing of a substance, as well as the importation of substances in products. The authorisation process makes manufacture and use in the EU more difficult but may still leave gaps for the importation of products.

For the instrument of authorisation, the Member States and the European Commission can prepare a dossier on nanomaterials that are on the list of substances of very high concern (e.g., carcinogenic). It can then be placed on what is known as the “list of candidates”: this entails stricter obligations to supply information about the substance in question. If the nanomaterial is also listed in the annex of substances requiring authorisation, then, after a transitional period, companies will be required to submit an application for authorisation, including a disclosure of its intended application, if the company wishes to keep using it.

CLP²⁵ Regulation

The European Regulation²⁶ on the Classification, Labelling and Packaging of Substances and Mixtures represents the European version of the Globally Harmonized Systems (GHS) advocated by the U.N. This system is intended to provide worldwide standards for the classification, labelling and packaging of chemical substances and mixtures, in order to make their use safer for people and the environment and to avoid an unnecessary duplication of efforts. The definition of substance is adopted from REACH; it does not contain any nanospecific regulations. As from 1 Dec. 2010, according to the CLP Regulation, all substances that have been registered or placed on the market or classified as hazardous must be notified to the European Chemicals Agency (ECHA) in Helsinki for inclusion into the classification and labelling inventory without defining any threshold levels. According to this Regulation, any deviations from the classification of substances that have already been registered must be justified and then appear in the inventory together with the justification. One such possible deviation, together with a justification, might regard particle size in the nano-range. This inventory is publicly available.

²⁵ Classification, Labelling and Packaging of Substances and Mixtures

²⁶ Regulation (EC) No. 1272/2008

The European Commission also recommended that nanomaterials should be specially classified and labelled in accordance with their altered characteristics in comparison to their initial substances.

The label must indicate any substances that are classified as serious health hazards, e.g., because they are acute toxic, skin irritants, or carcinogens. For substances that are merely classified as environmental hazards, the foregoing rule does not apply. In any case, the classification and labelling in accordance with the above-mentioned REACH Regulation will appear in the safety data sheet.

Cosmetics Regulation²⁷

For the evaluation of any environmental exposures, the new Cosmetics Ordinance has the advantage of requiring certain nanomaterials to be listed if the substance is used in the nanoform (if, in accordance with the definition, it is insoluble and biologically persistent – also see the chapter on health).

Medicinal products

The requirements of a medicinal product authorisation process now also include an environmental risk assessment. No nanospecific regulations are included in that respect. Active substances in medicinal products, however, are generally highly active substances, so that eco-toxicology tests should be performed even if the expected exposures are comparatively low. In any case, tests should be performed if substances are suspected to be endocrine active or particularly fat soluble.

Biocides

There is not yet any information about which nanoscale biocides are on the market and in what quantities. The regulatory system for biocides in the EU does not offer any guidelines for the time being, nor do the public authorities have any experience permitting the specific regulation of nanomaterials. The first specific discussions on evaluation of nanoscale biocides are expected in late 2010 as part of the European Review of the biocide dossier on silver and silver compounds, which includes silver in its nanoform.

According to the Biocidal Products Directive²⁸, products treated with biocides do not require authorisation or registration unless the active substance has an external effect (e.g., control of harmful organisms outside of the article).

Plant Protection Products

In Austria, no (declared²⁹) nano-based plant protection products are currently authorised. However, companies are not expressly required to declare the nanomaterials in their products.

²⁷ See also p. 38

²⁸ Directive 98/8/EC

²⁹ Since Directive 91/414/EEC does not contain a nano-definition, it is difficult or impossible to determine whether a product is a nanopesticide (unless the manufacturer declares it as such). That means that none exists so far as the public authorities are aware, at least.

Nanoargentum – a regulatory exception.

One regulatory exception is Nanoargentum 10, a silver colloid containing silver particles with a diameter of 26 nm in a concentration of 10 ppm. It is used for all indoor and outdoor plants and, according to the product information, has bactericidal, algicidal and fungicidal effects. It is also suspected to be a potential toxin for aquatic organisms.

Nanoargentum 10 is registered in the German list of pesticides. It can therefore be sold as “plant growth stimulant” in Austria³⁰ and is thereby exempted from the extensive evaluation required in the authorisation process under the Austrian Plant Protection Product Act (PMG), which is geared toward ensuring safe use. Despite the many unanswered questions about the risks of nanomaterials that could be at least partially clarified through such an authorisation process, the set of legal tools provided by the PMG cannot be applied in this particular case.

Austrian Federal Environmental Liability Act

Austria has comparatively high standards of liability for the European Union. In Austria, the regulatory authority with respect to liability is divided between the Federal and Provincial governments. No-fault liability has recently been introduced by the Austrian Federal Environmental Liability Act³¹. This system of public-law environmental liability is aimed at preventing, cleaning up or remediating environmental damage itself (soil quality, destruction of biodiversity); it also regulates the distribution of the resulting costs. It concerns water and soil, as well as nature conservation (regulated by the Federal Provinces). The exemption from liability for research and development is limited in the new Federal Environmental Liability Act.

Organisation for Economic Co-operation and Development (OECD)

Among other things, the OECD is involved with creating internationally applicable guidelines for the testing of chemicals. Those guidelines generally constitute the basis of the test methods required by EU law. The OECD “Working Party on Manufactured Nanomaterials” mainly deals with the risks of nanomaterials. In addition, the positive effects of nanotechnology on the environment are discussed. This Working Party is subdivided into nine sub-units designated “Steering Groups” (SGs):

- SG1³²: Constituting a database with relevant studies on nanosafety
- SG2: Knowledge gaps and research strategies (work already completed)
- SG3: Setting up a sponsorship programme in which 14 nanomaterials are to be tested for selected destinations. Austria is also participating in this programme as a co-sponsor for titanium oxide and provides (eco)toxicology studies
- SG4: Screening of existing OECD test methods for adequacy in testing nanomaterials, checks whether these methods need to be adapted, with a focus on sample preparation and dosimetry. Close cooperation with SG3
- SG5: Cooperation on voluntary and regulatory measures
- SG6: Screening risk assessment models for adequacy in addressing nanomaterials
- SG7: Alternative test methods in connection with the testing of nanomaterials
- SG8: Methods to determine the exposure of nanomaterials. Following the initial emphasis on occupational medicine, this group is now focusing on test methods relevant to environmental protection and consumers.

In these working parties, NGOs (environment, animal protection, occupational health, consumer protection) and the industry work intensively alongside government agencies. Together with the OECD Working Party on Nanotechnology (WPN), which deals with measures to promote nanotechnology, the positive environmental effects of nanotechnology

³⁰ According to the Austrian Fertiliser Ordinance of 27 February 2004

³¹ 55th Federal Environmental Liability Act, 2009

³² <http://webnet.oecd.org/NanoMaterials>

are also discussed. Voluntary measures taken by companies, such as obtaining a CENARIOS Certificate³³, help increase the safety of nanomaterials.

Overview of the registration systems for nanomaterials

Many countries have already had some experience with primarily voluntary registration systems: Australia, Canada, USA, Denmark, Germany, and Great Britain have all conducted voluntary surveys in order to get an overview of the use of nanomaterials. One common feature of all four of these approaches was that the participating companies could withhold data at their discretion.

The Canadian model is a hybrid of voluntary and obligatory approaches, scheduled for the latter half of 2009. In the Australian programme, 21 different types of nanomaterials were identified. The voluntary reporting scheme used in the USA gave an overview of more than 100 nanoscale materials. By December 2008, 29 companies had given information on a total of 123 nanomaterials composed of more than 58 different chemicals. The US Environmental Protection Agency admitted that two thirds of the chemical substances from which nanoscale materials were manufactured for consumer products were not reported. Likewise, some 90% of the nanomaterials consumer products are suspected to contain were not reported.

The programme carried out in the United Kingdom yielded a similar number. Between 2005 and 2007, Switzerland also carried out a project to survey the extent and significance of the use of nanomaterials in Swiss industry (Schmied/Riediker 2008). Out of the 198 companies surveyed, 55 confirmed that they produced nanoparticles and 54 confirmed that they used them.

All of these projects were of limited duration and helped the responsible authorities to get an initial overview of the product proliferation associated with the field of nanotechnology. In all the countries, the models and projects were viewed as complementary to the general legal framework.

Opportunities for the use of nanotechnologies

The following section will describe the potential positive consequences of nanomaterials and the corresponding nanotechnology processes in the environmental area.

The German NanoCommission has compiled areas of use of nanomaterials that may contribute to the efficient use of resources and to health protection:

“Large-sized lithium-ion batteries can provide greater energy efficiency. Thanks to the use of nanomaterials, they have become lighter, less expensive, and have a longer storage life. They are also suitable for use in electrical and hybrid motor vehicles and can store energy from alternative sources such as wind, water and solar power.

New lamps made of OLEDs help reduce electrical consumption and CO₂ emissions. Thanks to nanostructures, they require significantly less energy while producing a very high level of luminosity.

Carbon nanotubes are mixed with plastics and, depending on their design, produce very stable, tear-resistant materials or materials resistant to frictional electricity. They may be used, for example, as structural components for aircraft and automobiles or as blades in wind turbine power stations. Such nanotubes are used by manufacturers to minimise energy consumption and costs. Nanoporous foams can be used as insulating materials for renovation and construction of new buildings, where they likewise reduce heating costs and energy consumption.

Protecting our limited water resources: nanofilters are used for the treatment of wastewater from production, residential areas and landfills. Drinking water can be cleaned and purified.”

³³ A certifiable risk management and monitoring system developed especially for the conditions and requirements of nanotechnology by TÜV SÜD Industrie Service (Munich) together with the Swiss company Innovationsgesellschaft mbH.

Nanofilters can also be used to desalinate water and eliminate heavy metals with greater control over the precision of separation and flow rate than with conventional processes that are not nanotechnology-based. In environmental analytics, nanotechnology could be used to measure environmental pollutants such as organic hydrocarbon compounds.

The Swiss company Re, one of the biggest reinsurers of major risks, wrote the following passage in a report on nanotechnology³⁴:

“New forms of energy for environmental protection. On the one hand, the opportunities afforded by nanotechnology consist in saving energy, developing innovative energy sources and making better use of resources. On the other hand, nanotechnology can be used in new manufacturing processes, using fewer raw materials and basic materials and producing less environmentally harmful toxic waste. Thanks to weight reduction and the use of alternative fuels in the transportation or manufacturing industries, greenhouse gas emissions could be reduced, as well. The potential energy savings offered by nanotechnology concern not only new fuel cells in the form of nanotubes that function as excellent hydrogen storage devices but also innovative lighting materials and new types of solar cells that, according to researchers, will be capable of being sprayed onto buildings in the future or built into clothes. On the strength of dye coatings only a few nanometres thick, organic solar cells absorb sunlight and convert light into energy using a method similar to photosynthesis in plants.”

Nanotechnologies can be used to miniaturise production processes (e.g., mini-reactors with very high output) and, by using catalysts, very specific products can be made without generating undesirable by-products. One approach that saves detergent consists of a self-cleaning coating that makes use of the lotus blossom effect. A special surface nanostructure ensures that dirt particles do not cling to the surface of objects, thus significantly reducing the required cleaning work.

Nanotechnology will also enable the manufacture of more light-weight and intelligent tailor-made products that are more wear-resistant, sturdy and durable.

Another contribution to waste avoidance and waste recycling might lie in a separation process that can separate highly-specific individual chemical substances. In addition, nanotechnology might be used to facilitate the recycling of materials from scrap motor vehicles: there used to be 50 different types of plastic in a car. Now, thanks to nanotechnology, attempts are being made to satisfy all the requirements with a single basic type of plastic.³⁵

Life-cycle analyses are an appropriate tool for evaluating the potential savings in materials and energy.

Relevance of nanotechnology to plant protection products

There are already certain plant protection products based on nanotechnology. A distinction is drawn between those based on nanoscale formulations (e.g., emulsions, micelles, capsules, powder) and those in which the active substances or other co-formulants are nanomaterials. Neither the active substances nor other co-formulants are required to be declared as nanomaterials. Therefore, no information is available in this respect. As far as formulations and active substances are concerned, certain plant protection products are already known. The industry is particularly interested in nanoemulsions for the manufacture of plant protection products, because they can be dispersed/distributed better than conventional emulsions and are therefore more effective. Solid nanoparticles currently play a rather secondary role, although certain products that use them are also known to exist.

³⁴ www.swissre.com, “Nanotechnologie – kleine Teile große Zukunft” 2004

³⁵ Berger, J. (2004): “Schöne neue Plastikwelt”. Der Standard, Vienna. 12 July 2004, p. 9.

In comparison to conventional pesticides, companies expect the following benefits from nanopesticides:

- Better absorption in the target organism so that a smaller amount needs to be used, thereby reducing the exposure of humans and the environment
- Greater effectiveness can be achieved by means of customised active substances (designing of structure and properties)
- Emulsifiability is significantly improved through nanoscale droplets (micelles).
- The active substance can be released in a controlled manner thanks to micro- or nanocapsules.

Certain formulations are known that are based on micro-emulsions or micro-encapsulation. Nanoscale formulations have also been reported (e.g., micro-emulsions having droplets with a diameter of 50 to 100 nm). In these cases, however, that result was not deliberately intended.

One example of a “genuine” nanopesticide is Heritage TL (active substance: azoxystrobin), which is a true nano-emulsion used on golf courses. It has already been authorised in the USA.

Potential negative consequences of nanomaterials

Effects based on inherent characteristics (hazards)

Nanoparticles can be actively or passively absorbed by cells and trigger various effects. Harmful environmental consequences can be expected from potentially cytotoxic nanomaterials, such as nanosilver and zinc oxide or titanium dioxide. Direct effects on cells and intensified formation of radicals can also harm organisms such as bacteria, fungi and algae. Free radicals can arise in the cell itself or on the surface of the particles. The reactions triggered by the free radicals can lead to a wide variety of effects, such as inflammatory reactions, DNA damage and even cell death. The threshold value, i.e., the minimum quantity of absorbed nanomaterials required to trigger the effect, is not known, however. Studies show that aluminium-nanoparticles inhibit plant root growth. Studies with fullerenes, carbon black and nanopolystyrenes in aquatic organisms indicate adverse biological effects, as well.

Key arguments of SCENIHR 2009 (Risk Assessment of Products of Nanotechnologies):

“Reduction in size to the nanoscale changes the characteristics of particles, primarily due to the increased surface-to-volume ratio. There are, as yet, no paradigms to anticipate the significance of any of these changes in properties, so the safety evaluation of nanoparticles and nanostructures cannot rely on the toxicological and ecotoxicological profile of the original material. The biological behaviour of nanoparticles is determined by chemical composition, surface design, decrease in size (and the corresponding shift in chemical and physical properties and the associated increase in surface-to-volume ratio), and shape. One mechanism of toxicity of nanoparticles is likely to be the induction of reactive oxygen and the consequential oxidative stress in cells and organs. In addition, aggregations of nanoparticles may have an effect on their biological behaviour as well.

The biological evaluation of nanoparticles and/or products incorporating nanoparticles should be performed on a case-by-case basis. Testing for interaction of nanoparticles with proteins and various cell types should be considered as part of the (eco)-toxicological evaluation. The biological properties may differ in quantity and quality from those of chemical and biological substances in other physical forms. Three situations may be distinguished:

- The hazard is due solely to the substance existing in nanoparticle form
- The hazard is due mainly to the chemical composition of the particle
- a combination of these last two items.

It should be noted that because of the restricted range of nanoparticle types whose biological properties have been studied to date, it is uncertain whether or not the findings are representative of nanoparticles in general.

Note on dosimetry: The dose expressed as surface area or number of particles shows a better correlation to biological and toxic effects than the dose expressed as mass.”

The load or shape of nanoparticles may also be relevant from the toxicological standpoint: certain carbon nanotubes, for example, are too long to be fully absorbed by human phagocytes. This leads to inflammatory reactions that are considered potentially carcinogenic.

With respect to exposure in water, the agglomeration and aggregation behaviour of nanoparticles should be viewed as one of the key factors, since they are decisive for both exposure and toxicity. With respect to both mobility and toxicity, the studies on fullerenes exemplify what a massive influence sample preparation and the form of presentation of the particle under study have on the final result and on the toxicity. Solubility and degradation are other key parameters for the assessment of the environmental relevance of nanoparticles in aquatic media. Knowing that certain nanomaterials, such as metallic oxides, could be biopersistent, whereas other nanomaterials, e.g. in the pharmaceutical sector, have been designed explicitly to feature excellent biological degradability, it is obviously necessary to evaluate the inherent characteristics of nanomaterials on a case-by-case basis.

Another factor to be taken into account regarding environmental consequences is that the interaction of nanomaterials with the specific environmental medium (air, water, earth) or with substances from that medium can lead to a significant change of their characteristics (agglomeration behaviour, reactivity etc.). The interactions of nanoparticles with environmental pollutants such as heavy metals are particularly noteworthy in this respect. As already known in the case of colloids, nanoparticles may be carriers of toxic substances and spread them in the ecosystem or introduce them into organisms.

A fundamental problem for the assessment of eco-toxicology and environmental behaviour of engineered nanomaterials is the lack of analytic instruments/methods to detect and characterise (size distribution, shape, chemical and physical surface composition, type and extent of possible contaminants, etc.) engineered nanoparticles (NPs). In particular, there are currently no or only very few processes to detect NPs in a "natural" environment – such as air, water or soil, or in biological organisms (plants and animals) – much less to characterise them. Such instruments are a prerequisite for the further fundamental research on the eco-toxicology of NPs.

Another basic deficiency consists in the lack of standards to systematise the studies and ensure the comparability of the results. For example, there is a need for reference materials in order to be able to trace systemic reactions of organisms and eco-systems back to the relevant nanomaterials, attribute certain reactions to specific characteristics of these materials and situate them in relation to other nanomaterials. In this respect, there are already ongoing OECD activities and EU projects. In order to ensure the comparability of studies, standard test procedures are necessary, as well as the development of an unambiguous and uniform system of terminology.

Exposure scenarios

Through the use of nanomaterials in cosmetics, such as sunscreen lotion, nanomaterials have already been and are being introduced into bodies of water in considerable quantities. In particular, engineered nanomaterials enter the environment through the use of nanomaterials in wall coatings, paints and dyes, detergents, sprays, nanotextiles (nanofibres and coated fabrics) or medicines. Another significant field of application for nanoscale materials consists in modifying the characteristics of surfaces by applying coatings. This is usually done in order to endow surfaces with additional features or modify the existing surface properties. Be they textile surfaces, mineral surfaces, or surfaces of articles of everyday use, these structures, together with their nanoscale additives, are subject to a process of degradation and erosion (not least of all, in the form of waste products), which results in nanoscale structures finding their way into the environment. The same is true of processes that do not take place in

completely closed circuits and which can also be expected to release engineered nanomaterials.

Whether they are released in an intended manner or unintentionally, nanoparticles may be altered through photochemical and chemical influences or compounded with other particles or surfaces. Following these or other surface changes, further patterns of dissemination into the environment are possible; among these, a distinction must be made between introduction into the air, water or soil. Once they have reached these environmental media, they may come into contact with or be absorbed by organisms. At this stage, at the latest, persistence becomes a critical factor. Note: One study showed that ferrous nanoparticles in the groundwater may migrate over a distance of up to 20 metres and remain reactive for a period of 4 to 8 weeks.³⁶ The aggregation and agglomeration of nanomaterials are also of considerable relevance to their environmental behaviour, bioavailability and reactivity. We will now proceed to examine the effects of bioaccumulation and acute or chronic toxic effects and processes in parallel.

³⁶ Zhang et al. 2003: Comparative toxicity of standard nickel and ultrafine nickel in lung after intratracheal instillation. *J. Occup. Health* 2003, 45, 23-30

Approaches to risk assessments

Documentation on the effects of nanoparticles on organisms is currently limited to flash shots. Engineered nanomaterials appear to concentrate in certain aquatic organisms. It is still unknown whether nanomaterials can accumulate along the food chain – there, too, individual case studies are necessary. However, more and more findings support the plausible theory that the biocidal effects of engineered nanomaterials may also affect non-target organisms in the environment. This may be relevant, for example, for antimicrobial nanomaterials such as silver, zinc oxide or titanium dioxide, whose use is becoming increasingly widespread in the food and cosmetics industries, but also in food processing. It is also necessary to note combination effects, e.g., with ultraviolet light. This is true, for example, in the case of nanotitanium dioxide, which, in combination with UV light, is toxic to algae and water fleas. Nanozinc particles have toxic effects on these target organisms, as well.

More and more findings also suggest that antibacterial nanosubstances impact the symbiosis of plants with nitrogen-fixing bacteria and affect the nitrogen cycle in fresh and salt water environments. Our current state of knowledge does not allow us to rule out the possibility that ecosystems may be destabilised by such effects. It must also be taken into consideration that the interaction of nanoparticles with ecosystems is nothing new: incineration processes (whether through the combustion of wood or fossil fuel-fired processes) are noteworthy sources of nanoscale particle emissions (particulate matter). These are cited as arguments in support of the thesis that the use and release of engineered nanomaterials does not expose ecosystems and organisms to particles of this size for the first time. Considering the potential of nanoparticles to interact with proteins, nucleic acids and other biological molecules, unique negative effects, which have never been observed with chemicals before, are likely to appear in other physical forms. While there is still no concrete evidence of this, the methods to assess their degree of hazardousness should take this possibility into account.

The possible environmental consequences of nanomaterials in Switzerland have been estimated based on the modelling method adopted by the researchers of Empa, a Swiss interdisciplinary research and services institution for material sciences and technology development. What is known as PNECs (= Predicted No Effect Concentration)³⁷ were calculated from the existing toxicity values for aquatic organisms. Since little data is available and traditional methods of measurement were used, wide safety margins were adopted. For nanotitanium dioxide, they referred to a publication with acute aquatic toxicity levels for daphnia and fish, setting the calculated PNEC at <1µg/l year. According to their calculations, the current concentrations of nanotitanium dioxide have already entered this range (0.7 to 16 µg/l).

In the cases of nanosilver and carbon nanotubes the estimated PECs (= Predicted Environmental Concentrations) are far from attaining the PNECs distinguished according to that modelling method.³⁸

In the project “NanoRate – Benefit and risk of nanotech products: nanotech products from a life cycle perspective”, a tough, water-repellent, and easy-to-clean coating for wooden floors and an easy-to-clean coating for glass were evaluated. In a lifecycle analysis, risks related to health and the environment are taken into account, since they may call into question a possible energy and resource benefit. The project is being carried out by the IFZ³⁹ of Graz (project manager), Eco-Counselling Austria (die umweltberatung) in 2008, the Austrian Consumer Association (Verein für Konsumenteninformation) in 2009, the Austrian Institute of Ecology (Österreichisches Ökologie-Institut) and the Institute of Technology and Regional Policy/Joanneum Research (Institut für Technologie- and Regionalpolitik). The sponsors are

³⁷ The value that is expected to have no effects on the environment

³⁸ Nicole C. Mueller, Bernd Nowack: Exposure Modelling of Engineered Nanoparticles in the Environment. *Environ. Sci. Technol.*, 2008, 42 (12), 4447-4453

³⁹ Inter-University Research Centre for Technology, Work and Culture (Interuniversitäres Forschungszentrum für Technik, Arbeit and Kultur)

the Jubilee Fund of the Austrian National Bank and by the Chemicals Policy Department of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. The estimated duration of the project is until September 2009.

Aggregation and Agglomeration of nanoparticles⁴⁰

Individual particles, aggregates and agglomerates

It is important to distinguish between aggregates and agglomerates of nanoparticles. In aggregates, the particles are united by a very strong bonding force, so such aggregates are unlikely to release individual particles. When the 100nm threshold value (ISO) is applied, such structures are often not considered nanoparticles but rather nanostructured materials. Nanotitanium dioxide would be one example.

Agglomerates, on the other hand, are composed of weakly bound particles. The bonds may, in principle, be dissolved under certain environmental conditions and are therefore considered reversible. Examples are silicon dioxide nanoparticles and polymers such as polystyrene sulfonate nanoparticles or products of reduction such as gold nanoparticles in gold sol.

Agglomeration and effects

In general, an aggregate of primary nanoparticles or an agglomerate of a size outside the specified range will not necessarily lose its special characteristics, as demonstrated by highly aggregated titanium dioxides, which despite being larger than 100 nm still display the photocatalytic properties of the primary particles. It should be taken into account that under certain circumstances the reactivity may be weakened through consumption on the surface at the time of agglomeration or through inhibition of the transport processes in a porous agglomerate. Moreover, large aggregates/agglomerates will behave differently during transport through cell walls or may be excluded from penetrating them. It must be borne in mind, however, that de-agglomeration on the cell membrane or in an organism is conceivable. Proximity effects therefore deserve close attention.

Agglomeration and Transport

For behaviour in the aquatic environment, agglomeration and the aggregate size play an especially important role, since they control the transport behaviour and thus both the location of the substances and the primary target organisms. If the combination of the chemistry of the local water supply and the characteristics of the nanoparticles result in aggregation, giving rise to microscale agglomerates, then the sedimentation of the agglomerates will reduce the concentration of these nanoparticles in the local water. The particles will merely be relocated to the sediment, however. In the case of persistent materials, this may result in significantly higher concentrations in the sediment than in the water. Moreover, different-sized agglomerates may be transported different distances, so that the sediment further from the source of emission may be more heavily contaminated with smaller particles (the large ones being deposited close to the source while the small ones are transported a greater distance). If the effect is size-dependent, then a species that inhabits more remote sediment may be more endangered than one that inhabits the sediment close to the source or an aquatic species.

As part of the environmental risk assessment, special attention should be paid to nanoscale products that are released into the environment for an intended purpose. This is especially true of biocides and products that are intentionally designed to be chemically and biologically active (e.g., for agricultural applications).

⁴⁰ Frank von der Kammer, 2009

Nanosilver⁴¹

Silver has long been used for its biocidal properties against bacteria, fungi and algae. During the last few years, silver has been used increasingly in its nanoparticulate form, which exhibits a higher toxic potential than traditional silver compounds. For humans, silver is toxic only in very high doses. Products with nanosilver therefore constitute one of the most significant categories of nanoproducts, which are especially significant for germicidal surface coatings for clinical applications. They are distinguished by their effectiveness against a wide range of pathogens – even against those that are already resistant to modern antibiotics. In addition, nanosilver is used in a range of consumer products.

Such non-specific use of nanosilver as a bactericide raises certain doubts, however, since it might promote varieties of germs with multiple capacities of resistance. The possibility cannot be ruled out that the beneficial bacterial microflora of our skin might be harmed by cosmetics containing nanosilver. Silver becomes a potential environmental hazard when it ends up in the wastewater after use, thereby increasing the silver content of natural bodies of water. It could then be harmful to aquatic forms of life and beneficial bacteria in water treatment plants and in the soil.

Little is known about the environmental toxicity and environmental behaviour of silver nanoparticles. Conclusions drawn on the basis of conventional silver compounds do not mean very much, since nanoparticles have different characteristics. The initial studies suggest that silver nanoparticles are more potentially toxic than silver compounds and silver ions. This is attributable to the long-term deposit effect of nanoparticles accumulated in the cell, which continually release silver ions.

Nanotitanium dioxide

Several million tonnes of nanotitanium dioxide are being produced worldwide today: it has many fields of application: as a (photo)-catalyst in manufacturing processes, sunscreens, outer wall coatings, paints and much more, it is already being released into the environment in comparatively large quantities. Such nanotitanium dioxide materials should not, however, be viewed as a *single* substance, since they vary widely accordingly to the particles' size distribution, shape (spherical or elongated), surface reactivity, manufacturing process and mineral form (e.g., rutile or anatase). Moreover, these particles may be coated differently: they may differ by having inorganic or organic, or hydrophilic or hydrophobic coatings.

All of those factors may be responsible for different potential hazards. An important project for the assessment of such factors is currently being carried out at OECD level. Austrian researchers of the Department for Environmental Geosciences of the University of Vienna are actively working in this area to define the parameters of various nanotitanium dioxide materials that lead to different behaviour in water. This project is financially supported by the Austrian Federal Ministry of Agriculture, Forestry, the Environment and Water Management, as well as the Federal Ministry of Transport, Innovation and Technology and under the coordination of the Environment Agency Austria (Umweltbundesamt).

Sources of emission – Elements of the emissions situation in Austria

The potential spectrum of emission paths of nanoscale materials may be represented by a mixture of point and diffuse sources. Point sources include nanomaterial production sites, landfills and waste incineration sites. Diffuse sources may include atmosphere deposition and abraded matter from products and surfaces. The residue of pharmaceutical and cosmetic products that finds its way into the natural environment after use or in human excrement also has an environmental impact.

When assessing potential environmental contamination by nanomaterials in Austria, small-sized and sensitive ecosystems should be paid particular attention to. Based on our current

⁴¹ NanoTrust-Dossier 010 "Nanosilber", April 2009, Institute of Technology Assessment, Vienna

state of knowledge it is quite plausible, for example, that the biocenosis of water treatment plants could be impaired by localised introduction of biocidal nanomaterials. Analogously to the studies on lakes used for swimming, where the accumulation of substances originating from cosmetic was analysed, the contamination of such lakes by nanoscale residue from cosmetics should be studied as a possible hazard scenario specific to Austria.

Nanomaterial manufacturing sites may be considered another point source of nanomaterials emissions in Austria. Studies conducted in parallel with studies to assess the workplace situation should cover the possible consequences on the surrounding ecosystems. Analogously to the study of hospital wastewater and the studies of the degradation behaviour of pharmaceutical active substances in water treatment plants, specific research on nanoscale pharmaceutical components is necessary in Austria, if the solubility behaviour of such components does not preclude their transference to natural bodies of water.

Nanomaterials washed from façade paint might be an important source of emissions. Ralf Kaegi of Eawag, Swiss Federal Institute of Aquatic Science and Technology and his research group were able to detect engineered nanotitanium dioxide particles in surface water and traced the origin of these particles to the run-off from paint applied to façades that contained nano-TiO₂. Analysis of the walls using an electron microscope showed that the released particles were still partially embedded in the organic bonding agent but that many free nanoparticles were already demonstrable, especially in the case of older walls. The surface coating should also be taken into account in any toxicity tests.

Experiments with nanosilver have demonstrated nanosilver in the form of free particles in wall paint run-off: the particles were only a few nanometres in size (< 15 nm) and do not agglomerate. Initial ecotoxicology studies have shown that particles of this size can be absorbed by algae.

Summary

Nanotechnologies and products based on engineered nanomaterials have the potential to make a significant contribution towards saving resources and energy as well as preventing waste. Nanotechnology can also be used to reduce environmental pollutants by enabling new processes to remove harmful substances or by decreasing the utilisation of such harmful substances. When assessing the environmental impact of nanotechnology processes or products it is necessary to adopt a lifecycle-oriented perspective, i.e., the phases of production, utilisation and disposal must all be taken into account when analysing nanotechnology products and nanomaterials.

Effects based on inherent characteristics

Nanoform substances may have different biological characteristics than non-nanoform substances – mainly due to their higher surface-to-volume ratio. Both the shape and the load of the individual particles are important. Due to their extremely small size, engineered nanomaterials may be more easily transported in the body and absorbed by cells, where they might lead to oxidative stress and thus inflammatory reactions.

When analysing the possible environmental consequences, it should be borne in mind that nanomaterials may change through contact with air, water and soil. In particular, aggregating or agglomerating may influence the behaviour of nanomaterials.

In contrast to the conventional chemical safety test procedures, it is essential, from the (eco)toxicological perspective, to express toxicity not in terms of dosage or concentration by weight (e.g., g/l) but rather by parameters that refer to the surface area or number of particles.

Exposure scenarios

In light of the increase in the production, use and disposal of manufactured nanomaterials, an increase in exposure to such materials having an environmental impact is inevitable. As in the case of human health risk assessments, an assessment of the persistence and behaviour of nanomaterials in the individual environmental media is a basic prerequisite for predicting and assessing the potential eco-toxicological effects on individual life forms. An assessment of the release pattern of nanomaterials is of central importance. In order to determine the concentration of nanomaterial exposure in the environment, it is necessary to have a detailed understanding of the processes that describe the behaviour of such particles in the environment (SCENIHR, Risk Assessment of Products of Nanotechnologies 2009).

Approaches to risk assessment

Although certain isolated individual assessments of nanomaterials and their potential risks for the environment and human health exist, an appropriate set of tools to assess the engineered nanomaterials, their inherent properties, and exposure to a broad range of products is still needed. On the basis of a methodology that is capable of specifically mapping the inherent properties of nanoparticles, we likewise need representative data concerning exposure in order to draw conclusions about the potential risks to human health and to the environment. Such assessments should contemplate not only the current forms of use of nanomaterials but also the future forms of use. In addition, nanospecific risk assessments should take into account the potential release of nanomaterials - also in the product lifecycle phases of use and disposal.

Sources of emissions – Elements of the emissions situation in Austria

Even on the basis of the currently known nanomaterials and their forms of use, regional situations of nanomaterial exposure caused by localised sources of emission are conceivable. Large-scale use of nanomaterials might also lead to background exposure to such materials, especially in light of the processes of weathering and erosion. Special attention should also be paid to observing and assessing the potential dangers in the course of the manufacturing processes of nanomaterials (keywords: worker protection and industrial plant emissions).

Nanomaterials and REACH

The communication published in June 2008 on aspects of regulation of nanotechnology⁴² says that REACH covers the risks of nanotechnology in principle, even though it does not provide any specific regulations for nanomaterials. In certain areas, however, there is need for adaptations or specific guidelines for implementation. The EU working group “REACH-Nano” will therefore work on the areas of REACH specifically relevant to nanomaterials until 2012. The objective is to publish a REACH guidance document to nanomaterials by no later than June 2012 and to perform other adaptations. The working group will devote itself to the following areas: Annexes IV and V (substances exempted from registration), substance identity, registration, classification and labelling, information in the supply chain and test methods, Annex XIV (List of substances subject to authorisation), and Risk Management III1.

Voluntary systems

Although voluntary systems and surveys may be suitable for giving an initial insight into the scientific sector of nanotechnology and the production of nanomaterials, such instruments can by no means provide knowledge and assessments of a systematic and binding nature based on tools anchored in law.

⁴² <http://ec.europa.eu/nanotechnology>

3.3 BUSINESS

Nanotechnology is a trend-setting technology in the field of miniaturisation. It promises to provide many new products of great benefit to consumers, essential improvements in energy efficiency and far-reaching savings in materials. Besides making an immense contribution to the sustainable use of resources, nanotechnology offers innovative Austrian companies a distinct opportunity. It should be one of Austria's avowed objective to promote applied research and development with all its power. Particularly the areas that foster a civilian and peaceful applications of nanotechnology should be promoted. Possibilities must be created to provide adequate support for small- and medium-sized enterprises (SMEs) and researchers who are at the beginning of their work. The potential of these two groups for innovation is especially rich. At the same time, these groups can make a very big contribution to technical progress at relatively low cost.

In some areas, an in-depth examination of the risk nanotechnology substances entail is necessary. In order to avoid duplication of efforts, such exploration should be coordinated across the EU. That would enable efficient and coordinated use of resources while avoiding parallel projects. At the same, it would ensure fair cost-sharing among the Member States. It would be sensible to limit public subsidies in Austria to areas that are relevant to the country as a business location. Preferably, such Austria-specific studies should therefore be conducted directly in the context of basic and applied research.

The safety of the products available on the market must be guaranteed. An essential contribution towards this objective is made by the constant participation of business in well-targeted risk research within the framework of various authorisation and registration procedures. Moreover, nanorelevant test methods are already being developed with the participation of business, e.g., at international level with the OECD. Voluntary measures such as industry-specific guidelines or codes of conduct are another valuable contribution towards raising safety standards and warranting entrepreneurial responsibility. In this respect, it might be a good idea to set up systems of incentives in cooperation with business, e.g., by reducing the reporting requirements for companies that perform such voluntary measures. Against the backdrop of these extensive efforts, further obligations or financial and organisational expenditure would be inappropriate. It is precisely with REACH that extensive data is being generated. In this context, it must be assumed that data availability will generally be greatly improved by perfecting validated procedures for nanoscale substances. In this context, initiatives such as the current industry discussions of the Federal Ministry for Transport, Innovation and Technology are very useful and expedient.

The working definition for nanotechnology used in this Austrian Action Plan⁴³ covers nanoparticles (3D), nanofibres (2D) and one-dimensional nanopellets as well as nanolayers but neglects to take into account analytical techniques (scanning probe microscopy, reflection measurements, etc.). The same is true of coating technologies and areas of microelectronics. For a complete view of the economic opportunities and impact on processes in business facilities such as nanotechnology production plants and analytical technologies need to be taken into account. This was done by the Business working group.

⁴³ See page 6

The Situation in Austria

Preliminary remarks

Concrete incentives for business and research, are essential in order to strengthen a country's power of innovation. This should always be kept in mind in the context of Austria's integration into the community of European Member States and the trend towards globalisation: Austrian institutions therefore always face a host of competitors. The same is true of special provisions at national level. Even if the strict legal regime were to restrict or even prohibit the production or application of new technologies, that could not prevent nano-applications from being accessible to end consumers in the national market, which would amount to placing Austrian business at a disadvantage.

This makes it all the more important to keep individual countries from acting single-handedly and to strive for harmonised research into the risk but also harmonised legislation regarding nanotechnology.

Specific applications

In our effort to look into existing applications in Austria, we can currently give only a very incomplete picture of the situation, as other projects have already shown. This is primarily due to the fact that widely divergent definitions of nanotechnology are often used in different industries and sectors. In some areas, a certain general reluctance to make the "nano" declaration predominates. By way of justification, companies often invoke the at times irrational public discourse on nano-applications currently underway. In parallel, it has been observed in recent years that nanoproducts have been advertised whose eligibility as such can be seriously called into question. Especially such distorted views show that, apart from a precise definition of "nano", strategic considerations always play an important role in such a discussion. Take the following example: many commercial and industrial users, like many end consumers, already use paint and impregnating agents as well as analytical instruments whose qualification as a nanoproduct is a matter of definition. It is therefore difficult to assess whether such applications now represent a hope for the future, are already established or are of no interest.

In this context, it appears all the more difficult to provide clear labelling of nano-applications and nanoproducts. One possible objective might be to use the findings developed in this Action Plan to progressively determine which fields are of particular relevance to Austria – so that those fields could be analysed in greater detail with respect to employee protection, for instance. In so doing, it is important to establish, in the first place, who should be informed of what if any labelling is introduced, and whether that would even create any added value. In particular, it is important to keep in mind that obligatory labelling is generally interpreted as a sign of "danger". Voluntary labels, on the other hand, such as quality labels, have predominantly positive connotations.

For the time being, we can only give a tentative picture of the relevance of nanotechnology. A random survey of Austrian enterprises in industries that have repeatedly been associated with nanotechnologies describes the general atmosphere as follows:⁴⁴

Textile and leather industry

In the textile and leather industry, the companies who responded to the survey indicated that they expected 20 to 30% of their future sales revenue to come from nanoproducts. They rated the impact on economic success as "average". Individual companies even expect the percentage of sales to increase from the present 10% to 90%. In these areas, the trend is moving towards the production of high-quality specialty products. The motivation specified for the use of nanotechnology is that it offers new possibilities of surfacing, differentiation from

⁴⁴ For further details on the fields of application in business, see Annex 3

competitors and stimulation of demand. For customers, the benefits include improved product characteristics, such as improved soil-resistance. Customers demand functional surfaces. Companies consider that nanotechnology offers immense opportunities for extensive energy savings, longer operating lives in the production process and general strengthening of Austria's ability to compete as a business location.

Nanotechnology applications possible today appear to be more extensive but commercially limited to the areas whose impact on people and the environment has been studied. In terms of their power of innovation, people seem remarkably reserved in this sector. Companies hardly seem willing to take the economic risk related to conducting their own research. Appropriate subsidies for research projects would help.

Due to the immense growth potential, the textile industry would be very interesting for further development. The massive emigration of such plants from Austria over recent years might be offset or even turned around by innovative products. That would provide considerable relief for the job market situation and clearly lead to greater creation of value.

Paper industry

Compared to other industries, nanotechnology is expected to account for a relatively low share of sales in the paper industry: approximately 1.5% by 2012. At present, it is assumed that a high percentage of nanotechnology products will be imported. The general influence, however, and, specifically the impact on economic success, is rated very high.

Nanotechnologies make for products with improved, completely new characteristics. In particular, extensive energy savings are expected in the production processes. The costs of research and development (R&D) and for clarifying the potential risk are high however. Subsidised, cooperative R&D is considered an important factor for success.

The results obtained in the first pilot products came at a very high price. Without subsidies, such developments would have been practically impossible to finance. The results achieved encourage further development of nanotechnology applications for products and processes. In view of the related technological, environmental and health-related issues, further development without public support is practically inconceivable.

Glass industry

In the glass industry, too, nanotechnology's significance for future economic success is expected to be very high. This applies especially to the development of new characteristics for tools, products and production processes. The advantages come from new, improved characteristics, such as water-repellent or scratchproof glass. This will benefit consumers by providing products that are very enduring and long-lasting.

To a large extent, the applications are still in the advanced stage of development. The risks still need to be thoroughly researched. This is what is holding back a wide-scale market launch. For such types of developments and research, subsidies are very important. Especially in these difficult economic times, subsidies ought to motivate companies to undertake medium- to long-term projects.

Chemicals industry

The paint industry has been the only sector to date where nanoscale materials are already incorporated into products. Here, too, there is the view that within the next ten years products based on nanotechnology could account for nearly a third of the industry's sales revenue. Up-to-date figures based on actual sales cannot be collected because of the fluid boundaries between nano- and non-nanoproducts.

In other areas, the use of nanoscale materials is still based on experimental applications for the purpose of product development, mainly involving basic materials for catalysts, plastic packaging, fibre production, the manufacture of medicinal products and textile auxiliaries. It is known that competing products that have been awarded a prize for nanotechnology have already been introduced to the market. In the cosmetics sector, a special situation has evolved, with companies of the industry not retaining any production in Austria but nevertheless selling the products on the market (e.g., sunscreen lotion).

Electrical/electronics industry

The electrical and electronics industry plays a crucial role in the Austrian economy. Over the past decades, this industry has developed from a sector purely oriented towards goods manufacturing into a key infrastructure industry. Thanks to its varied range of highly innovative products and services, the electrical and electronics industry has become largely responsible for the modernisation and development of a wide variety of infrastructure areas, including energy, transport and telecommunications infrastructure, electrical power generation, transmission and distribution, as well as healthcare.

In all these areas, the use of modern information and communication technologies (ICT) has had an essential influence in many ways on our country's economic and technological development: First of all, this technology sector earns some EUR 15 billion in Austria every year. Secondly, the continuous progress in ICT is an essential pillar of Austria's development and ability to compete as a business location. In this respect, the exploration, development and use of nanotechnologies forms the logical basis for the further development of infrastructure in the fields of energy, communication, transport and healthcare, i.e., the core areas of the electrical and electronics industry.

On the way from electronics to microelectronics and now nanoelectronics, the "nano" limits were crossed very early on: the layers in CMOS technologies⁴⁵ were already on the order of 100 nm some 20 years ago! The electronic components, however, do not contain any nanoparticles that could be released into the environment during use or after disposal. The individual layers are very tightly bonded to one another and generally do not consist of nanoparticles such as those found in modern cosmetics or paints or coatings, for example. In the field of (micro)electronics, "nano" is often used as a marketing term for promotional activities without clearly specifying which dimensions fall within the "nano" range.

In the production of micro/nanoelectronic components (chips) the familiar risks tend to be of a chemical nature (substances used for separation, etching, cleaning, photo technology, etc.), which are already under excellent control thanks to appropriate regulations and protective measures. The finished products, such as silicon chips, generally no longer contain hazardous substances.

All components and equipment should generally be disposed of properly in order to enable recovery of recyclables. In all such cases, however, no nanospecific hazards or effects are to be expected.

To summarise, the promotion of nanotechnology as a key technology not only provides great benefits in everyday life. It also has enormous potential to develop the industry that is

⁴⁵ Complementary metal-oxide semiconductor

responsible for modernising and developing the infrastructure in Austria as a business location and therefore symbolises technological and social transformation in the new millennium.

Ceramics industry

In the production of ceramic products, only natural nanomaterials are used, such as highly active aluminium oxide. In Austria, those materials are further processed, resulting in greater dependency on imported raw materials. The general dependence on nanotechnology in this area may be considered high. Nanotechnology is used in engineering ceramics, refractory ceramics and mineral renderings.

In the sub-sectors of fine and engineered ceramics or refractory products, products containing nanomaterials account for up to 100% of the sales revenue. In a company with about 200 employees, this equates to about 3% of the total sales revenue, and that figure is expected to grow to 6% in the medium term. In this area, products containing nanomaterials play a vital role in exports, as well. The export rate of the companies concerned is generally between 60% and >90%. There is a high demand for products manufactured using nanotechnology due to their excellent characteristics.

For processing companies, advantages result from the remarkable savings in the use of energy and materials. Employees are not exposed to elevated risks thanks to the use of closed circuits, extraction and wet processes. During use of the products, the nanomaterials are securely bonded through hardening or directly incorporated into the plastic.

Automotive Industry

This area is considered to be very promising for nano-applications, which are mainly anticipated in the many-faceted automotive supplies industry. Tyres with low roll-off resistance, lightweight components, special paints, improved catalytic converters or optimised combustion processes are only a few of the fields of application mentioned.

Plastics processing industry

From today's point of view, it is very difficult or impossible to give a precise assessment of the economic influence of nanotechnology on the plastics processing sector. Many companies that could take advantage of the beneficial characteristics of nanomaterials and are primarily users hold back when it comes to answering questions. They avoid giving information, since the "nano" does not yet enjoy well-anchored positive connotations in our language usage.

The users are well aware of the possible risks and gaps in the available data, although negative incidents have not been recorded yet in the handling of nanomaterials. Based on the current state of knowledge, no elevated risk is assumed. A cautious approach is being taken, however. In any case, it would be a good idea to give the public more information about the advantages of nanomaterials in order to transform the rather sceptical attitude among many of those concerned into a positive attitude. That would allow us to make greater use of the opportunities offered by applying this technology and to reduce the fears concerning the associated risk. More intensive research in this field might make an important contribution.

The use of nanotechnology no doubt offers companies advantages, since their products could be made more attractive to customers through improved characteristics. Nanomaterials can be used, for instance, to produce surfaces that are highly soil-resistant or make packaged goods easier to slide. They could also be used to make surfaces that are specially adapted for subsequent adhesive processes.

Commerce (other than plastics processing companies)

The commercial sector is a very heterogeneous group largely made up of the smallest businesses. Such companies are primarily users who take advantage of the benefits of nanotechnology products. In particular, they make use of coatings such as antibacterial coatings or various paints. Self-cleaning facade elements are also used, along with

environmentally friendly fire protectants, thermal insulation and soundproofing, ceramic foils (wall coverings), etc. This group also includes the classic tradesmen, such as painters, carpenters, builders, etc.

Remarkably, nanotechnology per se is not even a subject of debate in this sector. Some of the companies that use nanotechnology products are not even fully aware of it. The main consideration for them is the improved characteristics and satisfaction of the customer's needs. They do not make any particular observations about the risks. In this context, they always refer to the safety datasheet. The wish to discuss the definition of nanotechnology in this sector was very pronounced. Compact information material on nanotechnology would be welcome.

Nanotechnology is relatively important not only to the plastics processing industry but also in the chemicals industry. There are many applications ranging from functional coatings, nanoparticles, colloids, micronized substances, nanosilica, easy-to-clean coatings, phyllosilicates, nanopigments, self-cleaning facade elements, anti-corrosion coatings, nanomembranes (e.g., in drinking water production), dye solar cells, sensor-based environmental monitoring, photocatalytic air and water purification, electrodes and electrolytes, X-ray contrast agent, lab-on-a-chip systems, bio-chip arrays, cancer therapy through hyperthermia, antimicrobial coatings, biosensors, marker agents, transport of active agents, sunscreen lotions and cosmetics.

Nanotechnology has obviously long become established in commerce thanks to excellent product characteristics. Although the awareness of potential gaps in the available data concerning risks has given rise to some debate, it is encouraging to note that no high risks have been observed in practice up to now. People are generally confident about the products on the market now.

The general tendency is towards a high degree of dependence on imports. A significant share of the products is not made in Austria. Most of the added value is already created outside Austria. That trend must not be exacerbated through a shortage of research and development investments and unreasonable technophobia. An information campaign in nanotechnology would be very useful in this sector. More intense communication about the safe use of nanotechnologies is needed in this context, in keeping with the objectives of REACH and employee protection. An especially important role should be played by the safety datasheet (SDS) and other new information tools defined by REACH, such as the extended SDS or the Regulation on classification, labelling and packaging of substances⁴⁶ with the classification and labelling inventory.

⁴⁶ Regulation (EC) No. 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC and amending Regulation (EC) No. 1907/2006

A precise economic assessment of the impact of nanotechnology is impossible. It is clear, however, that using it would benefit the market. Customer demand for such products is obvious, as well. In trade and business, too, smaller-scale research is an important factor, and special attention should be paid to the smallest structures.

Opportunities for Austria as a business and innovation hub

Current economic and social benefits

The above-described situation makes it clear that nanotechnology is being used successfully in lots of areas. In the process, a clear focus is being put on further technological development and risk-related manufacturing responsibility, making them essential aspects in the endeavour.

No doubt, the special advantages of nanotechnology include the many existing conveniences in the form of electronic devices that assist us in everyday life, including telephones, computers, pacemakers, and lots more. Other advantages of nanotechnology are not as discernible but omnipresent nevertheless: fundamentally new or improved surfaces on our means of transport, fronts or wind turbines that reduce energy costs and allow energy to be generated and used more efficiently.

For a new generation of researchers, nanotechnology offers a large field of activity that could give rise to many new pillars supporting Austria's reputation as an innovation hub. Many ideas are still dreams of the future, but many are within reach. For example, a form of cancer therapy based on the use of nanoparticles, also known as hyperthermia, may be possible in the foreseeable future. Muscle supports or other implants to alleviate problems that plague severely disabled patients are now still in the planning phase in various laboratories, but they already represent an opportunity for our universities and research institutions to become a part of that technological revolution.

Other products already on the market are of benefit to consumers. Climate changes are a reality. Energy is needed, whether for heating or cooling. Appropriate coatings can dramatically reduce the required energy consumption for such purposes. The situation with fossil fuels is similar. There, too, energy could be saved through optimised engines or catalytic converters and harmful emissions could be further reduced. Changing behaviour, especially in sunny regions, is increasing the prevalence of skin cancer. Sunscreen lotions optimised through the use of nanotechnology are excellent at filtering out cancer-causing solar radiation and offer consumers very effective protection.

Nanotechnology's potential to promote economic development

Along with the well-established environmental technology and biotechnology, nanotechnology is one of the great hopes for the future worldwide. At the same time, the Austrian economic and research landscape is now in a phase that will determine our future course of action. It is therefore the primary task of all stakeholders to develop a sense for the potential benefits and to send the right signals at the right time. While universities and research institutions are encouraged to supply basic and applied research in the proper proportion, it is the task of businesses to bring their visionary concepts to the proper recipients.

Last but not least, it is up to the politicians and sponsors to decide whether Austria offers a sufficiently attractive breeding ground for nanotechnology that would allow the institutions that have always rank among the pacemakers of a nation's economic development. A general survey of the international scene reveals how difficult it often is for nations to attract the right researchers or companies to their country. That is precisely why it is important to recognise promising areas early enough to ensure that they receive optimal support.

Strengthening our ability to compete on a global scale

The reason why Austria's economic situation was so good in recent years is that commerce and industry are highly export-oriented. Specifically, nanotechnologies are predestined to lend continued support to our past success, e.g., in environmental technology and biotechnology.

A few manufacturing sectors have turned their backs on Europe in recent years and decades, but at the same time we have succeeded in keeping some of the centres of innovation, such as research and development departments, in the country. It would seem dangerous to assume that they will remain here if we do not make any special effort, however, especially in the case of technologies where Europe has no distinct lead. It is indispensable to send out clear signals to secure the future of Austria as a hub for new technologies such as nanotechnology, both in manufacturing as well as in research and development, since the two are inseparable from the long-term perspective. Much rather, we can expect nanotechnology applications to serve as to work as seeds for developments in other areas that initially appear to be independent from it.

“Soft” factors to make Austria an attractive business location

A host of individual parameters can be decisive in determining whether new technologies are able to develop optimally in a given location. Due to the scope of this action plan, we are unable give an in-depth analysis of these. Nevertheless, the following aspects should be mentioned briefly:

- Mutually supportive structures (universities, enterprises, research promoting, interest representations, etc.) may create a breeding ground that allows flexible reactions to the various potential developments.
- Transparent requirements for authorisations (e.g., for research, laboratory work and application) promote security in planning and provide a secure framework for action.
- The “SME” factor – especially spin-offs of knowledge-based enterprises – is very pronounced in Austria, with all its strengths and weaknesses, and requires special consideration.
- Austria has a diverse environment of educational opportunities. Two basic pillars of the educational system are the general universities and universities of applied sciences. There would be no point in trying to impose uniformity on these two pillars. Rather, excellence should be further consolidated and strengthened in two mutually complementary systems. In the case of the general universities, this would be academic training in basic research; in the case of the universities of applied sciences, this would be training in applied and practical implementation of knowledge as well as this research.
- Objectification of the themes relating to technology policy often has a surprisingly magnetising effect on the institutions addressed. New technologies always entail risks as well as opportunities. It goes without saying that any risks must be brought under control as best as possible. A balanced social consensus on safe use and residual risk must be guaranteed. The decision-making process in such a consensual process must be fair, knowledge-based and transparent. This gives enterprises the necessary legal certainty and the motivation to demonstrate even more transparently and understandably why their products are safe. This is one of the factors that helps determine whether a country will merely become a paying importer and consumer of technologies or whether it will benefit from them itself.
- Different technologies have different cycle speeds. Whereas short-term research projects (approx. 2-3 years) tend to seek financing from banks, this becomes practically impossible with projects that take up to 15 years.
- Micro-grants might provide a special incentive and breeding ground for ideas that are still “on the drawing board”. Short projects of approx. 6 months might be a good idea in order to determine whether a contemplated project should be carried out in grand style. A maximum amount per project of € 20,000, for example, would be appropriate.

- Risk diversification and probabilities of loss are essential factors when evaluating projects. It is still largely uncertain where exactly nanotechnology stands in this respect and whether there is a uniform risk-benefit model applicable to nanotechnology.
- Existing recommendations on research policy should be taken into account, such as the recommendations of the Austrian Council for Research and Technology Development, since they arose out of a comprehensive awareness of the research environment.
- Finally, the “economic situation” is a fundamental factor. The present economic environment increases any willingness to innovate despite the difficulties in financing.

3.4 SCIENCE, RESEARCH AND DEVELOPMENT

The nanotechnologies, together with biotechnology and information technology, are viewed as key technologies of the 21st century with far-reaching effects on science, industrial development and the creation of new products. Nanotechnology is therefore held to be extremely important for the successful development of the national economy in coming decades. This is also apparent from the increasing amounts of research funds worldwide: it is estimated that in 1998, governments invested about USD 600 million in research and development of nanotechnologies worldwide, versus USD 2.1 billion in 2002 and close to USD 6 billion in 2006. Europe is spending comparable amounts to the USA and Japan.⁴⁷

The purpose of nanotechnology – which is a generic term for various technologies at the nanometre scale – is to manufacture, examine and use structures, molecular materials, internal interfaces and surfaces with critical dimensions or manufacturing tolerances ranging from a few to several hundred nanometres. The main branches of industry are becoming increasingly aware that controlling the structural and functional properties of “advanced materials” at the nanometre scale is the key to technological progress and the development of new products to conquer new markets. Today already, nanostructured materials are contained in many products of daily life, which have innovative properties thanks to their nanostructure. Examples of products already on the market include transparent wood varnish to prevent greying, nanostructured silver as disinfectants in clothes, highly sensitive gene arrays (lab diagnostics) and additives in cosmetics, toothpaste and food.

“Nanotechnology” is a generic term for research and work on structures at a scale from a few tenths of a nanometre up to a few hundred nanometres. One nanometre equals 10^{-9} metres. Handling materials and processes at this scale gives these materials and systems specific chemical, biological, electrical, mechanical or optical characteristics that enable new applications in the macroscopic world. Many specialty fields are involved with nanotechnology, especially biology, biotechnology, chemistry, electronics, power engineering, engineering, materials sciences, modelling, medicine, micro-mechanics, optics and physics. Interdisciplinary cooperation among these fields constitutes a fundamental challenge. This makes it all the more desirable to develop responsible accompanying research regarding the set of issues “opportunities, risks, regulations, governance and the public”⁴⁸, which is supported by the Federal Ministry of Transport, Innovation and Technology both within the framework of the NANO Initiative and beyond it in coordination with regional activities.

The Austrian NANO Initiative

In order to specifically promote the nanosciences and nanotechnologies, the Austrian Council for Research and Technology, guided by international development, among other factors, recommended setting up the Austrian NANO Initiative in 2002. It was finally created in 2004 as a multi-year support programme with the following objectives: to strengthen networking, to create critical masses, to make nanotechnology useful for business and society, and to provide enough qualified specialists. The NANO Initiative is carried out jointly by several ministries, federal provinces and funding bodies under the direction of the Federal Ministry of Transport, Innovation and Technology (BMVIT). The programme management is carried out by the Thematic Programmes Department of the Austrian Research Promotion Agency (FFG).

⁴⁷ TA-SWISS (2006): Nano! Nanu? publifocus Nanotechnologien und ihre Bedeutung für Gesundheit und Umwelt, Bern

⁴⁸ ITA (2006): Nanotechnologie-Begleitmaßnahmen: Stand und Implikationen für Österreich, commissioned by the Federal Ministry of Transport, Innovation and Technology, Vienna

Nanosciences and nanotechnologies are generic and therefore cover many different scientific disciplines and fields of research. The Austrian NANO Initiative banks on the strength of this diversity and enables the development of the latest highly innovative products with new physical or chemical property by means of intensive networking between science and business. This enables the selective, strategic development of nanotechnology expertise in Austria and establishes important new priorities in the extension of research competencies. The focus is on developing innovative high technology at the interface of fundamental and applied research and on making efficient use of national potential. The NANO Initiative also makes an essential contribution towards building awareness about nanosciences and nanotechnologies in Austria. In order to use the enormous economic potential of nanotechnologies (estimated at 1,000 to 2,000 billion dollars⁴⁹) and make Austria more competitive in the context of international development, another focal point consists of internationalisation and acquisition of know-how by cooperating with international, primarily European partners in accordance with the “NANO Initiative 2009+” strategy report⁵⁰.

As part of the European Commission’s Action Plan for Europe 2005-2009⁵¹, Member States are called upon to increase public investments in Research & Development (R&D) in nanosciences and nanotechnologies. Member States are invited to enter into the broad-based discussion concerning a safe, integrated and responsible strategy whose objective is to consolidate the European Union’s lead position in R&D and innovation in nanosciences and nanotechnologies, while at the same time addressing anticipated issues related to the environment, health, safety and society.

The Austrian NANO Initiative is broadly based. At the programme management level, the following institutions are represented on the steering committee: the three ministers entrusted with R&D policy: the Federal Ministry of Transport, Innovation and Technology (BMVIT), the Federal Ministry of Economy, Family and Youth (BWFJ) and the Federal Ministry of Science and Research (BWF); the three major promotion agencies of the Federal Government: the Austrian Research Promotion Agency (FFG), the Austrian Science Fund (FWF) and Austria Wirtschaftsservice (AWS); as well as the relevant promotion agencies of the Austrian federal provinces. Under the direction of the BMVIT, the FFG is responsible for the NANO Initiative.

Programme objectives

Based on two main programme lines, the NANO Initiative aims to pursue the following objectives in the 2009 - 2012 programme phase:

- broadening the basis of cooperation between science and business.
- strengthening the research expertise in fields of nanotechnology application relevant to Austrian companies
- accelerating the technology transfer and economic exploitation of nanotechnology
- improving the access to know-how and cooperation partners abroad
- alleviating doubts and shortages of information about the risks of nanotechnology concerning health and the environment
- anchoring nanotechnology in the public perception of Austria as a hub for research, scientific communication and promotion of young talents.

The programme objective “accelerating the technology transfer and economic exploitation of nanotechnology” is being pursued, in particular, through selective industry-wide discussions

⁴⁹ Jörg, L., Werner, M. (2006): Interimsevaluierung der Österreichischen NANO Initiative, commissioned by the Federal Ministry of Transport, Innovation und Technology, Vienna

⁵⁰ Jörg, L., Werner, M. Tiefenthaler, B (2008): Bausteine zur Weiterentwicklung der NANO Initiative, commissioned by the Federal Ministry of Transport, Innovation und Technology, Vienna

⁵¹ Commission of the European Communities (2005): Nanosciences and Nanotechnologies: An Action Plan for Europe 2005-2009, Communication of the Commission to the Council, the European Parliament and the Economic and Social Committee, Brussels

and events relating to NANO-related topics. The dissemination of the project results from the first two programme phases also help achieve this objective.

The programme objective “improving the access to know-how and cooperation partners abroad” is being promoted through the programme line of Transnational RTDI⁵² projects (see below), which involve ERA-NETs in particular. That is an important opportunity for national applicants to enter into transnational cooperation outside the EU Research Framework Programme.

The programme objective “alleviating doubts and shortages of information about the risks of nanotechnology concerning health and the environment” is being pursued and implemented in the programme for each RTD project submitted through an ex-ante evaluation of risks to health and the environment by other international experts in addition to the scientific-technical appraisal.

The programme objective “anchoring nanotechnology in the public perception of Austria as a hub for research, scientific communication and promotion of young talents” is being achieved through selective support by agencies. The purpose of these agencies is to support the programmes and perform systematic public relations work. For example, they provide support to practical NANO-Innovation training courses, which are carried out within the framework of a research training programme entitled “Forschung macht Schule”.

The Austrian NANO Initiative comprises the following programme lines, which are addressed in special calls for proposals:

Programme line for National RTDI projects

The objective is to develop new processes and applications in the framework of national cooperative RTDI projects, building on the findings from the nanosciences. Several research institutions and enterprises work together in multi-year projects that range from basic research on to industrial research and technology development (of a cooperative nature). Project proposals may be submitted in the framework of calls for proposals. Only consortia in the framework of which companies cooperate with research institutions are eligible. An international panel of experts evaluates the project ideas and selects the project that is to receive funding.

Programme line for transnational RTDI projects

In this programme line, it is possible to submit transnational projects outside of ERA NETs, too. Transnational cooperation projects receive particular support in the European Research Area Networks (ERA-NETs). The national subsidy programmes of the partner countries represented in each ERA-NET are available to transnational consortia. The submissions are made in the course of calls for proposals.

From 2004 to 2007, the Federal Ministry of Transport, Innovation and Technology (BMVIT) made € 45 Million in subsidies available to the NANO Initiative. More than 80% of this amount was invested in highly innovative R&D project clusters. These projects, some of which lasted as long as 7 years and involved more than 200 participating Austrian companies and research institutions, initiated a significant boost in innovation. For the years 2008-2010, another € 23 million will be invested in NANO projects. However, € 13.5 million of this amount was already spent in 2008 in order to extend the existing alliances. In the overall support portfolio of the FFG, the total volume of support for all programmes, initiatives and areas has risen from € 317.5 million at the time of its foundation in 2004 to some € 550 million in 2008.

⁵² Research, Technology, Development, Innovation

In addition to the support from the Austrian NANO Initiative, nanotechnology is also supported in individual projects via the FFG base programme, with subsidises amounting to € 26 million (period from 2002 to 2008).

RTDI project clusters promoted by the NANO Initiative

- The project cluster “NSI - Nanostructured Surfaces and Interfaces” is under the management of the NanoScience and Technology Center in Linz (an initiative of the University of Linz together with other institutes). Among other areas, the study focused on biocompatible nanostructures, as for use in medical diagnostics and therapy as well as nanostructured metallic surfaces and interfaces.
- The “Nano Health” project is being carried out under the direction of Joanneum Research in Graz. Its objective is to develop new therapeutic and diagnostic approaches to widespread diseases, such as diabetes. This should be achieved through the use of innovative nanoparticles, which, in the case of therapy, will bring pharmaceutical agents to diseased organs with great precision.
- The project cluster “ISOTEC - Integrated Organic Sensor and Optoelectronics Technologies” is also being directed by Joanneum Research and the Graz University of Technology. Thanks to the use and combination of new organic semiconductors, as well as structuring and production methods from the area of nanotechnology. new fields of application will be opened up in sensor technology and optoelectronics.
- The project cluster “NANOCOAT - Design and Production of Multifunctional Surfaces Based on Nanostructured Layers” is being directed by the Materials Center Leoben. Its objectives include developing wear-resistant coatings for tools as well as the coating of plastics.
- The objective of the research project cluster “PLATON - Processing Light - Advanced Technologies for Optical Nanostructures” is to bring together relevant activities in the field of photonics in order to create a critical mass in Austria. PLATON combines new nanostructuring technologies with innovative concepts for photonic devices and their applications. The coordination is carried out by the Vienna University of Technology.
- The coordinator of the project cluster NiLaustria, Profactor, brings together in this project cluster all the research institutions active in the field of nano-imprint lithography in Austria, manufacturers of tools, and a host of enterprises interested in nano-imprint lithography. All three types of nano-imprint lithography are used: micro- and nanoscale contact printing, UV-based nano-imprint lithography and thermal nano-imprint lithography.
- The project cluster “PHONAS – Photocatalytic NANO Layers” is composed of a network of five mutually complementary individual projects. Its objective is to develop the scientific and technical foundations for new transparent, self-cleaning and self-sterilising coating based on photocatalytic nanoparticles (PCNPs). The project is coordinated by the Austrian Institute of Technology GmbH (formerly Austrian Research Centers).
- The project cluster “NanoComp – Performance Optimization of Polymer Nanocomposites” is coordinated by PCCL (Polymer Competence Centre Leoben). It has the following scientific and technological objective: to develop compounding and processing technologies for polymer nanocomposites, to determine structural characteristic relationships for polymer nanocomposites or optimisation of specific properties or profiles of properties of nanocomposites.

Programme environment

In recent years, Austria has put great efforts into combining areas of expertise and building up critical mass. Several programmes have been set up to this end (see figure) which should continue to support such focusing processes in the future too. For nanotechnology, not only the established alliances of the NANO Initiative (NANO), the COMET Centres (K1 and K2) and the special research programmes and national research networks of the Austrian Science Fund (FWF) merit particular mention.

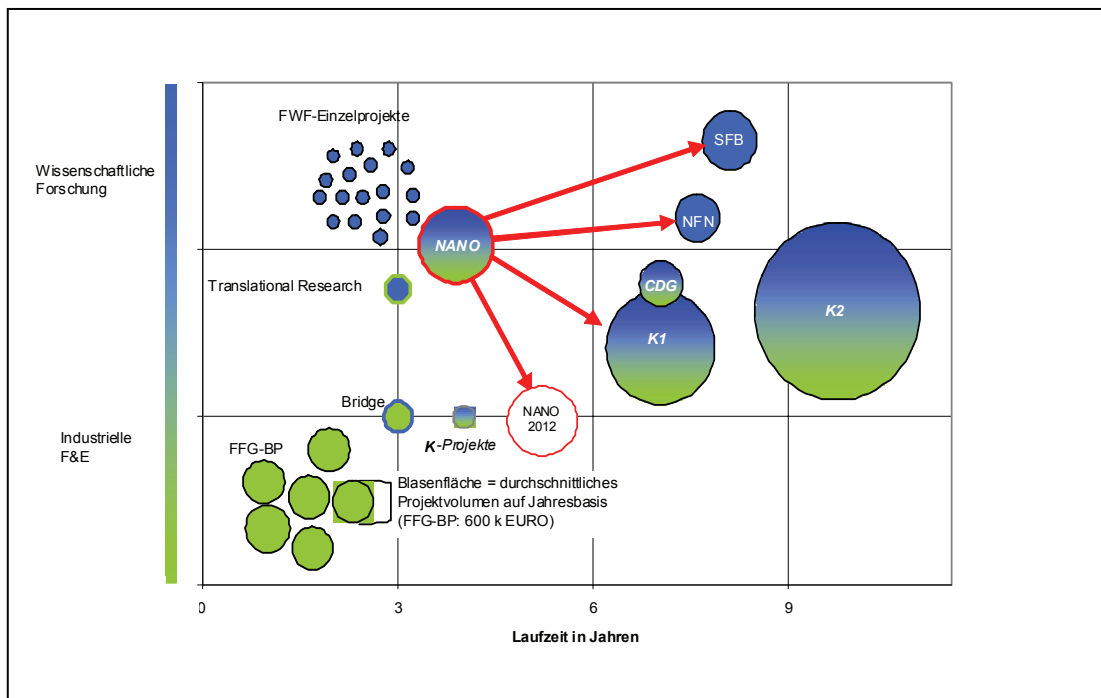


Figure 1

As shown by the figure, the NANO Initiative occupies a relatively small niche as a subsidy programme for R&D projects. Depending on the fields involved (medicine, materials sciences, optical technologies, nanocomposites, etc.), R&D projects in nanotechnology thus often have very differently pronounced basic research components alongside industrial research components at the start of the project. In the medium term (3-5 years) such projects develop into industrial research undertakings.

Nanotechnology is generally considered to be a highly capital-intensive area of research. This is related to the very demanding research infrastructure. Experience with implementation shows that the development of the research infrastructure is currently being addressed from several angles: on the one hand, by the Federal Ministry of Economy, Family and Youth (BMWF) as part of infrastructure support for universities, and on the other, by the Austrian federal provinces, which have invested in the research infrastructure to varying degrees in recent years.

Promotion activities of the Austrian Science Fund (FWF) in the field of nanosciences and nanotechnologies

Nanosciences and nanotechnologies cover many disciplines. Among them are areas - including the materials sciences - which in Austria are already further developed than others, such as pharmaceuticals, for instance. The aim is therefore to support various branches of science in various stages of development. In view of this, the FWF plays a key role as a bottom-up promotion agency. Overall, the FWF has provided support amounting to more than € 50 Million in the field of nanosciences in the period from 1999 to 2007.

The active role of Austrian nanoscientists

The active role of Austrian nanoscientists at European level is illustrated by the following quote from the 2007 Austrian Research and Technology Report (Chapter 2.4.6):

“Austrian scientists working in the field of nanosciences and nanotechnologies are highly successful – as is evidenced by a recent study among members of the expert panel for research in neutrons and synchrotron radiation sources (NESY) of the Austrian Society of Physics. Numerous high-profile projects could be carried out in recent years – due not least to the utilisation of top-of-the-tree international research facilities. The cost of membership was for many years paid by the BMWFa: thus, annual scientific membership cost € 900,000 at the European Synchrotron Radiation Facility ESRF in Grenoble/France; € 1,280,000 at the Institut Laue-Langevin ILL in Grenoble/ France; and € 280,000 at Elettra in Trieste/Italy. Such moneys allow Austrian scientists access to an infrastructure that is necessary to achieve outstanding results. In all these cases, Austria is a small but highly competitive player. As illustrated by the NESY study (2007), high-impact journals regularly run articles on Austrian scientists and their major scientific results, and those scientists are highly successful in getting their projects selected at the above research facilities. It should be noted that utilisation of these institutions is decided by a competition between project applications, with rejection rates of up to 75 percent. Yet it was only recently that one of Austria’s foremost scientists got his long-term proposal for a beam line⁵³ accepted by the ESRF against intense international competition.”

Austrian researchers are also well positioned in the 6th EU Research Framework Programme in the areas of nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and systems. As of March 2006, 344 projects in this area were able to reckon with support. In one out of five (75) of these successful projects, an Austrian partner organisation was involved; 126 of those successful participatory efforts come from Austria, which amounts to a share of 2.6%.⁵⁴ Austrian nanoscientists are proving to be very successful at the international level, too, although they are not spread evenly throughout the country: rather, their research activities are primarily carried out in the context of the research profiles of the Universities of Vienna, Linz, Graz, Leoben and Innsbruck, the Austrian Academy of Science, the Austrian Institutes of Technology (formerly Austrian Research Centres) and Joanneum Research. Although the scientists are especially involved in infrastructure-intensive fundamental research topics, they can rely on well-equipped infrastructure and well-qualified young scientists. It is not primarily new special courses of study that produce such well-qualified young scientists, but rather a solid basic education in the natural sciences. For this reason, it is also essential to guarantee such basic education in Austria while simultaneously raising the number of graduates in the relevant scientific disciplines. Not least in order to ensure the continued success of the universities in nanosciences and nanotechnologies in future. In the same way, we should strive to consolidate the position of the nanosciences and nanotechnologies in the Austrian universities of applied sciences, in order to ensure that an adequate supply of human resources will be available for the job market in the medium term.⁵⁵

Austrian examples of infrastructures and research institutions

Austrian Institute of Technology AIT⁵⁶

At AIT, the activities in the field of nanotechnology so far have been combined in the “Health & Environment” department. Partners include the Republic of Austria, the Federal Ministry of

⁵³ Radiation apparatus

⁵⁴ PROVISIO Report, Heinrich 2006

⁵⁵ “Aus- und Weiterbildung in Nanowissenschaften und Nanotechnologyn. Eine Bestands- und Bedarfserhebung in Österreich“, Humpl et al. 2006

⁵⁶ Formerly: ARC Austrian Research Center

Transport, Innovation and Technology, and the Association for the Promotion of Research and Innovation (Federation of Austrian Industries). In the field of nanotechnology, various research groups are working in the business unit Advanced Materials & Aerospace Technologies in order to develop surface-functionalised inorganic nanomaterials, coatings and nanoparticle/nanofibre-reinforced composites. Building on the personnel's many years of know-how, wet chemical processes are used for the production of nanoparticle dispersions up to the pilot plant scale. Together with partners from science and industry, the innovative solutions are implemented and exploited in a wide variety of fields of application, including self-cleaning surfaces, safety markers, and nanocomposites for the automotive and aviation industries.

In the AIT, the Nano-System Technologies division generates innovative product ideas and creates prototypes that specifically benefit the nanosciences and nanotechnologies in the form of added value. The vision is to implement and exploit nanotechnology in nanosensors and nanochips for diagnostic purposes, together with partners from the business world (SMEs and major corporations) and other divisions of AIT. The planned product ranges target attractive national and international markets. In this context, nanosystem technologies are understood to be a growth engine for Austrian business and industry.

Joanneum Research

At Joanneum Research, scientists at three institutes are working on various aspects of nanotechnologies: 1) At the Institute of Medical Technologies and Health Management work is being done in the field of nanomedicine and nanotoxicology, and innovative concepts of analysis are being developed. Moreover, work is being performed with the institutes described below in order to develop new in-vivo and in-vitro diagnostics. 2) The Institute of Nanostructured Materials and Photonics designs innovative optical, optoelectronics and photonic devices and systems, thereby providing a basis for the steadily growing range of technical applications for nanostructured materials. The focus of the work is on organic materials and organic-inorganic systems. 3) At the Institute of Chemical Process Control, work is being done on fluorescence systems for online process control.

The objectives go far beyond pure research and development work, ranging from the characterisation of materials, the production of laboratory samples and the development of production processes on to integration into existing production facilities. Through the close cooperation between industry and local enterprises, companies are actively supported in their efforts to introduce the technology of the new millennium.

Vienna University of Technology

The nano-activities of the Vienna University of Technology are an integral part of their current research portfolio and cover a range from basic research on to materials control and real devices. The focus is on chemistry, electrical engineering and physics, which are networked through cross-faculty centres of cooperation. At the national level, such networking becomes manifest in basic research in the special research areas ADLIS & IRON and in applied research in six clusters of the Austrian NANO Initiative. At the international level, it can be found in a variety of EU projects concerning nanosciences and nanotechnologies. Apart from proactive appointments in the key fields of computational science and engineering, quantum physics and technologies & materials and matter, the Vienna University of Technology has developed and expanded its infrastructure. Of particular relevance to N&N is the Centre for Micro and Nanostructures. Thematically, the Vienna University of Technology is working on manufactured electronic and photonic devices using a top-down approach. In addition to nanostructured and nanostructure-functionalising devices, functional surfaces, interfaces and nanoparticles are produced (bottom up) and analysed, including layer structures, quantum wires and quantum dots. New properties are used experimentally, mainly in the fields of electronics, photonics, catalytics, magnetism and sensor technology. Theoretical studies describe new production processes and customisable material properties. Nanostructured materials and devices enable the use of nonlinear optical and quantum effects in solids, but

also chemo-selective perception, metrology, information storage and processing, as well as materials for environmental technology and medical applications.

Karl-Franzens University of Graz

Nanotechnology as a strategic focal point of Karl-Franzens University is anchored in the Institutes of Physics, Chemistry and Pharmaceutical Sciences. Based on modern infrastructure for nanofabrication and -analytics, a broad range of nanotechnology issues are researched in national and international projects.

Graz University of Technology

The Graz University of Technology has, among other things, specialised in organic, molecular and nanostructured materials, with a special focus on the behaviour of the surfaces of those materials. Research provides the basic framework for important progress in technology, such as energy-efficient lighting, solar cells, electronics books, and sensors for environmental analysis and medical applications. Another focal point is the development of nano-optical light sources and applied crystallography using thin layers of organic materials.

Vienna University of Natural Resources and Applied Life Sciences (BOKU)

In keeping with the paradigm shift in which conventional individual sciences are being replaced by combined application and the merging of nano-, bio-, information and cognitive sciences, converging technologies form an integral part of the BOKU development plan for 2009. This is reflected in the establishment of the field of expertise “nanosciences and nanotechnologies”. The essential goals are to develop complex molecular modular systems for nanobiotech applications in life and non-life sciences, research on the functional principles of nanostructured composite materials inspired by nature, as well as research on the effects of nanotechnology products on health and the environment. With the Department of NanoBiotechnology (formerly the Center for Ultrastructure Research), which acts as the hatchery for such development, the BOKU has a 25-year tradition in research and teaching in the field of nanobiotechnology.

An essential boost to the development of the field of expertise of nanosciences and nanotechnologies will be given by awarding already advertised professorships in the fields of “nanobiotechnology” and “nanobiotechnology with a special focus on supramolecular structures” as well as “biophysics with a special focus on the nanosciences”. What is more, the new Scientific Director of the Austrian Institute of Technology, Prof. Wolfgang Knoll, is involved in the development of nanosciences and nanotechnologies as an honorary professor in the Department of NanoBiotechnology at the BOKU.

The research work at the Department of NanoBiotechnology is looking into issues of molecular nanobiotechnology and synthetic biology, with a focus on two-dimensional protein crystals, which are termed “S-layers” (i.e., surface layers). Based on S-layer proteins, a modular molecular construction kit is being developed consisting of S-layer fusion proteins, S-layer neoglycoproteins, cell-wall-associated heteropolysaccharides, lipids and nucleic acids, leading to new applications in the life and non-life sciences. The spectrum of applications is very broad, ranging from the production of ultrafiltration membranes with precisely defined separation behaviour, to the development of novel vaccines and immune-modulating components for allergy treatment, biomimetic virus envelopes for specific encapsulating processes and chemotherapeutic therapies. As precise molecular patterning elements, S-layers are leading to new strategies for the development of sensors, diagnostic systems and affinity structures. S-layer-stabilised lipid membranes have opened up new roads in sensor technology and high-throughput screening systems. In the non-life sciences, S-layer lattices are being used to develop molecular electronic and optical devices. The projects that are underway reflect a balanced relationship between basic research and goal-oriented development work, on to technology optimisation. Many of the projects are carried out in national and international cooperation with other research groups.

At the Muthgasse III location of the BOKU, an interdisciplinary strategic partnership with the AIT is being forged in the fields of nano(bio)sciences and nanotechnology.

Johannes Kepler University of Linz

The “nanoscience/nanotechnology” focus of excellence at Johannes Kepler University covers all the basic fields of expertise in the nanosciences and nanotechnologies in Master’s degree course by the same name. Starting in the winter semester of 2009, this course will offer an extensive interdisciplinary training programme for future academic specialists in the field. The focal points of the scientific and technical work will be on (i) the production and characterisation of materials systems and functional structures with critical dimensions in the nanometer range, (ii) the research and optimisation of novel physical, chemical and biological properties of nanostructures and devices based on such properties, (iii) the development of experimental methods and processes for the production, analysis and handling of nanoscale systems, as well as (iv) the development of theoretical models for quantitative description. These activities are highly interdisciplinary, with the participation of all the physics institutes and numerous institutes in the fields of chemistry and mechatronics. Of particular significance are the extensive infrastructure facilities that have been expanded and updated in recent years. Such facilities include the clean room in semiconductor physics, with its numerous nanostructuring installations, as well as the newly created Centre for Surfaces and Nanoanalytics (ZONA), which is currently being developed at considerable expense into one of the central facilities of nano-analytics. Extensive involvement in the project cluster of the Austrian Nano Initiative, the FWF, the Christian-Doppler Research Association and the EU are resulting in productive collaboration with Austrian and international companies and research institutions in the nanotechnologies sector. For example, the Johannes Kepler University is coordinating one project cluster of the Nano Initiative (NSI) and is participating in two others (PLATON, NILAustria). Other noteworthy activities include the international special research area “IRoN” as well as the coordination (ICFOF) and participation (NSoS) in two national research networks. Moreover, four CD laboratories with nanoscience/nanotechnology topics are being set up.

University of Innsbruck

Nanoscience activities at the University of Innsbruck have received increasing support in recent years. The “West Austrian Initiative for Nano Networking” involved the participation of six institutes of the University of Innsbruck and three departments or divisions of the Innsbruck Medical University as well as private-sector networking partners. One important field of research that has existed for decades concerns the production, characterisation and use of free clusters/nanoparticles at the Institute of Ion Physics and Applied Physics. Another central topic in applied nanotechnology is physiochemical characterisation and functionalisation of nanocrystalline diamond layers for applications in sensor technology, electronics and biotechnology (Nano Diamond Network). Another thematic area is the development of nanostructured materials for the transport and targeted release of pharmacological agents (Nano Health). Research is also being conducted on the chemical modification of surface structures⁵⁷ for use in metabolomics and proteomics. One recent addition consists of a working group concerned with a novel method of wood treatment. This method is based on the fact that, in a certain step of the process, nanoparticles form in the wood, creating nanoreinforced monoliths. Further areas of expertise are to be found in thin-film technology, the production and characterisation of hard material coatings and ion-radiation surface treatment (polishing, lithography).

Leoben University of Mining and Metallurgy

The research focus of the University of Mining and Metallurgy is in materials sciences and local analysis of nanoscale deformation and fractures. In particular, the Erich Schmid Institute

⁵⁷ “Nanocrystalline diamond” or “ultrananocrystalline diamond”

(ESI)⁵⁸ of Materials Science in Leoben is concerned with research on complex macro- to nanoscale materials. The objective of the scientific work is to gain a basic understanding of the properties of materials as a function of their structure and composition, using electron and ion microscopes, X-ray and synchrotron processes. In addition, in-situ experiments are being developed in order to gain new insights into the origins and interactions of defects in materials. Laws governing materials are derived from the experimental findings in order to describe the properties of materials. The ESI is internationally successful, especially in synthesis of new nanocrystalline materials through high deformation, in the analysis of deformation and fracture properties in solid materials, as well as in research on mechanical dimensional effects, e.g., in miniaturised materials. The institute has a staff sharing arrangement with the Department of Material Physics of the Leoben University of Mining and Metallurgy and hosts a Christian-Doppler research laboratory for local deformation and fracture analysis.

Danube University Krems

Danube University Krems does research on specific adsorption techniques in medicine using nanotechnology.

Institute of Biophysics and Nanosystem Research⁵⁹ (IBN)

The IBN focuses on nanobiosciences. The methodological core consists of X-ray nano-analytics with special expertise in synchrotron radiation. Among other things, the Institute also develops liposomal nanocarriers for medical imaging that enables early diagnosis of illnesses.

University of Vienna

In nanotechnology, the University of Vienna is mainly concerned with materials science, interfaces, molecular recognition, functional nanoparticles, pharmaceutical applications and the environmental risks of nanotechnology. With respect to the environmental risks of nanotechnology, the focus of the Department of Environmental Geosciences in Vienna is on aquatic systems involving biology and the effects on ecosystems, especially the characterisation of nanoparticles in the environment.

Materials Science Centre of Nanotechnologies

The chemistry faculty set up the Materials Science Centre of Nanotechnologies⁶⁰, which is specifically concerned with multifunctional nanoparticles for clinical therapies, sensor technology with molecular recognition as well as near-field scanning methods with ultra-fast phenomena. The focal points also include areas such as interface nanotechnology; multifunctional nanoparticles for clinical therapies; sensor technology with molecular recognition; near-field scanning methods using ultra-short laser pulses; new quantum phenomena of materials; quantum dots and quantum wires; computational biochemistry.

Erwin Schrödinger Society (ESG) for Nanosciences at the Institute of Physical Chemistry of the University of Vienna⁶¹

With the Erwin-Schrödinger institutes described below, the ESG promotes internationally recognised key players in topical fields of research. Nanosciences and nanotechnologies is expected to foster an improvement in the understanding of nanoscale structures and the development of new nanostructured substances and materials, as well as biotech and IT systems. The development of these new technologies at the atomic and molecular scales also involves the development of new instruments and processes.

ESG Institute for Nanostructure Research in Graz

⁵⁸ Part of the Austrian Academy of Sciences

⁵⁹ Part of the Austrian Academy of Sciences

⁶⁰ <http://pchem.univie.ac.at/index.php?id=59765&L=0>

⁶¹ <http://www.esg-nano.ac.at>

The mission of the ESG consists in supplying basic research findings in the fields of optics and laser technology at the Physics Institute of Karl-Franzens University in Graz for technological applications. In numerous research projects, topics in micro- and nano-optics have been treated intensively in recent years. This has resulted in extensive specialised knowledge concerning theoretical physics in micro- and nano-optics as well as a great deal of know-how pertaining to technology and measurement techniques in nanostructure research and nano-analytics. At present, the focus is on carrying out applied research projects with the Styrian extra-university research units (Joanneum Research Forschungsgesellschaft mbH) and industrial enterprises (AT&S Austria Technologie & Systemtechnik Aktiengesellschaft).

ESG Institute for Lithography Research (ILF)

The ILF developed and built the micro-dust-collecting unit for the ESA58 space exploration project "Rosetta". That unit made it possible to capture extraterrestrial nanoscale dust particles and then submit them to physical and chemical analysis on site. The space probe is currently traversing the solar system on the way to the comet Churyumov-Gerasimenko. The rendezvous is scheduled to take place in 2014. The ILF has succeeded in making positioning sensors with a precision of less than 50 nanometres, which may be used, for example, in medical applications to detect magnetic field variations in the pico-Tesla range. In Vorarlberg, the ILF developed a technology that makes it possible, based on a modified standard mask-aligner, to produce screens with 150-nm line/space resolution over large surfaces at low cost. In the field of selective laser ablation ("etching with high-energy photons"), a process step was successfully created for microelectromechanical systems production with ultra-short laser pulses (with pulse durations of 350 fs) in cooperation with the company High Q Laser Production GmbH. Current activities include simulation and optimisation of a high-resolution maskless electron-beam lithography process that works with parallelised electron beams; e.g., "RIMANA" (FP6), "MAGIC" (FP7), "MALS" (mask aligner lithography simulation, together with GenSys GmbH of Munich, Fraunhofer IISB of Erlangen and SÜSS Microtech of Munich), the Austrian Cluster project "NILaustria" (nano-imprint lithography).

ESG Institute for Molecular Nanobiotechnology in Vienna

This ESG focuses on research and application of S-layer proteins as base elements for the production of complex structures and devices in which the size of the decisive features is less than 10 nanometres. Native and genetically functionalised S-layer proteins are used as matrices in order to bind nanoparticles with specific electronic, optical or catalytic properties. The recrystallisation of the S-layer proteins on technologically important substrates, such as silicon, metals or plastics, is being studied by means of atomic force microscopy. This gives rise to new technologies and materials. In addition, recrystallised S-layer proteins are used to stabilise functionalised lipid membranes. This approach is one of the most innovative and promising strategies in membrane protein-based nanobiotechnology. The applications range from hazardous material detection and pharmaceutical substance selection on to DNA sequencing.

Nanotec Centre Weiz GmbH (NTC)

The NTC constitutes a basic hub, not only in Styria but in the whole of Austria, of research and technology activities related to "nanostructured materials, process and device development in the fields of optoelectronics, sensor technology and nano-analytics". The necessary infrastructure for the production of functional models/prototypes of optoelectronic devices and integrated sensors has been established in a pilot and demonstration facility.

Profactor GmbH

In nanotechnology, Profactor concentrates on the production of functional surfaces and nanostructures. Two fields of development are being pushed forward to this purpose: sol-gel technology is used for the chemical functionalisation of surfaces, the production of customised properties, and the production of nanoparticles that are also used in numerous innovative applications. Thanks to nano-imprint-lithography (NIL), the second pillar of nano-activities at

Profactor, a cost-effective process for extremely high resolution wide-area reproduction of nanostructures is available. This process has many applications: from nano-optics on to biochemistry and bionics. With the combination of structure (NIL) and chemistry (sol-gel) new possibilities are being created for unique properties of future advanced materials. Profactor applies these technologies together with SMEs and industry in new, innovative products and technologies.

IMS Nanofabrication AG

IMS Nanofabrication AG has established a globally unique selling point in the field of projections-maskless nanolithography (with electrons and multiple ion beams) and direct nanopatterning (with multiple ion beams). Work on industrial applications is intensive. IMS Nanofabrication AG employs 42 employees and coordinated the successfully implemented FP6 Projects RIMANA (Radical Innovation MASKless NANolithography) and CHARPAN (CHARGed PArticle Nanotech). In addition, it is a partner in the FP7 projects MAGIC (MASKless lithoGRAPHY for IC manufacturing), BISNES (Bio-Inspired Self-assembled Nano-Enabled Surfaces) and EUMINAFab (European Micro- and NANO-fabrication) as well as the FFG Austrian Nano-Initiative joint project NILAustria.

Examples of competence centres

The COMET Programme of the Federal Ministry of Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Economy, Family and Youth (BWFJ) promotes the development of competence centres around a top-level research programme jointly defined by business and science. The programme includes three lines of action: K1 centres, K2 centres and K-projects, which differ primarily in terms of the demands placed on the subsidised institutions regarding internationality, project volumes and project duration. In the field nanotechnology (in the narrow sense of the term), four competence centres are currently active:

Competence Centre for Electrochemical Surface Technology

This competence centre is concerned with applications such as electrochemical structuring of nanoscale surfaces. High-precision analytic methods are used to characterise nanosized surface structures. Special processes are used to deposit layers on surfaces that are only a few nanometres thick.

Austrian Centre of Competence for Tribology

In order to acquire greater understanding of friction, lubricant applications and the wear of surfaces subject to tribological stress, interdisciplinary multi-scale knowledge is required, ranging from the macro to the molecular levels. On the nanoscale (and both above and below it), surfaces, materials and lubricants are custom-designed (e.g., with nanoparticles, surface nanostructuring, designing of the chemical structure of lubricants). State-of-the-art analytical methods (e.g., X-ray spectrometry, mass spectrometry, nano-indentation) are used in a clean-room environment in order to study the nanostructure and chemical/physical interactions of their interactive surfaces. Nanoscale imaging characterisation methods (e.g., AFM, nano-scratch tester) are used to determine the nanoscopic topography and friction/wear. A globally unique high-resolution method for the measurement of wear (nVCT®) makes it possible to determine rates of wear to a precision of nanometres/hour. The modelling of tribological contacts at the molecular level enables rapid simulation of tribological effects on differently structured surfaces, lubricants and lubricant additives. Thanks to the pre-competitive practically oriented research conducted in this private-sector, extra-university competence centre in close collaboration with industry - and in combination with its top-level interdisciplinary approach - this competence centre has a special status in the European research community in the field of tribology.

Polymer Competence Centre of Leoben (PCCL)

The PCCL is the key contact in Austria for pre-competitive, industrially-oriented research in the field of plastics engineering and polymer sciences. The PCCL carries out pre-competitive research and development in the following three areas and focal points: performance-defined structural polymeric materials, functional polymeric materials and polymer surfaces, development of components, moulds and dies.

Competence centre for Materials, Processing and Product Engineering

This competence centre integrates new materials into innovative products. It is devoted to the path that leads from atoms, through process engineering, on to multifunctional products. The focus is on metals, ceramics and their composites. In the process, new materials are identified and integrated into new products, design and production methods. Precision processes, tool technology, fatigue-free lightweight construction and improved resistance of materials are topics of high relevance for the manufacture, processing and utilisation of materials (in almost all areas of the production sector) and guarantee that companies will actually be able to compete at the international level.

Christian-Doppler Research Association (CDG), LaboratoriesChristian-Doppler Pilot Laboratory for Nanocomposite Solar Cells

This CDG laboratory is concerned with the production of nanocomposite materials exhibiting controlled morphology for photovoltaic applications. The laboratory's basic research is concerned with formative processes and the detailed investigation of the morphologies of nanocomposite layers that consist of a mixture of an inorganic semiconductor phase and a organic semiconductor phase. Strategies and materials are developed that are intended to give rise to nanocomposites of high photovoltaic efficiency. In the process, the research project will deal with aspects of material chemistry, characterisation of morphology, kinetic processes as well as optical and electronic properties that will lead to an improved understanding of this class of materials.

Christian Doppler Laboratory for Nanoscopic Methods in Biophysics

This project is intended to develop a new atomic force microscope that will make it possible to measure topography, biochemical recognition, materials contrast and fluorescence data all at the same time.

Bionanonet Forschungsgesellschaft mbH

The founding partners of BioNanoNet Forschungsgesellschaft mbH are Joanneum Research Forschungsgesellschaft, the Medical University of Graz, piCHEM Forschungs- und Entwicklungsgesellschaft and Steiermärkische Medizinarchivgesellschaft. This Austrian network combines a wide range of expertise in numerous areas of pharmaceutical research, nanomedicine and nanotoxicology in a not-for-profit network platform. BioNanoNet Forschungsgesellschaft mbH is subsidised by the Federal Province of Styria. BioNanoNet pursues the clear objective of promoting innovative research by supporting cooperation and creating synergies, initiating national and international research projects in medical and pharmaceutical research, nanomedicine and nanotoxicology, providing expert support in writing up applications and coordinating projects. It coordinates the cooperative project Nano-Health under the auspices of Joanneum Research, for instance. BioNanoNet was also a thematic partner of Nanotechnology risk:dialogue.

Account of industry in the field of nanotechnology

Nanotechnology is already successfully used to a large extent both in well-established and new fields of technology. There is no "nano-industry" in the conventional sense in Austria, but rather two types of enterprises. The first consists of a wide variety of young technology companies that deal exclusively with nanotechnology and often originated as spin-offs from universities and research institutions. Such companies exist in all areas of nanotechnology, but they generally offer highly specialised products or services. The second type of nano-

enterprise consists of larger, older companies, especially in the materials and electronics sectors that have integrated nanotechnology into their technology portfolio in recent years, where it now plays a strategically important role. The enterprises mainly finance their commercial and development activities out of their cash-flow and governmental subsidies. Hardly any venture capital is used for new start-ups or young technology enterprises (cf. the chapter "Business").

A selection of research projects and platforms

Not least of all in light of our experience with genetic engineering in agriculture, we need to have a forward-looking nanotechnology policy that builds upon deep and well-prepared analyses. This means that there is a massive need for research and communication, as was already documented in detail in 2006 in the context of two projects on the status of accompanying research and risk research in nanotechnology (ITA and Joanneum Research of Graz). To fill these needs, the "NanoTrust" project was created, under the direction of the Institute for Technological Assessment at the Austrian Academy of Sciences. This research project is focused on continuously surveying, analysing and summarising knowledge about the possible health and environment risks of nanotechnology. For the first time in Austria, these important aspects of technology development will be examined in a systematic manner well beyond individual research and development projects, i.e., at a higher level. At the same time, research gaps will be identified and various evaluations will be collected. Such a "risk radar" provides the foundation for a clearing house for questions involving potential health and environmental risks. NanoTrust will serve as an information hub and discussion catalyst: setting up a sort of service point to summarise and evaluate safety systems for the general public, public administration and the nanoresearch community. The project was launched in November 2007 and will be initially supported for three years with an option for renewal following evaluation.

Detailed mission statement

- Austria-wide contact address for issues relating to the health and environmental risks of nanotechnologies, especially for the administration and policymakers as well as the research community
- networking with key players in Austria
- developing a comprehensive database of literature, including commentary, on the possible environmental and health risks relating to nanotechnologies
- summarising documents on current themes in national and international discussions
- developing a list of online links, offering speedy and well-structured access to key players and activities pertaining to nanotechnology issues
- updating a German-language glossary and Austria-specific database with FAQs
- organising regular workshops and meetings on special topics such as the use of nanotechnology, relevant public relations work, and unresolved risk assessment issues
- identifying important unresolved risk assessment issues
- making its own contributions to accompanying research related to nanotechnology.

BioNanoNet GmbH is the trademark owner of the European Centre for Nanotoxicology⁶², which is concerned with the development, implementation and performance of standardised in-vitro and in-vivo processes to study the toxicity to humans of nanostructured materials. Nanostructured materials are systematically studied for potential toxicological effects; mechanistic studies on the toxicity of such materials are also performed. The website features a catalogue of the existing toxicology tests.

⁶² www.euro-nanotox.at

Projects of the Federal Ministry of Science and Research: “NanoDialogue” and “Small is beautiful?”

The “NanoDialogue” exhibition gave interested members of the public an overview of the current status of nanosciences. The project entitled “NanoDialogue” or “Nanodialogue: Enhancing the Dialogue on Nanotechnologies and Nanosciences in Society at European Level”, is based on a two-pronged strategy: on the one hand, its objective is to tell the general public about the most recent developments in research; on the other hand, it strives to bring researchers and citizens together in a dialogue about science. This integrated approach to information and communication is intended to address important nanoscience issues in an interactive and generally understandable way, in the form of the above-described exhibition.

“Small is beautiful?” was a lecture series held together with the “Nanodialogue” exhibition. In parallel with this exhibition, nanoscience topics were presented in a simply way, in a manner understandable to everyone. Austrian scientists presented examples from their own fields of activities. Each lecturer gave an easy-to-understand summary, which was then supplemented in poster format in the “Nanodialogue” exhibition and made available online. Both the exhibition and lecture series were intended to give insights into science and research at the nanoscale, by making information available on this broad and complex subject area. The platform provided an opportunity to discuss and inquire about new findings with scientists and the politically responsible government representatives.

Austria and the 6th European Framework Programme “Nano, Materials and Production”

The programme “Nanosciences/nanotechnologies, Materials and new Production technologies” (NMP) is one of the thematic priorities in the 7th EU Research Framework Programme. Multidisciplinary applied research is being promoted in the framework of European research cooperation projects. Here are the themes in detail:

Nanosciences and nanotechnologies

- Gaining new knowledge about interface- and size-dependent phenomena
- Control of materials properties at the nanoscale for new applications
- Integration of nanoscale technologies, including monitoring and sensor technology
- Self-organising properties
- Nanomotors, nanomachines and nanosystems
- Methods and tools for characterisation and handling of high-precision and nanotechnologies in chemistry at the nanoscale
- Studying and producing components with nanoscale precision
- Impact on human health and safety and the environment
- Metrology, monitoring, nomenclature and standards
- Exploring new approaches and concepts for sector-specific applications, including integration and convergence of incipient technologies

As part of the measures, the impact of nanotechnology on society and the importance of nanoscience and nanotechnology for solving social problems will be studied.

Materials

- Gaining new knowledge about high-performance surfaces and materials for new products and processes and for their repair
- Knowledge-based materials with application-specific properties and predictable performance
- Greater reliability in design and simulation
- Model calculations, greater complexity
- Environmental compatibility
- Integration of functionalities at the nano-, micro- and macro-levels into chemical engineering in the materials processing industry
- New nanomaterials such as nanocomposite materials, bio-materials and hybrid materials, including designing and control of the processing, properties and performance

New production

- Creating the necessary conditions and capacities for sustainable knowledge-intensive production, including the design, development and validation of new paradigms in order to meet future industrial requirements and promote the modernisation of the European industrial base
- Developing non-specific production capacities for adaptive, networked and knowledge-based production
- Developing new technical concepts for the use of technological convergence (e.g., nano-, micro-, bio-, information and cognitive technologies, including their technical requirements) for the next generation of new or upgraded products and services of high added value, and adapting them to changing requirements.
- Utilisation of high-throughput production technologies

Integrating technologies for industrial applications

Integration of new knowledge, new nano- and microtechnologies as well as new materials and production processes in sector-specific or cross-sector applications such as health, food, construction, transport, energy, information and communication, chemistry, environment, textiles, clothing and shoes, forestry, steel and mechanical engineering.

The financial flow back to Austria in the 6th EU Framework Programme totalled € 39.8 million. The share for the “nanotechnologies and nanosciences” theme amounted to approx. 34% (€ 13.6 Mio). The funds in this area were distributed as follows: 67% to universities and 30% to industry. In comparison to the NMP total: 37% industry or 39% universities; also see the figure below (Proviso).

	Approved subsidies <i>Total</i>	Approved subsidies <i>Austria</i>
Nanotechnologies and nanoscience	276.1	8.1
Knowledge-based multifunctional materials	383.8	9.3
New production processes and devices	357.2	13.6
Integration of nanotechnologies, new materials and new production technologies	246.2	7.5
Cross-priorities actions and links to other research actions	28.8	1.4
ACC-SSA	0.5	0
NSF	5.0	0
NCP	0.7	0.04
<i>Sum total</i>	1,298.5	39.8

ANNEXES

ANNEX 1

Involved Institutions

This appendix includes an alphabetic list of all the institutions involved in the development of the Nanotechnology Action Plan as part of one of the following task groups - Health and Protection of Employees, Environment, Business and/or Science, Research & Technology:

- Austrian Agency for Health and Food Safety (AGES)
- Austrian Social Insurance for Occupational Risks (AUVA)
- BioNanoNet Forschungsgesellschaft mbH
- Austrian Federal Ministry of Labour, Social Affairs and Consumer Protection/Central Labour Inspectorate
- Austrian Federal Ministry of Health
- Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
- Austrian Federal Ministry of Transport, Innovation and Technology
- Austrian Federal Ministry of Science and Research
- Department of Environmental Geosciences, University of Vienna
- Eco-Counselling („die umweltberatung“)
- EU-Environmental Bureau
- Institute of Technology Assessment of the Austrian Academy of Sciences (ITA)
- Chamber of Labour
- University of Leoben
- Austrian Research Promotion Agency (FFG)
- PPM Research + Consulting
- Vienna University of Technology
- Environment Agency Austria (Umweltbundesamt)
- Austrian Consumer Association(VKI)
- Vienna Ombuds Office for Environmental Protection (WUA)
- Austrian Federal Economic Chamber (WKO)

Process management: Renate Paumann, Alice Schmatzberger

ANNEX 2

Working Group Business: Areas of Application for Nanotechnologies

The following selection offers a comprehensive overview of the currently known applications of nanotechnology. It also includes several niche areas in which wider application is expected in the coming five years. These areas, which have already become established in Austria, are examined more closely, albeit without any claim to be exhaustive. It must be noted that there is a distinction between production, application, processing and retail.

Precision Engineering/Optics/Analysis

- Devices for ultra-precise machining
- SXM nano-analysis
- White LED
- X-ray optics
- Applications for structuring under 50nm
- Scratch-resistant optical lenses
- Near-field optics for nano-analysis
- Organic LEDs (OLED)
- Optical microscope in nanoresolution
- EUV lithography lenses
- Gas sensors (e.g. contaminant analysis)
- Mass sensors
- DNA sensors

Chemistry/Materials

- Functional coatings:
- Nanotechnology plays a significant role in the development of paints and varnishes. They make possible coatings with significantly improved or entirely new properties (known as "smart coatings"). In so doing, the paint industry does not only use nanoparticles, but also new bonding materials with nanostructures.
- Nanotechnology represents a major technological step forward for the paint industry. The industry's research labs have very interesting innovations in the pipeline. These include painted surfaces used for the generation of solar electricity and self-repairing coatings able to automatically repair small scratches and return the surface to perfect condition. Automobiles would be able to change their colours at the push of a button, e.g. to improve safety in poor visibility situations.
- The global market for nanotechnological products is currently valued at more than 100 billion euros and experts expect this to increase to more than 1 trillion by 2015. The paint and coating industry will hold a significant portion of this market.
- It is calculated that in 10 years time 30% of sales in the paint industry will be earned by nanotechnologies in "intelligent coating materials".
- Nanoparticles
- Colloids
- Magnetic fluids
- Carbon nanotubes
- Carbon black
- Polymer dispersion
- Micronised substances
- Nanosilica
- Easy-to-clean coatings

- Phyllosilicate
- Only natural nanomaterials, e.g. highly-active aluminium oxide, are used in the manufacture of ceramic products. These materials undergo further processing in Austria, resulting in a high degree of dependence on imported raw materials. The general level of dependence on nanotechnology in this sector can be considered high. It is applied in:
 - technical ceramics
 - fire-resistant ceramics
 - mineral washes

In certain areas of precision and technical ceramics or fire-resistant products, products using nanomaterials can account for 100% of sales. In a company with some 200 employees this represents approximately 3% of total sales. A medium-term increase to 6% is expected.

Products containing nanomaterials also play a vital in this sector in terms of exports. The export rate of the companies concerned generally lies between 60 and >90%. As a result of their excellent properties, demand for products produced by means of nanotechnology is high.

The processing companies benefit from significant energy and material savings. There is no increased risk for employees thanks to the use of closed circuits, extraction or wet procedures. By hardening, the nanomaterials are firmly bonded when the products are used.

- Dendrimers
- Aerogels
- Nanopigments
- Polymer nanostructures
- Organic semiconductors
- Quantum dots
- Antibacterial coatings
- Self-cleaning facade elements
- Environmentally-friendly fire-protection agents
- Heat and noise protection
- Ceramic foils (wall coverings)

Energy/Environmental Engineering

The possible applications of nanotechnology in the environmental and energy sector are extensive. In the energy sector, this particularly includes more efficient energy distribution and transformation, energy transport by means of low-loss transmission lines and intelligent networks, optimised energy storage and energy saving potential in general. From a business perspective, the potential is immense for both manufacturers and users. Furthermore, a better use of energy offers potential for further research, but also immediate benefits in the form of lower energy costs and a reduction in environmental impact.

The situation in environmental engineering is similar, although in this sector the areas of application are already more firmly established and broader. The table below summarises areas of application and possibilities:

Application areas are:

	Examples	Possible areas of application
Water / Wastewater	Water treatment and wastewater treatment facilities, purification and sewage treatment technology	Filtration, membrane technology (colloid membrane), absorption and adsorption, ion exchangers, functionalised surface coatings, random packaging, selective catalysts, catalysis, sensitive contaminant detection
Waste / Recycling	Recycling, waste treatment and disposal, flue gas cleaning, landfill technology	Sensitive contaminant detection, filtration, heat-resistant wall coverings
Energy / Air Purification / Climate Protection	Solar energy, wind energy, biomass, fuel cell technology	Dye solar cells, organic solar cells, fuel cells (mobile hydrogen storage, separation of hydrogen, oxygen and water, catalytic fuel conversion and combustion), miniaturised battery systems, compact zeolith reactors
Integrated Product Policies	Production technology, material selection, enhanced efficiency	Targeted material design, innovative alloys / materials, lighter bearing and structural components, precise processing procedures, quality control at the atomic scale, changeable material properties, environmentally-friendly properties such as "non-polluting" etc., new bonding technologies, self-organisation processes
Analysis / Process Measuring and Control Technologies	Water and wastewater management, analysis, process monitoring and control	Lab-on-chip sensor systems, combined sensors / actuators

- Anti-corrosion coatings
- Optimised batteries and accumulators
- Particularly interesting are fuel cells for mobile hydrogen storage, miniaturised battery systems as well as compact zeolith reactors.
- Wear protection for mechanical components
- Catalytic converters
- Nanomembranes (e.g. drinking water abstraction)
- Nanotechnology is applied particularly in water treatment and wastewater treatment facilities as well as purification and sewage treatment technology. Membranes are used for filtration, membrane technology (colloid membrane), absorption and adsorption, ion exchangers, functionalised surface coatings, random packaging, selective catalysts, catalysis and sensitive contaminant detection.
- Dye solar cells
- Sensor-based environmental monitoring
- Photocatalytic air and water purification
- Electrodes and electrolytes
- Waste / recycling
- Nanotechnological products are used in recycling, waste treatment and disposal, flue gas cleaning and landfill technology. In particular as a possibility for sensitive contaminant detection, filtration and heat-resistant wall coverings.
- Alternative energy sources
- Significant optimisation in the generation of solar and wind energy is possible, for example in the form of coatings, particles and electronics.

Medicine/Life Science

- X-ray contrast agent
- Lab-on-a-chip systems
- Bio-chip arrays
- Cancer therapy through hyperthermia
- Antimicrobial coatings
- Biosensors
- Marker agents
- Transport of active agents
- Biocompatible implants
- Quantum dot tags

Automobile Construction, Air and Space Travel

- Nanoparticles for tyres
- Anti-reflective coatings
- Interference coatings
- Nanoscale bonding agents
- Nanocoated diesel injectors
- Anti-fogging coatings
- Scratch-resistant varnishes
- Magnetoelectronic sensors
- Nanocomposites as lightweight construction materials
- Polymer panels
- Fuel additives
- Fuel cells
- Catalysts
- Fuels
- Armour

Electronic/Information Technology

- GMR sensors (hard drives)
- OLED
- Diode lasers
- Si electronics < 100nm
- Polymer electronics (e.g. RFID tags)
- Phase change storage
- Ferroelectric storage
- Magnetoelectronic storage
- Carbon nanotube field emission displays
- Dispersions for chemical-mechanical polishing (CMP)
- Flexible screens
- Sputter material (cathode sputtering)

Textiles and Consumer Products in General (incl. Food and Cosmetics)

- Stain-resistant textiles
- Super-insulating thermal clothing
- Scent-impregnated clothing
- Anti-bacterial linens
- Clothing with integrated electronics
- UV-protected fibres
- Active temperature regulation
- Sunscreen lotions

- **Cosmetics**

Cosmetics are a growth market. In Austria alone cosmetics worth over € 1.3 billion were purchased in 2007, a 3% increase on 2006.

Product properties play a more important role than price in the purchasing decision. In order to achieve the desired improvement in properties, the cosmetics industry is increasingly relying on nanotechnological innovations.

Nanotechnological applications used in the production of cosmetic products are primarily nanoemulsions and nanopigments. In addition, according to manufacturers, cosmetic products also include other nanoscale materials such as nanoparticulate gold and silver, ceramic – nanoparticles and minerals.

Application in nanoemulsions

Nanoemulsions are widespread in nature, as in milk for instance. In cosmetic products it is macroscopic preparations containing oil and water droplets which are reduced to nanoscale dimensions in order to increase the nurturing oil content and to maintain the transparency and lightness of the formulation. In some cases, sensitive agents such as vitamins are protected from the air in bubbles with nanoscale dimensions.

Liposomes, for example, only release their contents upon contact with the skin at the time of use. Nanoemulsions do not penetrate the skin barrier. Health authorities around the world have confirmed that they are safe.

The advantage of nanoemulsions is that they are free of synthetic emulgators (tensides), meaning that fatty elements in the skin are not washed out by water. They are therefore particularly suited for sensitive skin. Because of their small droplet size, nanoemulsions are transparent and remain stable even over longer periods of time.

Applications in nanopigments

Titanium dioxide (TiO₂) and zinc oxide (ZnO) are elements which are widespread in nature. They are used in the form of nanopigments in sunscreen lotions because they reflect and disperse UV light. They therefore help to protect human skin from the negative effects of UV rays, including skin cancer.

Originally TiO₂ and ZnO were used as conventional white pigments on the micrometre scale. This, however, resulted in comparatively thick and sticky pastes which were difficult to manage and not well received by consumers because they left a white film on the skin. By using TiO₂ and ZnO in nanoparticulate form the pastes become transparent to the human eye, are easier to apply to the skin and feel better on the skin.

Further nanomaterial applications in cosmetics

Nanoscale calcium phosphate is used in some special toothpastes for sensitive dental necks, creating a thin layer resembling natural tooth enamel and which is intended to reduce the sensitivity to pain.

What is more, according to manufacturers, nanoparticles of gold and silver are used in certain day and night creams in order to give the skin a fresher appearance. Nanoparticles of volcanic ash for mascara and nanoparticles for nail polish are also used. Nanominerals (silicon, calcium, magnesium) in skin lotions, shampoos or massage oils extend the spectrum of cosmetic products.

- **Electronics**
- **Sports equipment**
- **Food components**
- **Nanoparticles are widespread in nature, meaning that even everyday food contains nanoscale particles: if you allow aspic to turn to gel or cook starch to make pudding, two and three-dimensional nanostructures similar to nets are formed. Further examples include whey proteins and caseins in milk. Silicon oxide, too, has long been used as an anti-caking agent for dry powdery food additives.**

- These nanoscale particles occurring naturally in food give no cause for suspicion. This is, however, not the case with admixed nanoparticles which are intended to give food new properties, e.g. in order to:
 - improve solubility
 - enable controlled release (e.g. Omega 3 fatty acids)
 - improve bioavailability (of vitamins, minerals)
 - prolong shelf life

The topic of nanotechnology in the food sector is very sensitive. It is currently unknown whether and/or how many such foodstuffs are currently on the market in Austria. According to Prof. Berghofer of the Department of Food Sciences and Technology at the University of Natural Resources and Applied Life Sciences (BOKU), however, the actual use of this technology in the food sector is currently very limited.

Communication from Prof. Berghofer

The worldwide nanoproduct database of the Woodrow Wilson International Center for Scholars in Washington DC contained only 30 products under the keyword "food" on 9 December 2006. 15 of these 30 products are designated as food additives in which vitamins and mineral compounds are included in nanostructures or present in colloid form in order to increase their stability or bioavailability. 10 products relate to the surface coatings of food packaging, storage containers or refrigerators in order to give them antibacterial properties or to ensure easier cleaning. Colloidal silver is used in seven of these products. Only 5 of these products actually represent direct areas of application in food, including one oil-containing phytosterols embedded in liposomes intended to prevent the entry of cholesterol into the bloodstream and a cocoa shake in which the cocoa ingredients are intended to be transported to the body cells better and more quickly by what is known as nanoclusters. None of the 5 products listed is currently available in Austria.

Selection of possible application areas for nanoparticles and nanostructured materials

- Nanocapsules, nanoemulsions, nanospheres of milk protein as a means of encapsulation, improvement of solubility, protection and controlled release in "functional food";
- Membranes in water treatment, filters;
- Nanoceramic coating for the cleaning and keeping fresh of frying oil;
- Nanopowder in healing herb additives;
- Nanolycopin as antioxidant for dietary supplements and foodstuffs;
- Nano-beta-carotin as a colorant for beverages;
- TiO₂, SiO, CaO, ZnO, MnO as coating for sweets.

Packaging

Nanoparticles in packaging materials can provide improved protection for food by reducing the permeability of foils, functioning as a deodorant, blocking UV light, raising resistance to heat and mechanical stress or by killing bacteria or fungi.

TiO₂ in nanoform is transparent but retains its UV resistance and is used by many companies as random packaging in foils and plastic containers. Nano-TiO₂ in packaging materials is considered safe for food.

Nylon nanocomposites are used for packaging food (e.g. PET bottles for beer and other alcoholic beverages) as they form a barrier against oxygen and CO₂ and therefore maintain the freshness of the product and/or prevent the development of unpleasant odours.

General fields of application:

- for the production of surfaces which reduce the collection of dirt to a minimum;
- to improve the sliding properties for packaged goods;
- to adapt surfaces for subsequent gluing;

- to achieve a very thin but complete coating through finest sputtering of paints and adhesives.

ANNEX 3

Environment Working Group: Recommendations by Institution

University of Vienna, Department of Environmental Geosciences

Environmental analytics

There are serious shortcomings when it comes to the quantitative analysis of nanomaterials in environmental media and products. It is important to distinguish between:

(1) the quantification of materials per se (i.e., differentiation from the natural background, but without information concerning factors such as the state of aggregation or surface chemistry) and;

(2) the detailed quantitative characterisation of relevant properties, as in a pollutant speciation analysis.

In the first case, initial steps to a solution have already been taken, whereas in the latter case there are virtually no ideas on how to proceed.

To evaluate the relevance of an established environmental concentration, it will be necessary, however, to quantify the parameters that determine the harmful impact. It is practically intrinsic to nanoparticles that the mass concentration of the material alone frequently says nothing about the harmful impact at all. The ongoing discussions concerning possible strategies for the measurement of nanoparticles in environmental media place greater priority on developing analytical methods than on developing analytical technology. It is assumed that the instruments of measurement are already highly developed and satisfy most realistic requirements, but that complex environmental samples still need to be appropriately prepared in order to enable measurement. This notion is consistent with the classic analysis of pollutants in environmental media.

Homo- vs. heteroaggregation

In light of the low concentrations that may be expected from potential sources of emission (e.g., effluents from water treatment plants) as opposed to particles and flocculates that are naturally present, heteroagglomeration may be assumed to be more likely than homoagglomeration. It will therefore be important to study especially the interactions of the engineered particles with the natural particles and flocculates.

Functional persistence

The presence of an engineered nanoparticle at a certain place does not necessarily mean that it will cause undesirable effects. Since harmful effects may be the result of very complex reactions, e.g., on the surface of the particle or through solar radiation, changes to the particles or its environment may strengthen or weaken the potential harmful impact. Besides physical persistence (e.g., dissolution of the particle), functional persistence therefore requires greater study, i.e., changes in the potential harmful impact through external influences such as the build-up or breakdown of coatings or surface oxidation.

Vienna Ombuds Office for Environmental Protection

- A financing plan determining how nanotechnology research in Austria is to be supported in the years to come. The plan should include specific percentages (and minimum amounts) for risk research, broken down by health and ENVIRONMENT, in order to ensure that the studies of environmental risk are not neglected.
- Support should primarily go to projects on risk research to which Austria is exposed too (e.g., the contamination of bathing waters as a result of nanoparticle from sunscreen lotion or health risks posed by nanosilver in products that are used around the body).
- Public funding for products developments at the nanometre scale should be used selectively wherever a direct benefit for the general population and environment can be

expected (e.g., for new developments in the field of photovoltaics or nanoapplications for the control of serious illnesses).

- A commitment by business to provide financial support for independent risk research projects, e.g., by making annual contributions to an industry-independent fund.
- A plan for Austria's participation in international nanotechnology risk research projects.
- A catalogue of measures describing how employees who work with and/or are exposed to nanomaterials in Austria are protected by preventive measures despite insufficient risk assessment data. In so doing, all the potential properties of the substance rather than just the particle size and quantity should be taken into account.
- A position paper on the topic of "nanomaterials and products with the eco-label" (based on the precautionary principle, especially in light of the harm that might be done to the eco-label's image and credibility by awarding it to a nanoproduct that was previously classified as hazardous).
- Introducing the mandatory disclosure of nanomaterials by companies participating in public calls for proposals at federal and provincial levels, in order to get a quick initial overview of the existing supply of nanoproducts on the market (the information acquired in that way will be forwarded by the governmental procurers to Environment Agency Austria (Umweltbundesamt), where it will be stored in a special database accessible to specialists).
- Creating a NANO monitoring centre in the Environment Agency Austria tasked with comparing the current research results in risk assessment and commercially available nanoproducts and quickly identifying any risk products. The corresponding results will be updated and made available on the Environment Agency Austria website.
- Measures to continue and further expand the risk dialogue with the involvement of the population/interested members of the public. In the process, instruments should also be created to give the population latitude to take action.
- Enactment of an Austrian law regulating nanomaterials and products which would allow the removal of products from the market immediately if there is good reason for suspecting them to be hazardous to human health or the environment, especially when the appropriate labelling and warnings are missing from the products.

A catalogue of demands addressed to the EU with the following contents:

- Either a moratorium on products that contain nanoparticles and that are used around the body (cosmetics, food, sprays), until such time as suitable statutory regulations exist for nanomaterials, or
- Quickly introducing a special obligation to register nanomaterials and products that are already on the market or will be launched on the market. In so doing, it will be necessary to include information about the possible exposure of employees, consumers and the environment and to provide a standard set of information about the conventional toxicity assessment of the nanoform of the respective material. This would significantly raise the authorities' level of awareness of current market developments across the EU.
- Adding a special code to the EINCES number (and CAS number), when material in nanoform is present
- Introducing mandatory labelling to identify nanomaterials and nanoproducts

AGES Institute of Plant Protection Evaluation and AuthorisationGeneral

- Internationally acknowledged and harmonised rules for testing nanobased plant protection products as well as the corresponding legal adjustments.
- Mandatory indication by the applicant whether the plant protection product contains nanomaterials
- Specific guidelines for the assessment of nanomaterials (active substance(s), co-formulant(s), formulation)

Identity and physiochemical properties

- Since the properties of nanomaterials are highly dependent on their structure, surface and particle size, new parameters are necessary to identify and keep record of the physiochemical properties.
- Uniform terminology and chemical nomenclature need to be developed for nanomaterials.
- New methods of analysis need to be developed for nanomaterials.

Toxicology

- There is a strong need for research concerning the altered toxico-kinetics (absorption through biomembranes, permeability of blood-brain barriers, dermal absorption), as well as the suspected increase in the reactivity of nanoparticles (lipid-peroxidation and tissue damage, production of reactive oxygen species, mutagenicity, carcinogenicity, cytotoxicity)
- The suitability of conventional protective clothing for employees and users in contact with nanoparticles should be tested
- A study should be carried out to determine whether the conventional models of exposure are also suitable for exposure to nanoparticles. It is assumed that instead of specifying the dose or exposure in terms of weight (mg/kg of body weight), it will be advisable to specify them in terms of the surface area of the particle or number of particles per kg of body weight.

Ecotoxicology and environmental fate

- The existing labelling of plant protection products should be revised in view of the introduction of nanoparticles into the environment.
- The existing data disclosure requirements for chemical pesticides should be re-examined to make sure they cover the effects of nanoparticles sufficiently. Moreover, it should be clarified whether the existing test guidelines (OECD, ISO) sufficiently cover the possible effects of nanoparticles.
- The exposure models that have been used to date should be revised in view of the properties of nanoparticles. Besides exposure via surface waters and soils, exposure via air also deserves closer attention.

Federal Ministry of Agriculture, Forestry, Environment and Water Management

- Financial participation in developing adapted, validated test methods for nanomaterials within the OECD Sponsorship Programme of the Working Party on Manufactured Nanomaterials with a focus on the environmental impact of certain substances
- Implementing the requirement (currently opinion of the European Commission) that the nanoform of substances should be made clearly recognisable in the chemical safety report
- Implementing the requirement (currently opinion of the European Commission) that the nanoforms of substances should be separately classified and labelled by reason of their altered properties

- Collecting data about the possible “properties of very high concern” of certain nanomaterials that are used in large quantities in Austria and might end up in the environment.
- Possibly, evaluation by the Austrian authorities of one or more selected nanomaterial(s) that are especially relevant to Austria, in the context of the REACH substance evaluation

Environment Agency Austria (Umweltbundesamt)

- Promoting risk research for ecotoxicology issues – especially in relation to test methods. Funding tests related to parameters that are decisive for the environmental toxicity and environmental fate of nanomaterials. The data collected should be made as transparent and internationally accessible as possible and included in the OECD Sponsorship Programme of the Working Party on Manufactured Nanomaterials.
- The development and validation of toxicological in-vitro methods and the current risk assessment methodology itself should be supported, since it is necessary for reasons of social policy to reduce animal experimentation and provide improved protection of people and the environment. The corresponding results could be included in the OECD Sponsorship Programme of the Working Party on Manufactured Nanomaterials.
- Risk research on the physiochemical hazards of nanomaterials, such as the increased danger of explosion, should be promoted.
- In order to record the actual degree of contamination of the environmental media with nanomaterials, corresponding analytical test methods should be (further) developed in a testing programme.
- Environmental exposure data on nanotitanium dioxide, nanosilver, nanocarbon tubes, fullerenes and other selected nanomaterials should be collected.
- Promoting research on the benefits of nanotechnology regarding environmental issues (e.g., developing methods for environmental analysis or water treatment using nanotechnology)
- Promoting studies and research on risk perception, forms of dialogue and participation
- Promoting accompanying research on measures (incl. dialogue)
- Promoting network structures for an efficient mutual exchange of knowledge and shared developments
- Dialogue with the public that takes seriously the great need for information and possible fears while pointing out the potential for innovation (benefits/opportunities/risks)
- Investigations to determine the extent to which waste collection and treatment leads to the release of nanomaterials into the environment.
- Financial support for entering the Austrian research data into the OECD Nanosafety Database of the Working Party on Manufactured Nanomaterials.
- Funding research focused on Austria to determine the extent to which the use of nanomaterials might save resources and avoid waste or contribute to waste recycling.

Medicinal products

- Environmentally relevant information about nanoscale medicinal products should be combined and made transparently accessible at the EMA (European Medicines Agency).

Biocides

- In the future, it will become necessary to distinguish nanoscale biocides from their corresponding non-nanoforms for the risk assessment of biocides. To do so, the Biocidal Products Directive and corresponding technical guidelines must include a binding definition of nanoparticles and impose a requirement to disclose information characterising the size and shape of the biocide (specifying whether the biocide has at least one nanosized dimension). Furthermore, a guideline for comparative assessment of the nano- and non-nanoforms should be developed at EU level. For the purpose of informing users, these characteristics should at least appear in the REACH safety data sheet.

- Besides the formal prerequisites for a risk assessment of nanoscale biocidal agents and products, the technical prerequisites must be satisfied as well. For this reason, the development of nanospecific methods of measuring human and environmental exposure should be promoted, along with the corresponding models and validation.
- With respect to products treated with biocides, the clarification required in the Biocidal Product Directive in the course of the review phase should include a discussion of the technical requirements.
- Generally, the precautionary principle should be required for nanobiocides in Austria by limiting their use to areas in which the necessary effect is covered inadequately by other methods.

REACH

- Promoting an Austrian position on:
 - Introducing a definition of nanomaterials in REACH
 - A mandatory disclosure of the identity of substances that contain a material in nanoform and the corresponding relevant information about safe use in the safety evaluation of the substances and in the safety datasheet.
 - Ensuring that the information requirements are satisfied by (reasonably adapted) results of the tests on the nanomaterial used.
 - Ensuring specific classification and labelling of nanomaterials; when necessary, a detailed chemical safety report must be drawn up for the nanomaterial even if the material is not classified in its non-nanoform.
 - Lowering the tonnage limit for non-phase-in materials.
- Performance of REACH nanosubstance evaluations by Austrian authorities.
- Participating in the development of adapted, validated test methods for nanomaterials as part of the OECD Sponsorship Programme of the Working Party on Manufactured Nanomaterials with a focus on the environmental impact of certain substances.
- Collecting data on the hazardous properties of certain nanomaterials and data on Austrian exposure to such materials.

EU Environmental Bureau

1) Strict application of the precautionary principle/Reversal of the burden of proof/Obligation to provide complete information

Nanotechnologies should be treated carefully, because certain hazards to human health and to the environment are currently not foreseeable. The objective should be maximum transparency in the fields of research, development and utilisation.

When introducing new products using nanotechnologies, the burden of proof should be reversed. The mere fact that nothing is known about the potential effects should not lead to giving carte blanche for marketing. The rule “no data – no market” must be applied. In addition, product and liability laws must be adjusted to take the new technologies into account. The population must be granted the right to complete information. Data material and product information about nanoscale substances should be freely and transparently available to the public, i.e., it should be treated as environmental information within the meaning of the Environmental Information Act (UIG) and the Aarhus Convention. Everyone must have the right to demand that the authorities and state-controlled enterprises disclose the available information on nanotechnologies and authorisation procedures.

2) Clear and complete set of rules for nanotechnology risks and liability.

An EU-wide system of rules is necessary. Such rules should at least contain the substance category “nanochemicals” and a classification as “dangerous for the environment” according to the Austrian Chemicals Act (Chemikaliengesetz) and Hazardous Substance Ordinance (Gefahrstoffverordnung). Uses and applications of nanomaterials should be subject to

mandatory registration and special labelling should be required for nanoproducts. These rules should apply to research as well as to production, utilisation and disposal.

Developers of products based on nanotechnology and all entrepreneurs who launch them on the market should be subject not only to civil liability but also to a no-fault liability system for environmental damage. Entrepreneurs and developers can obtain economic advantages from new technologies. In return, however, they must bear the risks of development. Otherwise, the general public would end up shouldering the costs resulting from the use of such technology (environmental damage and the like). In light of the uncertain risks, entrepreneurs and developers should be required to take out insurance coverage sufficient to prevent a lack of funds in case the polluter cannot pay for the damage. This system is in keeping with environmental liability in the legal and economic meaning of the term, which is derived from the “polluter pays” principle.

3) Development of risk assessment methods

Research efforts to study the ecological and health effects as well as the social, ethical and societal aspects of nanotechnology must be stepped up significantly. The current rules for the determination of toxicity and exposure are insufficient. New methods must be developed in order to assess the qualitative differences between the effects of a nanomaterial and those of its original macro-substances. The manufacturer should bear the burden of proof.

It is necessary to assess the exposure of people, animals and plants, as well as identify and assess the risks, in view of the following considerations:

- setting up exposure scenarios for the entire lifecycle (manufacture, use, disposal) of nanoparticles.
- taking into account the effects on risk groups, people or organs that have suffered prior injuries (e.g., inflamed mucous membranes, damaged skin), etc. Long-term observations are particularly necessary in this respect.
- studies on persistence and bioaccumulation.

4) Public participation in the authorisation process

Introducing nanotechnology-based products on the market constitutes a risk for the environment and for human health. The effects of such a market launch might be irreversible. An authorisation process involving public participation with all the rights provided for by the Aarhus Convention (access to information, participation in the process, legal defences against decisions) must therefore be provided.

Eco-counselling (“die umweltberatung”)

- Taking the whole lifecycle of nanoproducts into account.
- More funding for nanorisk research and the corresponding accompanying measures.
- Developing specific procedures to detect nanoparticles in the air: such procedures, followed by other analytic methods to detect them in other media such as water and the soil, are urgently needed for the observation and monitoring of their distribution in the environment.
- Disclosure of synthetic nanomaterials on product packaging.
- Comprehensive stock-taking of the utilisation of nanomaterials and nanotechnologies in Austria.
- To allow companies and authorities to act with confidence, it is necessary to check the applicability of the basic statutory conditions to nanomaterials and, if need be, introduce new rules. Voluntary agreements are no substitute for rules, since such agreements are not actionable in the event of a violation.
- It is also urgently necessary to introduce clear, uniform definitions and classifications in the field of nanomaterials.
- Introducing mandatory registration for the use of nanomaterials and mandatory licensing for applications that are especially sensitive or close to consumers, as food or cosmetics.

The following research areas are urgently necessary as the next step:

- Studies of the resorption, systemic availability, accumulation and elimination of nanomaterials following oral exposure (e.g., food and food packaging)
- Assessment of the toxicity of nanomaterials following oral exposure, closing the existing knowledge gaps quickly, and a final assessment of nanotitanium dioxide and nanozinc oxide, in order to create certainty for consumers. Especially in the case of nanotitanium dioxide, certain issues are still unresolved and different forms available on the market should be evaluated differently.
- Research on particles that are absolutely or virtually insoluble, as well as fibres and tubes that are toxicologically relevant when they combine to form agglomerates or aggregates.
- Until their hazards can finally be assessed, the precautionary principle must be followed. Thus, exposure should initially be avoided as much as possible in order to minimise risk.
- Utilisation of new relevant parameters such as particle form, catalytic properties (reactivity), the surface/volume ratio, tendency to form aggregations, or surface charge.
- Altered risk of fire and explosion in the case of catalytically active nanoparticles
- Articles such as sunscreen lotions with nanoparticles whose ingredients end up in large quantities in the environment, e.g., in the bodies of water we swim in.
- Sprays, since atomised droplets of chemicals (aerosols) can be inhaled and damage the respiratory tract. The Swiss Federal Health Office is particularly critical of aerosols with nanoparticles, since “free nanoparticles can be taken in by breathing in the air. If used regularly, certain nanoparticles may accumulate in the lung tissue, with possible negative long-term effects.” The intake of nanoparticles through the sink or accidental swallowing is classified as less hazardous.
- Questions of fair distribution of wealth and ethics (e.g., relocating the production sites of hazardous nanomaterials to countries with low safety standards)

Austrian Consumer Association

- Clear and uniform definitions and classification of nanomaterials, in order to avoid misunderstandings and delays in the regulatory process. There is special reason to criticise the definition proposed in the new Cosmetics Regulation, since it pertains only to insoluble or persistent materials.
- More funding should be available for risk research, with an internationally coordinated effort to close the knowledge gaps.
- The top-priority research objectives are:
- Specific synthetic nanomaterial detection procedures to determine exposure levels, for the protection of workers, consumers and the environment.
- Test methods to determine the dangers of synthetic nanomaterials and their future uses.
- A publicly available catalogue of nanomaterials should be drawn up: It should list all nanomaterials that are contained in consumer products, with which consumers come into direct, close or regular contact, and products that release nanomaterials into the environment.
- Mandatory labelling of nanomaterials in consumer products is necessary – in parallel, background information should be made available to consumers.
- Participation of all stakeholders: the public must be drawn into the nanotechnology decision-making process in both policy-making and research activities. In so doing, broader social and ethical considerations should also be taken into account. In order to enable a truly democratic process in the legislation and decision-making concerning research subsidies, the lobbying of consumers and their representative should be supported financially to ensure that they have the same resources as the industrial representatives.
- Prior to the market launch of consumer products, a safety assessment must be made. Appropriate regulatory guidelines should be established to this purpose. The aim is to

ensure a comprehensive assessment of the risks to workers, consumers and the environment throughout the product lifecycle. This assessment should be based on different weightings, depending on the specific product – in the case of products used directly on the body, a complete safety evaluation should be made for people and the environment. For others, such as a nanosilver coating on a washing machine, greater weight should be allocated to the environmental effects.

- In order to follow up complaints, monitoring standards must be established. It is important to demonstrate the benefits of nanoproducts, as well, in a well-grounded and impartial manner.
- Concerning REACH: The tonnage limits for the registration of nanomaterials in accordance with REACH are unsuitable, since, in the case of nanomaterials, quantity is much less important than other properties, such as surface, concentration, surface composition and tension, etc. It is therefore important to specify these properties, too, in the REACH guidelines and to incorporate them in the description of the identity of the substance.
- Nanomaterials should be specifically taken into account in the evaluation (assessment).
- The materials assessment is most important in that respect. At least one material should be assessed by each Member State, to the extent possible
- In the review phase of REACH in 2012, nanomaterials must be a focal point.
- It is urgent to check whether nanomaterials that give indications of being particularly suspicious, e.g., CNTs (Carbon NanoTubes), are substances of very high concern (SVHCs); it is urgent to place such substances on the candidates list.
- All nanomaterials in use that exceed a certain threshold level (e.g., from 1 kg) should be registered with the authorities.
- Regarding the draft Cosmetics Regulation: the terms insoluble and biologically persistent should be removed from the definition as quickly as possible – preferably before the final version of the Regulation is enacted.
- The 3-year deadline for notification is far too long: files on products that are already on the market should be submitted within one year.
- A uniform assessment system must be established.
- The provisions concerning transparency should have been set two years earlier.
- Regarding food: In the Novel Food Regulation and Food Additive Regulation, principles similar to those applicable with cosmetics should be established: especially regarding the safety evaluations (authorisation!) and the guidelines for transparency of nanomaterials in food – with shorter transitional rules and a broader and more generally recognised definition of nanomaterials.

NanoTrust

- Since the number of commercial applications is steadily growing, an adequate, scientifically based monitoring system should be set up quickly, together with a system of safeguards.
- With nanomaterials, such as nanosilver, research is required to determine their negative effects, pathways, biopersistence and bioaccumulation in natural ecosystems.

Analytics and Methodology

- In order to assess the ecotoxicology and environmental behaviour of synthetic nanomaterials, efforts must be put into developing analytical instruments/methods of detection and characterisation (size distribution, form, chemical and physical surface condition, type and extent of possible contamination, etc.) of synthetic nanoparticles (NPs). This is especially true of the detection and characterisation of NPs in the “natural” environment (air, water, soil, but also in biological organisms (plants, animals)).
- Sub-issues in the area of in-vitro test methods include the identification of suitable solvents and methods for the dispersion of nanoparticles in order to make them accessible for further characterisation.

- Standards are needed to ensure the systematisation of the investigations and comparability of the results. Thus, reference materials need to be developed and used.
- To guarantee the comparability of investigations, standardised test procedures are needed and clear, uniform terminology should be developed.
- Another important methodological requirement is to identify relevant destination points of experiments with new nanomaterials.
- The existing methods of life-cycle analyses (LCAs) to assess the introduction of nanoparticles into the environment should be adapted. The main barrier to performing LCAs is currently the lack of detection methods.

Specific essential issues for evaluating the ecotoxicology and environmental behaviour of synthetic nanoparticles should be studied separately for each environmental medium (air, water or soil) and type of organisms (plants and animals).

- (Long-term) stability, solubility, degradability (e.g., under UV radiation, heat resistance)
- Dispersive behaviour
- Reactivity, (especially: catalytic and biocidal properties)
- Aggregation and agglomerations behaviour
- Adsorption behaviour
- Interactions with biological organisms
- Accumulation behaviour, especially bioaccumulation
- Bio-availability
- Interaction with other substances in the environment, especially with environmental toxins such as heavy metals
- Kinetics (“fate”) of nanoparticles in ecological systems, e.g., sedimentation behaviour.
- It is especially urgent to study the environmental behaviour of biocides and catalytically active nanomaterials, such as silver nanoparticles or nanoparticulate photocatalysts (TiO₂).

Cytotoxicology issues

- What are the toxicological mechanisms (formation of free oxygen radicals, DNA damage with reproductive disorders or successful development)?
- Is the disturbance caused by the particle itself or by the release of ions, as in the case of nanosilver?
- How stable are the particles in the intracellular environment?
- Are there processes of degradation or detoxification in the cell and, if so, what determines their rates?
- Are the particles stored and thereby withdrawn from the organism? What happens when the cell in which the particles are stored dies? Will the particles then be released again?

Recommendations by the Austrian Federal Economic Chamber

Promoting nanotechnology nationally

Existing and newly to be created funds for research and development should be invested precisely in fields that have already become established as focal points of Austrian research institutions and, even more so, Austrian companies. The national Nanotechnology Action Plan might already give indications of such fields, but more thorough analysis is indispensable. Significantly improved communication among research institutions and companies is necessary, in any case, in order to better meet the relevant needs.

Risk research must be internationally coordinated

More in-depth research into the risks created by the commercial use of nanotechnology is needed, but it should absolutely be carried out on an EU-wide scale and in the framework of the current OECD studies. This approach will make it possible to avoid project duplication and to use resources in an efficient and coordinated manner. It is advisable to conduct risk

research only in those areas that are relevant to Austria. This can be done most efficiently by closely linking risk research with applied research. Under no circumstances should Austria end up spending significant public subsidies on risk research instead of investing in applied local research while other economic areas merely reap the benefits of our research results.

It is necessary to develop standardised methods

When determining the degree of exposure to nanomaterials in the environment, it is first necessary to make sure that natural or entirely distinct sources of nanoparticles do not distort the findings through “background noise”. It is advisable to develop and establish test methods at international level. Under no circumstances should results based on non-standardised methods be used for the risk assessment and, as a consequence, for the interpretation of the required course of action. In particular, methods of calculation should not be used in the initial phase. Such methods, as is generally already recognisable by the high degree of uncertainty surrounding them, are of doubtful reliability when it comes to nanoparticles. Appropriately validated models of calculation for rough exposure estimates should also be developed in an internationally coordinated manner.

No separate rules for nanomaterials are needed

Unlike “nano-specific” adjustments, entirely new rules specifically intended for nanotechnology are not considered necessary in the EU legal instruments (note: possible reformulation of position on measures).

Raise the incentives for voluntary measures by business

Measures that are voluntarily carried out by business are often a more flexible and efficient instrument than specific rules. Before introducing new rules, such generally effective opportunities (e.g., corporate certificates and codes of conduct) should be exhausted. In order to ensure the widest possible degree of acceptance of that voluntary approach in business, such measures should be specifically supported and companies should be offered incentives to participate (e.g., relief measures in other legal areas, reduction of administrative costs, exoneration from similar reporting or testing obligations, etc.).

ANNEX 4

A Selection of Areas Requiring Further Research in Nanotechnology

As mentioned in the chapter "Need for Action and Recommendations"⁶³, the need for further Austria-specific research - in the context of international research and research projects in the field of EHS - must be defined. Consequently, this need for further research could be specified in the form of concrete calls for proposals.

The selection of areas possibly requiring further research cited in this appendix were identified in the course of the work carried out for the Austrian Nanotechnology Action Plan. They represent an initial assessment and are by no means exhaustive.

Health and Protection of Employees

General

For public subsidies to be granted for projects in the field of nanotechnology research and development the following approach should be taken:

Development of criteria to determine which problem issues and to what extent accompanying risk research would have to be integrated into the calls for proposals.

Advantage: no additional costs, could produce useful results, however, and, in any case, would be an expression of the federal government's political commitment to the "safety first" principle.

Food

Studies to explore the potential in the use of nanomaterials in food packaging in Austria:

- Which applications already exist?
- Which are in planning?
- What opportunities will result for Austrian companies?
- What would possible benefits for consumers be (e.g. increased shelf life of foodstuffs)?
- What economic and ecological benefits can be expected (e.g. reduction in the use of material, waste prevention)?
- What possible health and/or safety risks could result from these applications?

This theme area lends itself to possible co-operation with stakeholders in environment and business. Similar studies concerning cosmetics and possibly flavours/additives could also be commissioned.

Participation (with know-how and/or funds) in EU/international projects for the

- development (adaptation) of detection/measurement methods and for the
- development (adaptation) of (eco)toxicological test procedures for nanomaterials.

Occupational safety

- Overview of nanomaterial applications in the workplace, especially in SMEs, as well as applied risk management measures (RMM).
Aim: Overview of the current state of the use of NM in the workplace and of RMM; building on this: identification of priorities in any further need for action in terms of RMM (e.g. regarding safety data sheets, guidelines, legal loopholes, etc.)
- Results 2011/2012
- Knowledge of the effects of the substances under the aspects of occupational medicine/toxicology

Measurement methods/exposure profiles/limit values in the workplace

- Compilation of existing measurement methods

⁶³ EHS: Environment, Health, Safety

- Creation of exposure profiles (exposure categories) for various applications in the workplace, but also with regard to (temporary) occupational exposure limits and recommendations for future exposure limits (literature review)
- Development of existing measurement methods for routine measurements
Objective: Overview of exposure situations, creation/improvement of RMM guidelines, improvement of safety data sheets, creation of (temporary) occupational exposure limits and also a contribution to the adaptation of existing measurement methods for routine measurements (manufacturers of measuring instruments!)

Environment

- Nanotechnology benefit research in relation to environmental issues with a focus on Austria (e.g. water treatment using nanotechnology, improved or new technologies for energy generation and/or conservation, photovoltaics based on nanotechnology, development of environmental analysis methods).
- Research into the environmental behaviour and ecotoxicology of synthetic nanoparticles (esp. nano silver and nano titanium dioxide) incl. adaptation and standardisation of test procedures: e.g. in relation to aggregation, agglomeration, dispersion, adsorption and sedimentation behaviour, (long-term) stability, solubility, degradability, pathways, (functional) persistence, (bio)accumulation, bioavailability, reactivity and effects on organisms (especially catalytic and biocidal properties). Particular attention needs to be paid to questions relating to the use of appropriate solvents and dispersion methods as well as to the identification of relevant endpoints.
- Research into cell toxicology: toxicological mechanisms (such as the formation of free oxygen radicals, release of ions) and possible resulting genotoxicity, carcinogenicity, reproductive toxicity or other toxic effects; stability as well as degradation and detoxification processes (incl. deposition and its effects) of nanoparticles in intracellular environment.
- Development of a measuring concept for the detection of nanomaterials (such as nano titanium dioxides, nanosilver, carbon nanotubes) in the environment (waters, soil, air, organisms) (animals, plants, fungi, bacteria), in Austria (including the coverage of questions with particular relevance to Austria such as the pollution of bathing waters resulting from the use of nanoparticles in sunscreen lotions). Here appropriate analysis methods for general quantification (including the distinction from natural backgrounds) need to be developed, as well as methods for a quantitative characterisation of relevant properties such as surface chemistry.
- Research into exposure scenarios and exposure models specific to nanomaterials as well as sustainability in relation to their life cycle (manufacture, usage, disposal) with reference to Austria. The media water, soil and air should also be covered. The existing methods for life-cycle analysis used to assess the entry of nanoparticles into the environment should also be adapted.
- Research/survey of shortcomings as well as possibilities for improvement in relevant legislations, such as REACH and CLP, as well as in biocide and plant protection regulations (incl. plant strengtheners), cosmetics regulations, medicinal product specifications regarding environmental data, waste regulations, environmental liability and information regulations, as well as other environmentally relevant legislation such as the Water Framework Directive.
- Collection of data about hazardous properties of specific nanomaterials with particular relevance for Austria.
- Research into the adaptation of nanospecific risk assessment.
- Research/survey of products containing nanomaterials and/or application of nanomaterials and nanotechnology in Austria.
- Research into the development of nanorelated reference materials.
- Research in relation to risk perception, dialogue and participation formats.

- Research into distributive justice as well as ethical and social effects of the usage of nanomaterials.
- Investigations in relation to waste:
 - To what extent are nanomaterials released in the process of waste collection and treatment?
 - To what extent can the usage of nanomaterials contribute to the conservation of resources as well as to waste prevention and/or treatment?
- Research into the interaction with other substances in the environment, especially with environmental toxins such as heavy metals.
- Research into the modified physical and chemical parameters of nanomaterials – in relation to explosion and fire hazards, for instance.
- Analysis of nanorelated priorities that Austrian companies and research institutions have set.
- Research/surveys of occupational exposure through sprays and/or the medium of air.
- Research in the area of human toxicology with a focus on in-vitro methods and their validation.

To ensure an efficient use of resources and in order to avoid the duplication of efforts, research projects should be embedded into international programmes such as the OECD's Working Party on Manufactured Nanomaterials Sponsorship Programme or European initiatives if possible.

ANNEX 5

Nanotechnology Information Platform

Objectives, tasks and structures

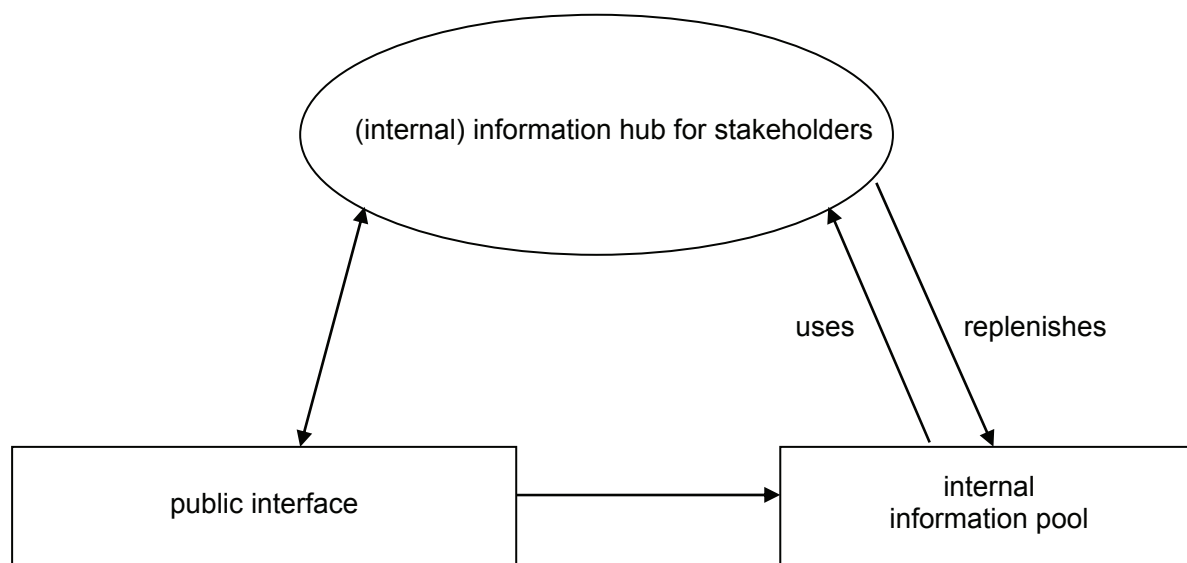
The experience of recent years has shown that when it comes to communicating new technologies, the public greatly appreciates transparency. The aim of a Nanotechnology Information Platform (NIP) is to provide qualified, even-handed material that facilitates opinion-forming on the subject of nanotechnologies.

This shall be accomplished by networking the relevant stakeholders in order to aggregate up-to-date and reliable knowledge and enable an exchange of information.

On this basis, a repository of coherent information will be developed for interested groups in civil society (citizens, decision-makers, media, representations of interest, educational institutions, etc.).

A necessary first step is to establish a network of relevant stakeholders for the creation of a Nanotechnology Information Platform.

The following structure would be appropriate:



The Nanotechnology Information Platform should perform the following core tasks:

- Information hub to promote communication between network participants.
- Continuous sourcing and compilation of the stakeholders' knowledge and creation of a repository of shared knowledge.
- Design and creation of a suitable interface to the public.