NANO*futures*

AN INTEGRATING MULTI-DISCIPLINARY, MULTI-SECTORIAL, CROSS-ETP

EUROPEAN INITIATIVE FOR SUSTAINABLE DEVELOPMENT WITH INNOVATIVE NANOTECHNOLOGIES

DRAFT

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Content

1 Summary

1.1 Introduction

Nanotechnology will help Europe to address global challenges such as climate change, constraints in energy production and shortage of resources, insufficient access to clean water and food safety, as well as widespread diseases and affordable health care worldwide.
Nanotechnology is the basis for the next industrial revolution. However, the true potential of nanotechnology is not yet exploited exhaustively. Currently, the creation of new business opportunities in this domain does not show the same industrial dynamics as other, more mature industrial branches. This can be attributed to the following peculiarities of nanotechnology related research and industrial sectors:

1. The knowledge required for economic exploitation of nanotechnology enhanced materials and products is extraordinarily high. Europe has to face fragmented research and technology and innovation initiatives.
2. The large depth of knowledge needed on different aspects related to life sciences, chemistry and microelectronics leads to the need for a different profile of manager from the typical entrepreneurs traditionally working in other industrial branches. Nanotechnology requires fully networked poles or clusters of technology that support research to innovation cycles.
3. At its present state of development, nanotechnology is an enabling technology rather than a product. It operates mostly with unstructured value chains in which technology strategies have little chance to meet market needs. There is need for clear market drivers.
4. Because of the emphasis on new applications and markets for nano-inventions, established companies are unlikely to enter this domain, since it requires different approaches from those successfully applied in the past. Therefore, it is more likely than new start-up companies derived from other industrial branches aim at the exploitation of a given nanotechnology and its applications. There is a need for a dynamic and updated framework based on industrial foresight.
5. In the public perception, nourished often by publications in the media which lack of scientific evidence, nanotechnology is still associated with an unusually high level of risk. As a consequence, even large companies consider it wise to exploit nanotechnology in new, independent small companies -in particular start-ups- as part of their strategic risk and image management or even choose not to disclose the nano-content on which the product appeal is based. Europe must address the crucial issue of safety with an evidenced-based approach.

1.2 Sustainable Nanotechnology

The diffusion of nanotechnology-enhanced products opens up a great potential for market growth in several industrial sectors. In this framework, it is important to build strategies for the development of nanotechnology in a sustainable way (i.e. Sustainable Nanotechnology). Sustainable Nanotechnology shall consider the impact of nanotechnologies not only on the economy, but also on the environment and citizens' health.
The analysis of the worldwide market forecasts a considerable market revenue for nano-enabled product, reaching near 3.5 trillion dollars in 2015. Most of industry and research sectors will benefit from this growth (Figure 1).

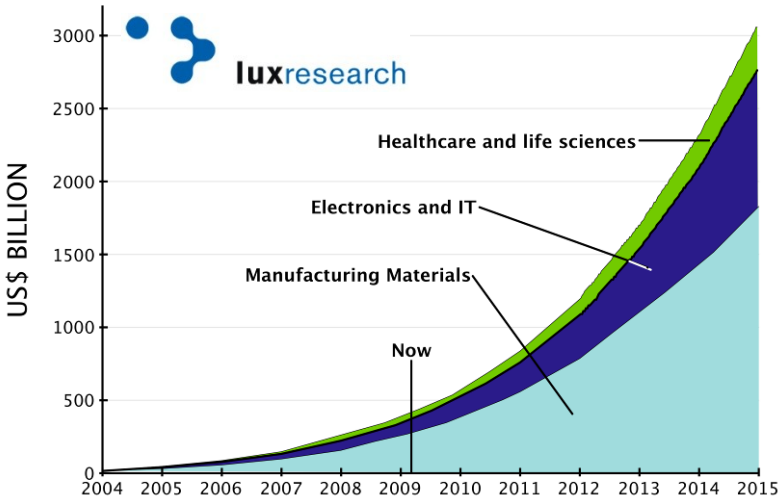

Figure 1: Market growth of nano-enabled product, segmented by sector.

In the last few years, nanotechnology funding has been increasingly driven by central initiatives, at EU and worldwide level. While traditionally government funding address mainly basic research, in nanotechnology a significant and expanding portion of it focuses on commercialisation. Collaboration not only between research centres and industries, but also between EU and other countries (e.g.US, China) has been also promoted.
In this light, the state of the art in nanotechnology, current challenges and future opportunities should be carefully indentified for each sector, in order to build a common strategy for the development and spreading of nanotechnology in Europe.

As far as **the Environment sector** is concerned, the following issues need to be addressed concurrently with the development of nanoscale R&D projects and the creation of nanotechnology products:

1. Environmental knowledge and specific measures in nanotechnology in both research and industrial units,
2. Cross-sectors and internationally accepted nomenclatures, norms, standards and regulations for the development of science, engineering, technology and new markets,
3. Management of risk analysis for the private sector and government.

There issues require long time intervals to addressed, and must be on the radar of the governments and civic organizations that work to ensure an equitable and responsible growth. NANO*futures* mission will be to make aware industries and the related institutional and political entities about the environmental concerns related to micro –nanotechnologies promoting actions finalized to the adaptation of standards and rules for the rational and safe use of these new technologies and materials.

Regarding **Health and Safety** issues, little is known about the health risk associated with nanoparticles and nanomaterials. For example, in the field of pharmacological agents based on nanotechnology, most of the effects of these nanodrugs are hardly known. Moreover, up-to-date there is no specific safety regulations available for nanoparticles, even if some of current European directives and initiatives are applicable to nanomaterials (e.g. Directive 98/24/EC: Protection of the health and safety of workers from the risk related to chemical agents at work).
More generally, industrial sectors have a specific need of detailed information about safe production and use of the nanomaterials. NANO*futures* represents the critical mass necessary for the diffusion among the industrial community of scientific information regarding health and safety risks associated nanomaterials as well as of EC safety policies and regulations.

As far as the **Energy** sector is concerned, one of the major concerns of the global warming is the energy mass production at zero carbon emission. The European Union has the ambitious goal to cover at least 20% of the whole energy consumption in Europe with renewable energy by the year 2020. Furthermore, Europe aims to reach a decrease of 20% of greenhouse gas as well as an increase of 20% of energy efficiency. In this light, nanotechnologies will have a decisive role on the development of primary energy sources and on the efficient conversion, storage, transport and utilisation of energy.
Planning of a prospective energy systems requires long-term investments in research activities and infrastructures, which are based on realistic assessment of potential innovations. Sector and discipline overlapping dialog between all actors is essential to get the new nanotechnology innovations as soon as possible into practice especially in such a broaden field like the energy sector. NANO*futures* initiative makes a contribution to span a bridge to new nanotechnology innovations and development in related areas.

1.3 Strategic Vision

The capacity to weight risks and benefits, to judge and to decide, derives from knowledge of the nanotechnology but even of the market, the environment, the policies, the biology and the industrial processes.
Nowadays there is a huge amount of information around nanotechnology coming from various initiatives and programmes such as industrial projects on new production systems, fundamental research carried on by universities, ETPs and their Strategic Research Agenda and action plans etc.
In this contest there is a **need for a inter-sectorial view**, able to analyse the key nodes in strategic nano-activities, including policy and environmental issues (i.e. "Responsible Nanotechnology") allowing to optimise and maximize the impact of resources deployed, avoiding duplicated, disconnected and fragmented actions and operating, in general, under a single-reference-responsible capable of communicating with the general public and political institutions and actors.
To achieve these aims, a multi-sectorial and multi discipline structure with the capacity to harmonize and disseminate standards must be adopted.
Moreover, the industrial community has the expertise to highlight the specific sector-based needs of nanotechnology (Nano Needs).Collecting the Nano Needs is the starting point for a strategic and organic approach. The second step is to recognize the horizontal issues shared by different **Nano Needs** (Figure 2)

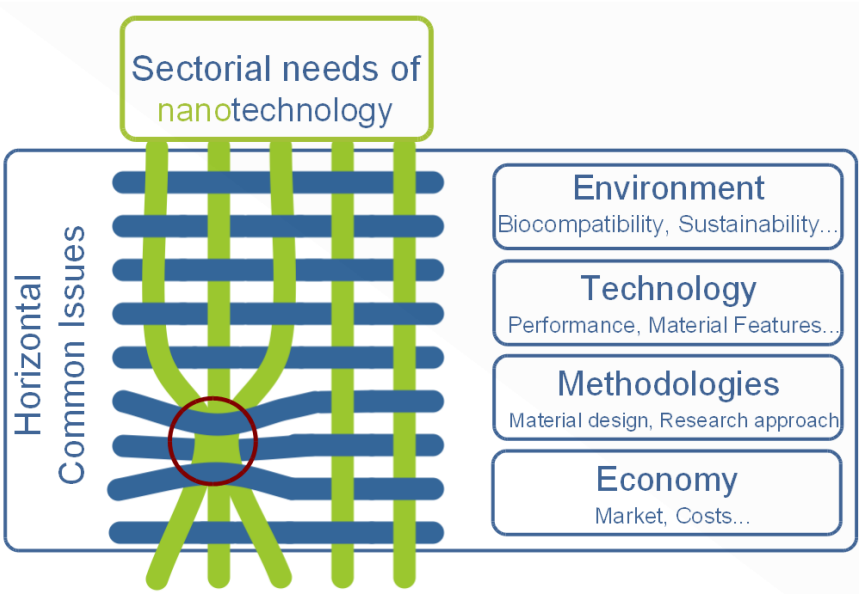

Figure 2: Key node identification on the need/common issue texture

1.4 Nano*futures*

NANO*futures* will be open to a broad range of industries, SMEs, NGOs, financial institution, research institution, universities and civil society with an involvement from Member States at national and regional level. It will be an environment where all these different entities will be able to interact and come out with a shared vision on nanotechnology futures.
Due to its wide configuration, NANO*futures* environment would become a European multi-sectorial, cross-ETP, integrating platform with the objective of connecting and establishing cooperation and representation of all relevant Technology Platforms that require nanotechnologies in their industrial sector and products. NANO*futures* and its operative branch MINAM association have the inspiration to act as a sort of "Nano-Hub" by linking external entities (JTIs, associations, ETPs) with its experts group under the industry driven management structure (former MINAM members) and strong operational secretariat.
NANO*futures* as "**Nano-Hub**" will contribute to enhance the commitment of industry in European Nanotechnology and in the meantime collaborate with the other ETPs for nanotechnology development in Europe.
To better follow and manage its continuous evolution towards the constitution of a work environment, NANO*futures* has to be open and flexible in order to get new inputs from any source and elaborate them in a collaborative cross-framework.
NANO*futures* will be instrumental in the industrialisation of nanotechnology by cross bridging the gap between research, technological innovation and company/market innovation aspects, supporting nanotechnology industrialization to the benefit of European economy and its citizens. An important objective will be to connect and establish cooperation and representation of all relevant Technology Platforms that require nanotechnologies in their industrial sectors and products.
An important role of NANO*futures* will be also the linking and integration between nano-micro and macro technology based industries and the general manufacturing field ensuring timely provision of the required state-of-the-art manufacturing technologies. To do so, NANO*futures* will inevitably be dependent on foresights concerning challenges and technologies required by its "client communities". Therefore, its road mapping and development of its fields of cooperation and competence remain a continuous process, allowing for a permanent readjustment of priorities according to the requirements of the NANO*futures* environment and its related industrial areas. A multidisciplinary approach is needed to cross-traditional boundaries between different fields and disciplines and forming a new methodology for understanding and decomposing effectively, following the strategic approach, the shared nanotechnology challenges (key nodes).

Main objectives of NANO*futures* can be summarized as follows:

1. Addressing the shared need of existing ETPs for overseeing and implementing tasks of common interest, while observing the subsidiary principle
2. Contributing to the (joint) programming of European public nano-programmes, increasing cooperation and synergies between European and national funding mechanisms
3. Reducing fragmentation and increase synergies between the various European and national research and innovation activities
4. Addressing technical issues of common trans-sectorial/horizontal relevance such as safety, environment, metrology, standards etc.
5. Ensuring societal acceptance by addressing horizontal issues relating to safety and standards.
6. Communicating the potential of nanotechnology for increasing European competitiveness and sustainability simultaneously.
7. Establishing an accepted "nano-identity" with a single voice in the public debate (green nano), with the aim to overcome any reservations concerning "nano inside"
8. Increasing cooperation and synergies between the actors from the various industrial sectors, research and education communities addressing above objectives.

Finally, NANO*futures* will work towards an open, networked and adaptive nanotechnology innovation system by creating synergies between stakeholders from different sectors and regional, national and European and international bodies. In particular, NANO*futures* will foster nano innovation through the following steps:

- Clear identification of barriers for business growth;
- Creation of a seamless link between research output and innovation needs;
- Identification of opportunities for European leadership;
- Reduction of research fragmentation, by promoting and developing joint programme of activities;
- Identification and dissemination of a commonly agreed European innovation strategy.

1.5 NANO*futures* Organisation (work in progress)

NOTE: NANO*futures* Organisation will be defined and discussed in details during the next meeting in Brussels (14/10/09) The following paragraph is a preliminary overview of NANOfutures Organisation.

Nano*futures* is established on the basis of the shared need of existing ETPs for a "nano-hub" that will oversee issues of common interest, not sufficiently addressed under their existing activities (the subsidiary principle will prevail).

A Memorandum of Understanding to plan the interaction to constitute NANO*futures* collaborative environment has been signed or is being signed by 13 ETPs and JTI having interest in nanotechnology.

Because of NANO*futures* multi-sectorial, cross-ETP nature, it will be in a different way to the existing ETPs:

- Steering committee will be composed by operational manager and a representative from each of the member ETP
- Management will be performed in a lean structure adapted to the agreed activities
- Members will be the participating ETPs, and their individual members
- Technical working groups will be defined where existing ETPs share common needs

Public support is foreseen through application to CSA, to cover costs from inter-ETP activities.

NANOfuturespolicy covers the development of Strategic Research Agenda (SRA). To this aim, roadmapping activities will be performed, in order to provide providing holistic overview, linking together major driving factors, such as applications, market requirements and technological capabilities of the highly interdisciplinary field of nanotechnology). Both SRA and roadmapping activities will be build upon the previous experience and knowledge of MINAM association.

The promotion of the NANOfuturesactivities will be carried out by means of different channels, i.e. both by MINAM webservices (on-line brokerages, web news etc.) and by using the nano-oriented partner networks (e.g. Euspen, SEMI, nanoindustry, nanowerk, nanopaprika.eu).Website and newsletters will be also provided.

1.6 Members and Networking

As previously mentioned, NANO*futures* will be open to a broad range of industries, SMEs, NGOs, financial institutions, research institutions, universities and civil society with an involvement from Member States at national and regional level.

Among Nf partners are:

- MINAM ASBL and MINAM web portal members,
- Industrial companies and research institutes active in nanoIAG;
- Prodintec. As partner in the inter - regio project “nano2market”
- Several former, running and recently started projects, to be integrated in the platform (e.g. NanoCom, ProNano)
- The 4M network project follower, which is a knowledge community in multi-material micro manufacture.
- Several ETPs (e.g. Manufuture, SUSCHEM).

The applied networking strategy includes a fast penetration of nano-interested groups all over Europe as well as the use of informal channels (e.g. social media and networks like linkedin and xing micro - nano group). NANOfutures will also develop and exploit structured co-operations with other European Technology Platforms, with local and regional networks and projects, global industry associations like SEMI, local industry associations like IVAM, Veneto - nanotech, Scandinavian network and public private partnerships like www.zirp.de.

2 Introduction

Nanotechnology is defined as the understanding and control of materials at dimensions of roughly 1 to 100 nanometers. Because of their unique size-tuneable properties (e.g., the quantum size effects) and large surface areas, nanomaterials present vastly different properties from those of bulk materials. Nanotechnology research will help to address global challenges such as climate change, constraints in energy production and shortage of resources, insufficient access to clean water and food safety, as well as widespread diseases and affordable health care worldwide.
Nanotechnology is the basis for the next industrial revolution. However, the true potential of nanotechnology is not yet exploited exhaustively, and the creation of new business opportunities in this domain does not show yet the same industrial dynamics as other, more mature industrial branches. This can be attributed to the following peculiarities of nanotechnology related research and industrial sectors:

1. The knowledge required for economic exploitation is extraordinarily high due to the remarkably large interdisciplinary and complexity of the Nanoscience. Europe has to face fragmented research, technology and innovation starting from its own research and innovation activities such as the various RTD initiatives and European Technology platforms with substantial Nano related activities.
2. The large depth of knowledge needed often for Nanoscience and its large overlap with life sciences, chemistry and microelectronics leads to the need for a different profile of manager from the typical industrialist / entrepreneur traditionally working in other industrial branches. Nanotechnology requires fully networked poles or clusters of technology that support research to innovation cycles.
3. At its present state of development, nanotechnology is an enabling technology rather than a product. It operates mostly with unstructured value chains in which technology strategies have little chance to meet market needs. There is need for clear market drivers, for example, industrial problems that can be solved by the application of nanotechnologies.
4. Because of the emphasis on new applications and on new markets for nano-inventions, established companies are unlikely to enter this domain, since it requires different approaches from those successfully applied in the past. Therefore, it is more likely than new start-up companies derived from other industrial branches aim at the exploitation of a given nanotechnology and its applications. There is a need for a dynamic and updated framework based on industrial foresight.
5. In the public perception, nourished often by publications in the media, which lack of scientific evidence, nanotechnology is still associated with an unusually high level of risk. As a consequence, even large companies consider it wise to exploit nanotechnology in new, independent small companies -in particular start-ups- as part of their strategic risk and image management or even choose not to disclose the nano-content on which the product appeal is based. Europe must address the crucial issue of safety with an evidenced-based approach.

3 Sustainable Nanotechnology

Since a few years, the catchwords “nano” and “micro” are synonyms for the future evolution in technology fields. The reasons are obvious and understandable: the possibilities for the use of nano- and micro- products rush to a nearly unlimited number. Already today, materials on nano and micro basis play an important role. Nanotechnology is everywhere, in our clothing, cars, windows, computer, and displays, even in our medicine adding new functionalities, intelligence, integrations, portability and networking capability in many new products with high market potential in several industrial sectors. A whole branch is growing that handles the issues of construction and fabrication. Additionally, there is an increasing number of suppliers for measuring instruments at nanoscale or researches, which address biological compatibility issues of nanomaterials.

In this framework, it is important to build strategies for the development of nanotechnology in a sustainable way (i.e. Sustainable Nanotechnology). Sustainable Nanotechnology shall consider the impact of nanotechnologies not only on the economy, but also on the environment and citizen’s health.
Nanotechnology has great potential for beneficial environmental uses, by enhancing product/production efficiency and opening new paths for renewable energy harvesting. Nanotechnology applications in the field of nanomedicine may be of great help in fighting major diseases, such as cancer. However, the risks associated to nanotechnology, such as the potential adverse effects of nanoparticles on human health and the environment, should be identified and carefully addressed.

In the following paragraph, an overview of market trends in nanotechnology is provided, with a brief description of EU and international country positioning with respect to technology development and nanotechnology activity. The impact of nanotechnology in each major sector of EU society is then described in the subsequent paragraphs, with the aim to depict the state of the art, to identify current challenges and future trends and to point out the advantages coming from NANOfuturescross-sectoral initiative.

3.1 Europe and World Market Positioning

Nanotechnology has grown in the past decade mostly thanks to the hype that surrounded this word. The promising of big paydays has attracted financiers, corporation, stakeholders and governments to invest in start-up companies and research. However, customers are not willing to pay a premium just because nanotech is incorporated in the product: there must be value-added, real or perceived, and/or cost savings to the manufacturer to boost profit margins. The research and the work done has permitted to have now applications and technologies inserted in several markets that are making the difference and that are producing revenue thanks to their peculiar performances.

The data and the graph below belong to the recent document "Nanomaterials State of the Market Q1 2009” which is a service by Lux Research Intelligence. Lux Research “State of the market reports” providing strategic advice and ongoing intelligence for emerging technologies providing constantly updated reports on nanotechnology market analysis and forecasts.

The market has been analysed subdividing in three distinct segments:

1. Nanomaterials: engineered structures of matter like carbon nanotubes, ceramic nanoparticles and metal nanoparticles;
2. Nanointermediates: intermediate products that integrates nano/micro/macro technologies, like coatings, composites, catalysts, sensors, energy storage devices;
3. Nano-enabled products: finished goods of the value chain that incorporate nanomaterials and nanointermediates, like mobile phones, automobiles, buildings.

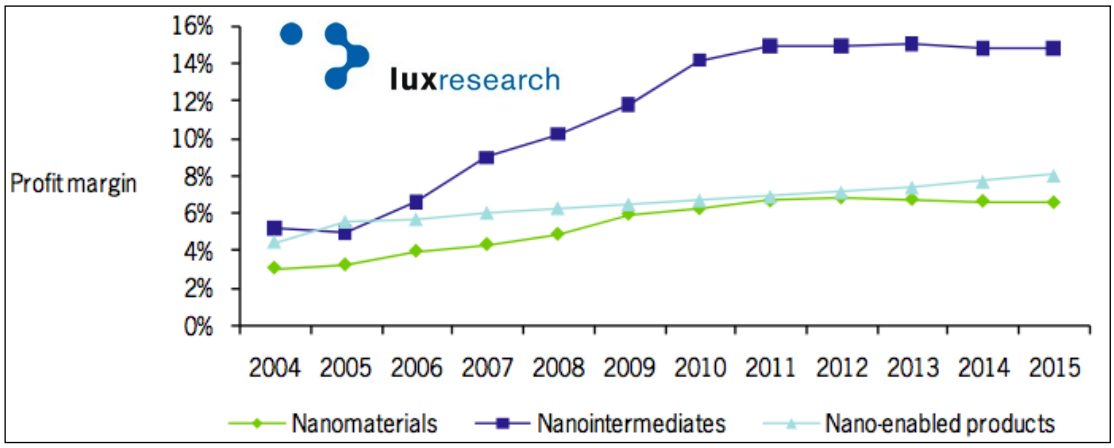

Figure 3: Time projection of profit margins in terms of type of market segment

The diagram reported in Figure 3 reports that segment concerning the **integration of nano/micro/macro technologies** in nanointermediates is emerging as the most promising in terms of profit margin. The profit margins forecast for nanointermediates in 2015 correspond to 14%, a value that will be stabile from 2012 and that is double respect nanomaterials and nano-enabled product's margin. This value chain segment garnered more than twice the profit margin of nanomaterials and nano-enabled products. Indeed Since 2004 nanomaterials specialists have begun to heed the call of the value in nanointermediates, as many have shifted business models from nanomaterials to move down the value chain to capture more value.

The total revenue instead will be greater for nano-enabled product, as shown in Figure 4: the forecast for the nanotechnology market revenue in 2015 is near 3.5 trillion dollar.

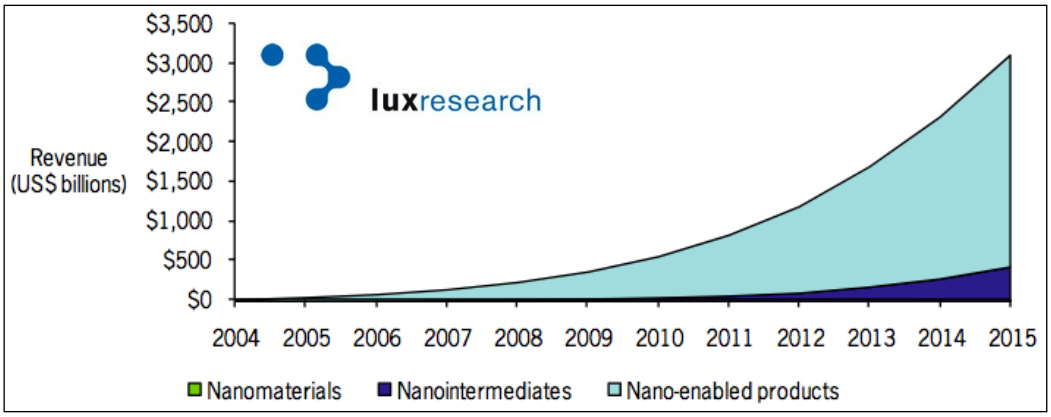

Figure 4: Time projection of total revenue per type of segment

Regarding nano-enabled product, Figure 5 presents a segmentation by sector of the forecasted total revenue: the estimation highlighted the key role of manufacturing materials in the future market growth.

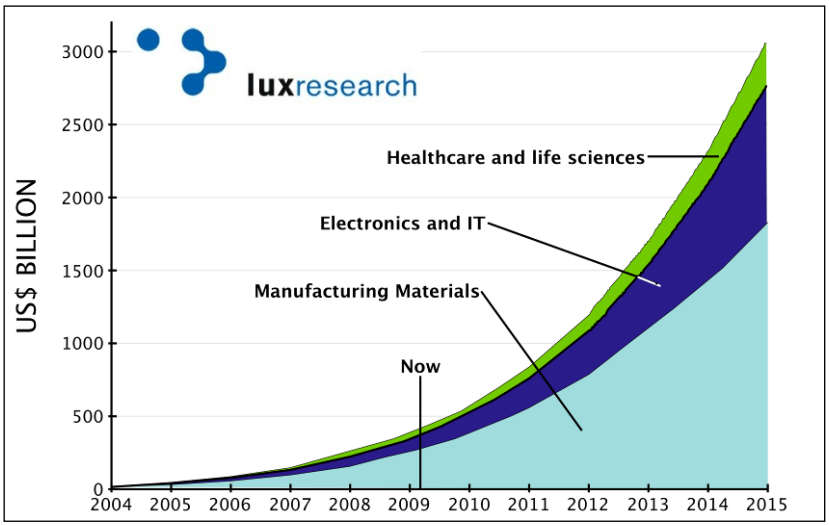

Figure 5: Market growth of nano-enabled product segmented by sector

Nations ranking in nanotechnology has been estimated using two scales:

- Nanotechnology activity: an absolute measure of the row element for nanotechnology development, like n-initiatives, n-centres, founding, publications, patents, active companies
- Technology development strength: a relative measure of technology commercialisation prowess

The graph below Figure 6 reports the two scales, evidencing four quadrants from dominant countries to minor ones.

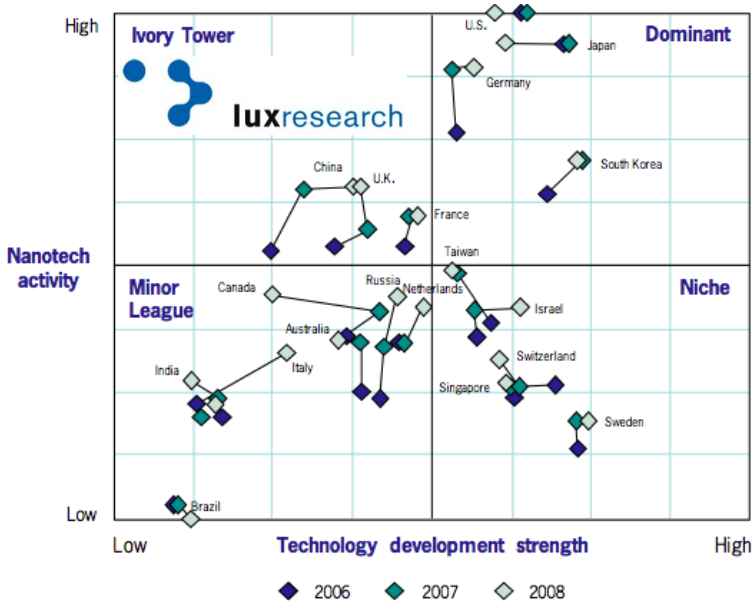

Figure 6: Technology development strength of Nations

Countries with low nanotechnology activity and low technology development are poorly positioned to gain from nanotechnology commercialisation, however several players in this quadrant, like Russia, Italy and Netherlands, have been making noise and asserting themselves in a bid to become more prominent players on the global nanotechnology stage. Country with high nanotechnology activity and

low technology development has a strong research, usually founded by governments, but lack in capability to commercialise the technology. China is the exact example of this ivory tower syndrome.
Countries in the bottom-right quadrant, niche, have strong technology development, but lack the resources to promote internationally competitive levels of nanotechnology activity, often choosing to focus on specific domains.
Countries in the top-right quadrant, dominant, are exceptional both in the amount of nanotechnology activity occurring within their borders and their ability to commercialise scientific innovation.
Countries that look like burgeoning nanotechnology activity powerhouses, but which lack the industrial bases to effectively commercialise those innovations, look like fertile hunting grounds for technology scouts: consider Canada, the U.K., Russia, and the Netherlands.
A number of up-and-coming nations have clearly found ways to promote nanotechnology activity. However, shifting the structure of their economy to increase technology development strength is a difficult and slow-moving task. To take advantage of this nanotechnology activity sooner, they should make sure national initiatives also placing emphasis on creating forums for innovators at home connecting with companies abroad that can help to bring these ideas to market. For instance, Italy could reach across the Alps and emphasize building bridges between its increasingly productive universities and start-ups and industrial partners in Germany.

Spending on nanotechnology research and development (R&D) all around the world maintained its growth in 2008, as the breadth of nanotechnology's influence continued to expand. Global spending on nanotechnology from governments, corporations, and venture capitalists (VCs) totalled $18.2 billion in 2008, up 15% from the $15.8 billion spent in 2007. Governments and private corporations investment is almost equal, venture capitals instead provided about 7% of total spending in nanotechnology (Figure 7).

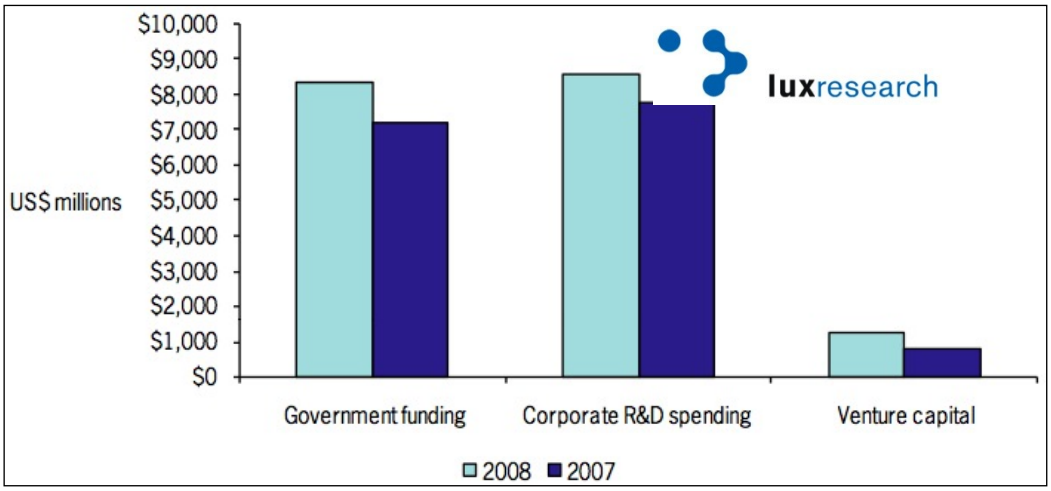

Figure 7: Global spending for nanotechnology in the world

Government funding for nanotechnology grew for all nations around the world and Asian governments collectively spent more than US and Europe.
Collaborations between governments across the globe are becoming increasingly common.

Since the U.S. National Nanotechnology Initiative set the mould in 2001, many countries are stepping up efforts to coordinate their nanotechnology work. This causes the nanotechnology funding to be increasingly driven by central initiatives. This increasing coordination involve also the collaboration between governments across the globe as the joint research initiative of China's Ministry of Science and Technology (MOST) with the government of Alberta, Canada in 2006 or Russia nanotechnology collaborations with U.S., China, Israel, Germany, U.K. and South Korea.

While traditionally government funding drives mainly at basic research, in nanotechnology a significant and expanding portion centres on commercialisation. The U.S. NNI, for example, supports commercialisation by offering companies access to its nanotechnology facilities, providing Small Business Innovation Research (SBIR) grants, and running a network of technology transfer centres that help identify commercially promising technologies and market them to the industry.

Despite worries about how the global economic downturn will affect spending on long-term R&D, corporate nanotech funding continued to grow, albeit modestly. The overall growth of corporate funding is 11% from 2007 to 2008. Europe's corporate spending actually decreased about half a percent from to 2008 and is skewed heavily toward materials and manufacturing. Asia leads in corporate spending; it has marked an increase of 12% from 2007 to 2008, and with a predominant role of electronics and IT. Nanotechnology will look very different by 2015 and beyond, it will ultimately become such standard practice that many will stop referring to it at all, shifting the outlook to financing and public policy in the field along the way. As nanotechnology continues to mature, we expect to see notable shifts in the materials, products, and industries that are of greatest commercial significance, as well as how companies approach nanotech strategy and how politicians and regulators view the field.

Every human action on earth has a consequence on the environment often neglected or forgotten. The last years have been characterized by the multiplication of environment emergency that result from growth of the ignored consequence of human actions: an un-sustainable development. Nowadays we cannot neglect the effect of our development on nature system and, in addition, we have to compensate the wrong behaviours of the past. Nanotechnology can help a sustainable development and even environment recovering, enhancing product/production efficiency and opening new paths for renewable energy harvesting.

3.2 Nanotechnology Sector – Environment

Introduction

Nanoparticles can comprise a range of different morphologies including nanotubes, nanowires, nanofibres, nanodots and a range of spherical or aggregated dendritic forms. These materials have seen application in a wide range of industries including electronics, pharmaceuticals, chemical-mechanical polishing, catalysis, and it is likely that the next few years will see a dramatic increase in the industrial generation and use of nanoparticles. When this occurs, the workforces in these industries may be exposed to unknown levels of airborne nanoparticles (these are also known as ultrafine particles with aerodynamic diameters < 100 nm), and unique health outcomes associated with these particles may result, if work is not carried out at an early stage to develop a better understanding of the risks, and to develop guidance on how to measure and control worker exposure to these particles.
There are immediate and continuing issues that need to be addressed concurrently with the development of nanoscale R&D projects and the creation of nanotechnology products.
They may be separated into three groups:

4. Environmental knowledge and specific measures in nanotechnology in both research and industrial units,
5. Cross-sectors and internationally accepted nomenclatures, norms, standards and regulations for the development of science, engineering, technology and new markets,
6. Management of risk analysis for the private sector and government.

For the industrial sectors point of view, the nanomaterial environmental assessment is based on the three main phases:

1. production of nanomaterials and integration on the industrial products,
2. usage/functional life of the industrial products (including nanomaterials functionalities),
3. end of life/recycling of the industrial products (including the nanomaterials).

State of the Art (R&D and Industry Perspectives)

Estimation of the potential health risks associated with these new materials requires understanding of the mechanisms of disease, the identification of some property or metric of the material, which relates exposure to the material to health risk and some method for measuring exposure in relation to that metric. Once these are in place, it is potentially possible to define safe levels of exposure to these materials and if needed to design control methodologies to enable exposures to be maintained at or below these safe levels. For nanoparticles, there is currently poor understanding of all of these issues.

Three preliminary studies have been funded by HSE (The Health and Safety Executive, which is the primary regulator of health and safety in British industry) as part of its horizon scanning activities to look at the potential hazards and risk of nanotechnology. The performed investigations considered the following aspects:

- Fire and explosion
- Occupational hygiene
- Toxicological hazard

All these studies reported limited amount of available and the difficulty of reading across from existing data. They also highlighted that the hazards from nanoparticles and fibres are sufficiently different from bulk materials to require further careful study. They also indicated that the areas of initial occupational health concern should be:

- potential for enhanced toxicity
- potential to cross the skin barrier
- existing control measures are unproven
- possible persistence in the workplace

Table 1summarizes European and International efforts finalized to the control of environmental and health safety of nano-materials.

ORGANIZATION	EFFORT
U.S. Food and Drug Administration; U.S. Environmental Protection Agency (Washington, D.C.)	Relying on existing protocols to regulate new nanomaterials, while developing data on toxicology, environmental fate, and tissue accumulation
U.K. Royal Society, U.K. Royal Academy of Engineering (London, England)	Commissioned a blue-ribbon study to assess the risks and benefits of nanomaterials and make regulatory recommendations
Center for Biological and Environmental Nanotechnology, Rice University (Houston, TX)	Director Vicki Calvin recommended that 5% of federal nanotechnology expenditures be devoted to the study of environmental and societal consequences
ETC Group (Winnepeg, Manitoba)	Calling for moratoria on nanotechnology R&D until safety can be established; seeking an international convention to evaluate nanotechnology
Greenpeace Environmental Trust (London, England)	Calling for far more research on nanotechnology's environmental impact, but not endorsing moratoria

Table 1: Efforts and proposals on nano-particle safety in Europe
(Source: "Nano's Safety Checkup," by I. Amato, Technology Review, Feb. 2004, pp. 22-23)

In the recently published Royal Academy of Engineering report "Nanoscience and nanotechnologies: opportunities and uncertainties" http://www.nanotec.org.uk/finalReport.htm) starts with a definition of nanotechnologies proposed as: '***Nanotechnologies*** *are the design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometre scale"* .and ends with 21 recommendations. These include some specific ones as well as broad issues that impact upon occupational health.
Interest in the unique properties associated with materials having structures on a nanometer scale has been increasing at an exponential rate. By restricting ordered atomic arrangements to increasingly small volumes, materials begin to be dominated by the atoms and molecules at the surfaces, often leading to properties that are strikingly different from the bulk material.

Difficulties
As stated in the review Nanoscience and Nanotechnologies," The Royal Society and the Royal academy of Engineering, July 2004:" There is virtually no information available about the effect of nanoparticles on species other than humans or about how they behave in the air, water or soil, or about their ability to accumulate in food chains. Until more is known about their environmental impact we are keen that the release of nanoparticles and nanotubes to the environment is avoided as far as possible. Specifically, we recommend as a precautionary measure that factories and research laboratories treat manufactured nanoparticles and nanotubes as if they were hazardous and reduce them from waste streams and that the use of free nanoparticles in environmental applications such as remediation of groundwater be prohibited."

Whenever a new technology arises, there are gaps in the knowledge base relating to its potential health, environmental and safety hazards and risks. In some cases, extrapolating from what is already known can easily fill these, but in others such as nanotechnology new techniques and or data must be generated to fill those gaps.

Risks
Nanoparticles are encountered in ambient air as well as in the workplace, and in terms of particle number and surface; they totally dominate the ambient particle levels. Epidemiological studies have shown an association between increased particulate air pollution and adverse health in susceptible members of the population, in particular the elderly with respiratory and cardiovascular diseases. This association has been found to be particularly relevant for the finer fractions of the airborne particles (PM2.5, and PM1).
Current tendency over the considerations of the possible health hazards and environmental impact of nanomaterials have pointed out some similarities with the widespreading diffusion of asbestos fibres occurred in the Seventies.
It has been known since the early 1960's that asbestos can be a cause of pneumoconiosis, a serious lung disease, and mesothelioma, a cancer of the lining of the chest which is often fatal. However, the mechanism by which the silicate fibres cause the damage, at least in the case of mesothelioma, is believed to involve the catalytic formation of reactive oxygen compounds. It seems unlikely that (plain carbon) nanotubes would have the same effect. Nevertheless, in the lack of any definite information on the toxicity of Fullerene-related carbons, it is wise have caution when preparing and handling these materials. Same carefulness should be used in the evaluation of nano – materials for which no extended investigation has been yet carried out. It is very unlikely that new manufactured nano-particles could be introduced into humans in doses sufficient to cause health and environmental effects that have been associated with the nanoparticles in polluted air. However, some may be inhaled in certain work places in significant amounts and steps should be taken to minimize exposure. Toxicological studies have investigated nanoparticles of low solubility and low surface activity. Newer nanoparticles with characteristics that differ substantially from these should be treated with particular caution.

Future Trend and Potential

In practice, the Life Cycle Assessment (LCA) methodology must be applied at the complex industrial products and the nanomaterials impact must be assessed in all the LCA phases.

For example, on the Automotive and Aeronautic sectors the nanomaterials should be considered in the production phase of the vehicles/vectors, in the usage and at the end of life/recycling of the vehicles/vectors components. It is important to outline that the vehicles/vectors impact is not only measured in term of emissions, but also in term of resources consumption. In particular, for the Automotive and Aeronautic sectors the resources consumption is traditionally represented by the fuel consumption during the off life (the use) of the vehicles/vectors, but in last 5 years the attention has moved to the energy consumption to produce the vehicles/vectors. This new concept is very interesting because the energy efficiency in production phase represents for the industries the opportunity to reduce at one time the environmental impact and production costs of the process chain. It is important to outline that the energy necessary to produce, store and apply the nanomaterials to vehicles/vectors is included in the total energy consumption and cost of the Automotive and Aeronautic sectors production phases and, for this reason, in the next decade it will growth the interest on the efficiency of nanomaterials production.

Other efforts will be established to use nanotechnology for protecting the environment, for example with cleaning methods for contaminated soil or with special filter systems in air. It is assumed that such kind of nanotechnology bring forward economic and environment friendly solutions such as those to decontaminate toxic exhausted gas. These approaches are welcome for the handling of increasing pollution and shortage of resources.

Finally, other environmental issues should be addressed in the future, namely waste disposal, recycling and separation of nanomaterials.

Advantage with Nano*futures*

Long-term environmental issues for responsible development of nanotechnology are related to its broader social and economic outcomes, require longer time intervals to be recognized and changed, and must be on the radar of the governments and civic organizations that work to ensure an equitable and responsible growth. These issues include, environmental protection and improvement of restrictive measures for investors, approaches and criteria for sustainable development of technology, energy supply and transportation including life-cycle analysis of products, materials flow analysis, clean-up techniques on new principles, weather implications, and other global effects. NANO*futures* mission will be to make aware industries and the related institutional and political entities about the environmental concerns related to micro –nanotechnologies promoting actions finalized to the adaptation of standards and rules for the rational and safe use of these new technologies and materials.

Moreover, NANO*futures* represents the critical mass necessary for the collection, elaboration and supply to the industries of the data necessary for the application of LCA to nanomaterials, with a special care on emissions and energy consumption aspects.

3.3 Nanotechnology Sector – Health & Safety

Introduction

The common trend, namely miniaturisation and size reduction, in industrial manufacturing is mirrored by nanotechnology; as nanotechnology is less just one technology rather than a generic term for a variety of applications and products, which include smallest particle to obtain defined properties. Any material which is reduced to the size of a nanoparticle acts suddenly in a different way as for example electric insulating material becomes conductive or insoluble material becomes soluble.

The full range of this new technology is not assessable in relation to potential risks and dangers parameters. As it is not only possible that nanoparticles change their behaviour and their mobility, but also they have nearly unrestricted access to the human body. The possibility of entrance over lunges, the digestive system or dermal is presumed to be sure. Once entered in the blood system there is no limitation for these particles to circulate in the human body even through the blood-brain barrier.

State of the Art (R&D and Industry Perspectives)

The increasing commercial usage of nanomaterials has lead to critical discussion in expert groups over the potential advantages and disadvantages of this technology. In the last time even political discussions results in controversial opinion about associate possible risks. Special attention concentrates on the so-called "advanced nanotechnology" which deals with topics as "nano robotics" and "self assembly". But such ideas are still far away. In consideration of the various applications, different sectors such as industry, research and regulatory authorities have to work hand in hand to evaluate the risks and chances of the unknown impact. In the last few years, it becomes more and more a topic in the consciousness of the public as well. As a conclusion completely new material properties open the door to a European success story in manufacturing of nanoparticles and material development.

Today no specific regulations are available for nanoparticles, but some of current European directive are applicable to nanomaterials, in particular the Directive 67/548 – 1999/45 (Classification, packaging and labelling of dangerous substances) and the Directive 98/24/EC (Protection of the health and safety of workers from the risk related to chemical agents at work). Moreover the REACH (Registration, Evaluation Authorisation and Restriction of Chemicals, 1 July 2007) include nano sized materials as also a number of voluntary code of conduct at National and European level that have been recently published.

One of the major challenges for the nano/micro community is the identification and classification of the different kind of nanomaterials. Therefore, it did not come as a big surprise that hazard guidelines could not find a way in workplace regulations, yet. In principle, a material safety data sheet has to be prepared for each kind of nano particle, reporting all the properties related to possible toxic effects (dosimetry and physico-chemical properties). Moreover, screening methods have to be defined for quick determination of the toxic properties. However, this would induce too much effort, if realised individually. Today some national voluntary schemes (UK, Switzerland, and USA) encourage the industries and research institution to submit data on nanomaterials, but for better coordination and valuation of possible risks an European network is needed to get first of all a definition of international standardisation and nomenclature which would be the basic of sort of classes.

Obviously, this standardisation will include also guidelines for the nanomaterials exposure assessment; in particular measuring methods for nanoparticles in the working environment are still today are a critical and crucial issue. In fact a large variety of equipments are available to measure the nanoaerosols at workplace, but the evaluation of worker exposure to nanoparticles is more complex because should be considered the respiratory area, the toxic form of the particles (shape, size, material, crystalline structure, electrical charges) and the appropriate correlation with biological effects.

The normal way to get rid of foreign substances is the elimination by so- called "specialised phagocyte". For nanoparticles that attain the human body this is not the case anymore. These particles migrate in any cell independently from their actual role. They have unlimited access through the whole body including heart, bones, muscles and even in the brain. To answer the question of what happens to them and are they harmful it is necessary to differ between biodegradable and non biodegradable particles. The former will be covered with a protein layer after a while so the body egests it in a natural way. The latter are able to enrich in organ and accumulate but this behaviour is known to be worse. Until now it isn't clear in which concentration and dose the nanoparticles could be harmful.

A well chosen example for potential access of nanoparticles is the blood-brain barrier, because the only way to reach into this area is an active assimilation. For this reason the pharmaceutically industry has high hopes in nanotechnology. By use of nanoparticles as carrier it will be easier to get access with medication compared with medication alone.

Difficulties

In the environment, coated nanoparticles are extremely movable and reactive. Because of their minor weight, they are not settling on surfaces as microparticles do. They only come to standstill when they are breathed in or restrain in their dissemination. On the ground, in the soil and water the same occur, nanoparticles spread over different layers and disperse in liquid medium. However, the pure presence does not mean consequently a hazard for the human body or the environment, only if the properties emerge to be harmful it would be a risk.

In consideration of employees it is necessary to distinguish between nanomaterials in form of powders and in liquid medium. The latter are easier to stick and not to spread over whereas the former disperse quite simply. In view of health aspects work-related risk valuations are measured in reference to bigger forms of particles. Especially industrial stakeholders and research institutes should have a high interest of new limited values, because there is a constant risk of exposition and contact in nano/micro manufacturing, packaging and transport.

Recent studies (NanoSafe EU Project, dissemination reports January 2008) showed that the fibrous filtration media seem to able to stop large particles (≥ 1000 nm) by interception and inertia mechanism, and small particles (2 nm ≤100 nm) by diffusion mechanism, whereas they do not seem to be efficient for particle sizes between 150 nm and 300 nm and there is a lake of information for particle sizes≤ 2 nm. Moreover, it has been demonstrated using graphite nanoparticles that no woven fabric seems to be efficient against nanoparticles penetration; thus, conventional cotton and polypropylene protecting clothes should be avoided. Also a "traditional" nanomaterial, as carbon nanotubes, exhibit potential explosion risks, whereas simple aluminum nano-sized particles present dangers of combustion that should be considered in case of large scale industrial storage.

Risks

The point to verify the issue is what happens with nanoparticles when they get access into the human body either over inhalation, through ingestion or absorption dermal. Controversial discussions grow about the question if nanoparticles are able to be absorbed dermal. Despite of high interest, this is one of the main unresolved questions which need to be clarified in the nearest future. Above all nano particles are already in use in different products so for example titanium dioxide in sunscreen, no one knows how or how many particles could be absorbed. The same questions described above obtain for ingestion of nanoparticles. Here sources could not be only drinking water, or food additive, furthermore dust, which is deposited from the atmosphere.

It is mentioned that deposition of nanoparticles in the lung is deeper and more intensive by inhalation than it is for bigger particles. On the one hand, the surface activity is higher because of the smaller particle size; on the other hand, the phagocytes are overloaded with such a high amount of foreign substances. A third aspect is the formation of free radicals in the human body; these radicals could start a chain reaction and destroy tissue in an uncontrolled manner.

A few cases have been described where nanoparticles already have disrupted biological processes, for example interference within construction phase or recycling of biological material. By means of enzymes numberless control and regulation procedures run in the human body. Furthermore, it could have an influence to the messenger, which would decrease communication amongst cells. However it becomes apparent that the human body has lots of repair and compensating mechanism, so that information demand is required to clarify the elementary question about the possibilities of interactions from nanoparticles in biological processes.

Future Trend and Potential

Purportedly Europe is the second leading position in development of pharmacological agents and innovative medicament just behind the US. The medical market offers a huge growth potential as it deals with a sector where quality and efficiency of products has first priority.

These advantages bear a lot of potential risk factors and raise a lot of questions, to mention a few below:

- Do nanoparticles agglomerate after a while and how reactive are they?
- What happens if the particles fail their primary destination?
- How long do nanoparticles remain in the body, permanently?
- Do they interact and harm to cellular tissue?
- Do they deposit in preferable organism?

As these and more questions have not been answered yet, it is only possible to monitor side effects within a long time delay.
The industrial sectors have a specific need of detailed information about safe production and use of the nanomaterials. At this purpose it would be useful a network database, constantly updated, collecting all the available info for each nanomaterial concerning personal protective devices such as fibrous filter media, respirator cartridges, protective clothing and gloves, on explosively and flammability of nanopowders and nano aerosol, on safe procedures for handling nanoparticles.

Advantages with Nano*futures*

NANOfuturesrepresents the critical mass necessary for the diffusion among the industrial community of scientific information regarding health and safety risks associated nanomaterials as well as of EC safety policies and regulations.

3.4 Nanotechnology Sector – Energy

Introduction
In view of a rising energy demand worldwide, threatening climate changes based on the continuous increase of carbon dioxide emission and foreseen shortage of fossil fuels, the development and provision of renewable energy sources is one of the most urgent tasks of the future. One of the major concerns of the global warming is the energy mass production at zero carbon emission. Up to now energy mass production by conventional technologies was rarely using micro and nano manufacturing in the core processes. However, this behaviour is changing fundamentally because both oil rarefaction and public mistrust for the nuclear energy has pushed the development of alternative renewable energy production. Nanotechnology know-how is expected to realize innovations in these emerging energy fields. Nanotechnology offers a multiplicity of potential applications in the energy sector.

Technologies experts estimate new nanotechnologies to enable (with new developed processes and components) a profitable value chain from the development of primary energy sources over the conversion, storage, transport and utilisation of energy.

State of the Art (R&D and Industry Perspective)
In particular, the use of sunlight by means of photovoltaic has enormous potential. The photovoltaic energy is considered as one the most promising and encompasses a huge market growth. Today photovoltaic technologies based on **thin semiconducting films** has more and more complex architectures (e.g. a-Si, µ-Si, CIS,..) to match as closely as possible the solar spectrum.
Another example is **quantum based photovoltaic cells** by using the nano structuration of dots ore wires to adjust the light absorption.
As today the market dominating technology is using expensive mono- or rather multi-crystalline silicon, cost reduction is a major challenge. Basically there are two main approaches to achieve this:

1. By reducing the necessary raw material with new technologies e.g. concentrator lenses[1]
2. By replacing silicon with alternative material, e.g. polymers.

New developments include alternative cell types, such as thin film solar cells, dye solar cells or polymer solar cells. For example, one recently started project is the NASA contract with Kopin Corp, who has been awarded $ 600,000 for the production of nanostructured solar cells made from indium gallium phosphide (InGaP) materials.

[1] An example is the ASPIS project which develops a Parallactic Tracking technology concept that supports flat, fixed solar panels with internal concentration and dynamic suntracking http://www.aspisproject.eu/index.html

Energy Conversion

The highest achievable efficiency is targeted for the conversion of primary energy sources into electric power, heat and kinetic energy. These days, another important effort is to generate environment friendly electricity. Improvements could be heat and anti corrosion coatings on the nanoscale, which improve the efficiency based on higher operating temperature or the usage of light materials. Innovation potential in the field of hydrogen oxygen fuel cells is coming from nano-structured electrodes, catalysts and membranes, which are used in the process by the conversion of chemical energy with higher electricity efficiency. In coal burning power plants membranes with new nanomaterials encourage the separation and climate neutral storage of carbon dioxide to improve in long-term issues the method of electricity generation environment friendly.

Energy Transport

Low-loss power transmission and intelligent electricity networks aim to use the remarkable electrical conductivity of nanomaterials such as carbon nanotubes for the application in power cables. Moreover, there are new approaches for the optimisation of superconductivity materials. Long-term options are wireless energy transport by laser, microwaves or electromagnetic resonance. Nanotechnologies deliver urgent contribution to these visions by nano-sensors and electronic power components, which are handling the complex steering and monitoring of these huge electricity networks.

Storage of Energy

Energy harvesting by thermoelectric devices based on nano- structuring enables a significant increase of the conversion efficiency. Devices using electrochemical reaction to produce or store energy can also be strongly impacted by the application of nanotechnology because the energy density is directly related to the density of active sites; it is straightforward that micro-manufacturing can offer a great breakthrough perspective by increasing the number of active sites by order of magnitudes. With the help of nanotechnology, Lithium-Ion batteries could improve capability and security, for example with new ceramic, heat consistent, and flexible separators as well as with high potential electrode materials. Hydrogen as an energy storage system seems also a promising possibility in the long-term view.

Utilisation of Energy

Besides improving the production of renewable energy, there is also enormous potential in minimizing the energy consumption applying new nanotechnologies in several areas. The most important impacts are seen in the automobile sector with lightweight constructive materials and in buildings for heat insulation or energy saving lightning by LEDs.

Future Trend and Potential

The European Union has the ambitious goal to cover at least 20% of the whole energy consumption in Europe with renewable energy by the year 2020. Furthermore, the aim is a decrease of 20% of greenhouse gas as well as an increase of 20% of energy efficiency. Potential innovations within exploitation both conventional (fossil and nuclear fuels) and renewable energy sources (geothermal energy, sun, wind, water, tide or biomass) are featured by nanotechnologies.

Advantage with Nano*futures*

The impact of the micro- and nanotechnologies on this industrial sector have shown to the energy production experts that micro- and nanotechnologies will have a decisive role in the mass production of energy and energy systems. The implementation of nanotechnology innovations should keep track of macroeconomic and societal context. Planning of a prospective energy systems requires long-term investments in research activities and infrastructures, which are based on realistic assessment of potential innovations. A sector and discipline overlapping dialog between all actors is essential to get the new nanotechnology innovations as soon as possible into practice especially in such a broaden field like the energy sector. NANOfuturesinitiative contributes to span a bridge to new nanotechnology innovations and further development in related areas.

3.5 Nanotechnology Sector – Chemical

3.6 Nanotechnology Sector – Electronic

3.7 Nanotechnology Sector – Medical and Pharmaceutical

3.8 Nanotechnology Sector – Textiles

3.9 Nanotechnology Sector - Transport

3.10 Nanotechnology Sector - Construction

3.11 Nanotechnology Sector - Forest

4 Strategic Vision

4.1 Strategic Approach : Key Nodes

The many benefits of nanotechnology have to acquire strategic significance because nanotechnology can help Europe to achieve its sustainable growth and competitiveness objectives. These benefits have to be weighed against the risks involved: this is the unique way to achieve a sustainable nanotechnology development.
The capacity to weight risks and benefits, to judge and to decide, derives from knowledge of the nanotechnology but even of the market, the environment, the policies, the biology and the industrial processes.
Nowadays there is a huge amount of information around nanotechnology coming from various initiatives and programmes: industrial project on new production systems, fundamental research carried on by universities, several healthcare researches, projects collecting results on environment impact of nano-systems, Strategic Research Agenda and action plans collecting information regarding nanotechnology needs for specific industrial sectors, national and regional initiatives on nano field as well as some ETPs which includes nano-related activities.
In this contest there is a need for **inter-sectorial view** able to analyse what are the key nodes in strategic nano activities, including policy and environmental issues (i.e. Responsible Nanotechnology), enabling to optimise and maximize the impact of resources deployed, avoiding duplicated, disconnected and fragmented actions and operating, in general, under a single-reference-Responsible capable of communicating with the general public and political institutions and actors.

To achieve these targets, a multi-sectorial, a multi discipline structure with the capacity to harmonize and disseminate standards is needed (standardization). .Standards must be created, the Industry has to point out their customers' needs (pull-principle) and the scientists need a forum to public their results (push-principle). From these contributes, if properly managed, it will be possible to define widely accepted standard that are an essential requirements for a shared approach of the responsible development.

Moreover, a focus on the research efforts is needed. The industrial community has the expertise to highlight the specific sectoral needs of nanotechnology (Nano needs), most of which have been identified by a recent survey performed in the Nano-IAG group. Collecting the NANO needs as shown in Figure 8 (green columns) is the starting point for a strategic and organic approach.

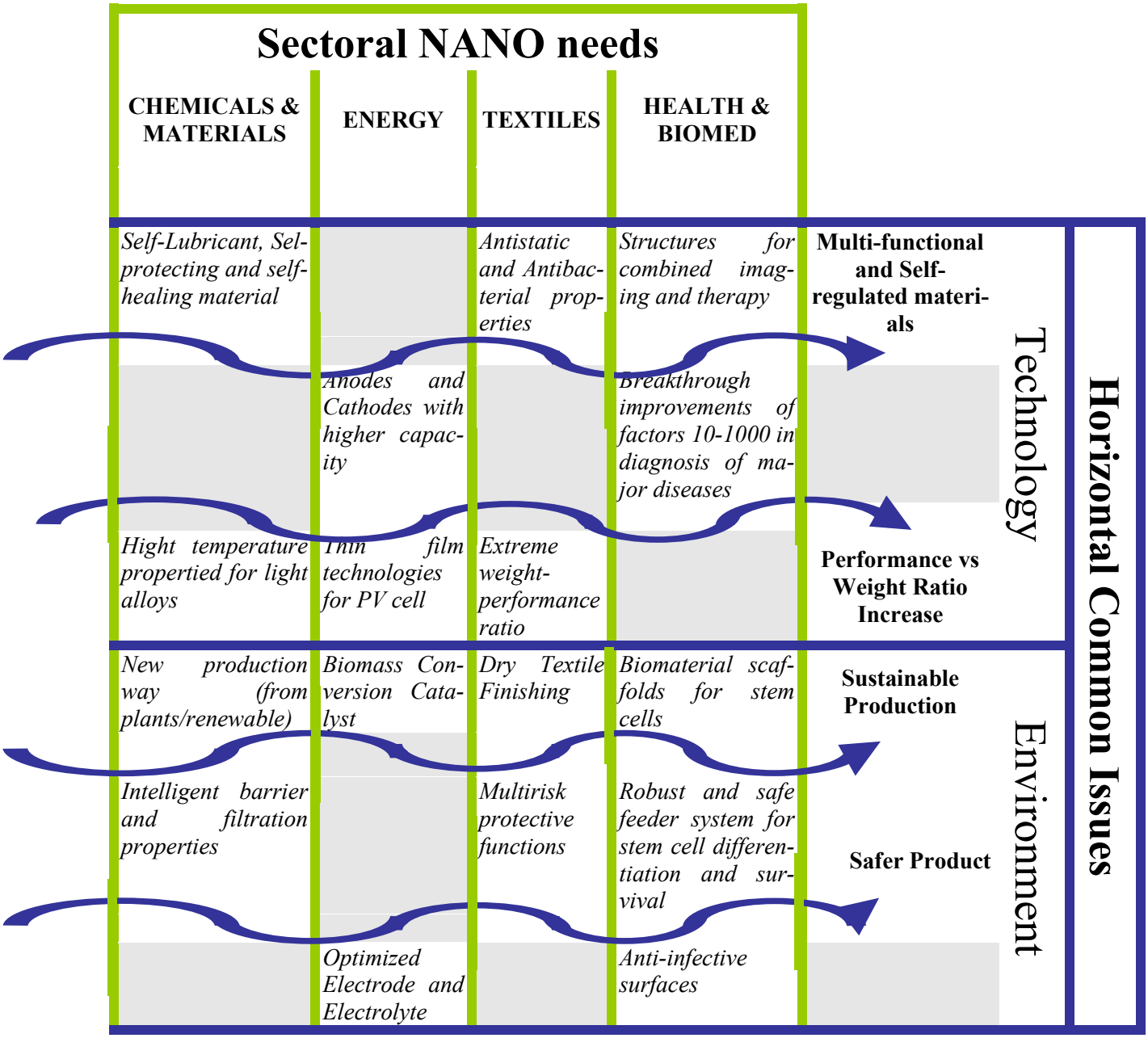

Figure 8: Example of texture made by nano needs and horizontal common issues

The second point is to recognize the horizontal issues shared by different Nano Needs. In Figure 9 some examples are given.

Horizontal common issues are:

- Environment: The worldwide trend of environmental awareness gives strict rules for new technologies. They have to be "green" i.e. environmental friendly. That means less contamination, less need for energy and more efficient use of resources than ever before.
- Technology: Find a way to solve a particular technological features, for instance an extreme light and resistant, can be an interesting topic for several industrial sector. It is more efficient, when possible, to sustain technology which are shared among several sector than niche technology.
- Methodology: The instruments to obtain quickly satisfying results have to be chosen and strengthened. Material design and modelling are an example of powerful methods that can give a response to several Nano Needs and boost the research.

- Economy: The markets have rules too. Little effort shall lead to a big outcome; the whole value chain shall be included. The product life cycle gets faster. More products have to be created within the same period of time with high quality and low costs.

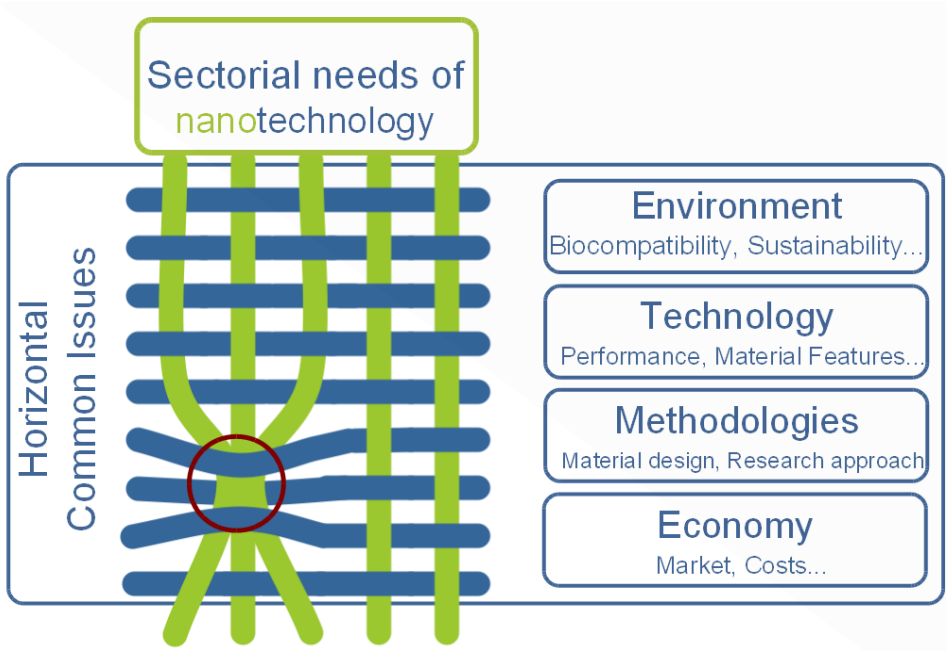

Figure 9: Key node identification on the need/common issue texture

Horizontal common issues are also represented by growth and competitiveness objectives, ETPs visions and European policies. These are many and different but equally important issues that are cross linked together with Nano Needs and are deeply interdependent constituting a single texture. On this texture it is possible to recognize the key nodes where common points of interest (needs, solution, and policies) get in contact and overlap (see Figure 9). Work on the texture means to collect and organize the knowledge from the European universities and research institutes, to gather the needs and ideas from European industries and SMEs and to address the efforts of the ETPs already active on nanotechnology. Besides, it is necessary to provide industries with knowledge of possible benefits of nanotechnology.

4.1.1 Modus Operandi: Example

A survey in the industrial and research community aimed to select and prioritise the technology requirements for each field has been performed by Lux Research.
The following list of industrial needs has been identified:

- Automotive: Battery/Energy storage; Wear resistant coating; Catalyst
- Aerospace: Structural Material; Wear resistant coating; Electrical Infrastructure
- Construction: Structural Materials
- Electronics: Thermal Management
- Medical and Pharmaceutical: In vitro diagnostics
- Oil and Gas: Down hole power; Advanced structural material

All these needs could find a potential response in nanotechnology and in particular in nanostructured materials[2] and in a new approach for their selection on the base of specific indexes as could be performance or eco design. Therefore, "nanostructured materials" it is identifiable as a key node. Focusing research activities on the nanostructured material node can act as spin-offs for many related issues belonging to different fields of application.

Identifying these key nodes is the first challenge to overcome in order to be really effective on promoting nanotechnology. To this aim, an innovative multi-sectorial and multi-disciplinary work environment, i.e. **NANO*futures* Environment,** needs to be established among the nanotechnology scientific and industrial community.
Since several existing European Technology Platforms are already operating in technology fields and sectors relevant to the Nanotechnology (i.e. NMP theme), they play an important role in establishing a new common environment. In fact although ETPs have been capable of addressing the specific needs and challenges of their technology areas effectively, issues such as broader socio-economic challenges, going beyond the technological needs, can only be tackled through a cross-platform, collaborative approach: the **NANO*futures* Environment**.

This process has been launched and is currently sustained by MINAM, the Micro and Nano Manufacturing association, with the commitment of legal wing of this initiative. Manufacturing is indeed the common step between research and products for every sector. MINAM has got a privileged point of view due to its role collecting the interest on micro- and nano- of several hundreds of manufactures from different production fields. It has also the experienced skills needed to token up NANO*futures* defining its roles and prospects. MINAM trusts on NANO*futures* as superstructure that can boost a more effective effort in nanotechnology research.

4.1.2 Comparision to Worldwide Initiatives

NANO*futures* is a multidimensional and multilevel action with a clear industry orientation:

- Multi-dimensional because it brings together different ETPs and different industries
- multi-level because it works at different levels, i.e. local, regional, countries, Europe and abroad.

Thus, the NANO*futures* approach combines best practices from governmental approach (e.g. US) with the strong industry orientation. Both features are tuned to meet the size and needs of European regions.

While the US, China and South Korea activities were in the past governmental driven, common approach is a given strategy for "be Nr. 1" including faster industrialisation success by NANO and orientation based on research centres (with very high investment volumes e.g. in US). US stated that there is an increasing need not only for cooperation between research centres and industry but also for international cooperation, e.g. with Europe. As an example, the first nano transistor pictures shown by IBM came from IBM Zürich.
China seems to have understood they need more industry involved so the strongly invites companies to come to China, build joint ventures and use research infrastructure and university teams for free.
Brazil program has a strong focus on the cooperation of industry with research, compared with the relatively small amounts of public money used the industrial results seem to prove them they are on the right way. For more details see Appendix C: Worldwide Nano .

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[2] In nanostructured metals, nanometer-sized grains provide sliding wear resistance, a low coefficient of friction, and corrosion resistance due to the small number of defects in the surface. Other nanostructured materials may comprise layers of different materials whose thickness range in the scale of hundred nanometers

5 Nanofutures

5.1 NANO*futures* as Nano-Hub

Nano*futures*, being open to a broad range of industry, SMEs, NGOs, financial institution, research institution, universities and civil society with an involvement from Member State at national and regional level, is a ready environment where all these different entities can interact and come out with a shared vision on nanotechnology future.

Due to its open configuration, NANO*futures* environment would become a European multi-sectorial, cross-ETP, integrating platform with the objective of connecting and establishing cooperation and representation of all relevant Technology Platforms that require nanotechnologies in their industrial sector and products. NANO*futures* and its operative branch MINAM association have the inspiration to act as a sort of "Nano-Hub" by linking external entities (JTIs, associations, ETPs) with its experts group under the industry driven management structure (former MINAM members) and strong operational secretariat (Figure 10).
NANO*futures* as "Nano-Hub" will contribute to enhance the commitment of industry in European Nanotechnology and in the meantime collaborate with the other ETPs for nanotechnology development in Europe.

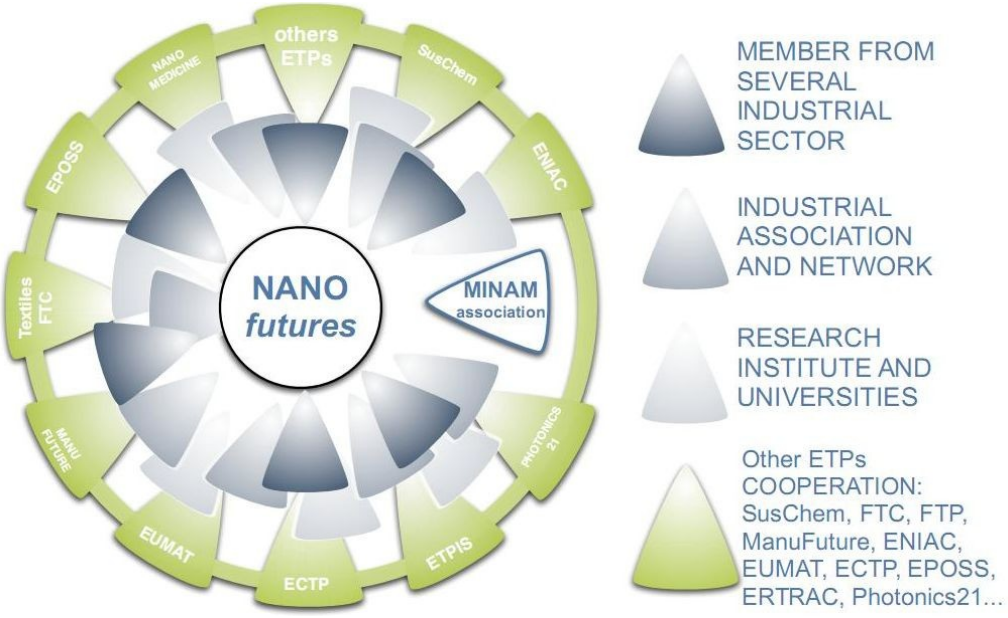


Figure 10: NANO*futures* as „Nano-Hub"structure

NANO*futures* as Nano-hub will help recognising the emerging nanotechnologies and defining a ten year horizon end-point and with a well understood mid-point in five years. For these new technologies, in the next years there will be a transition to a new industrial environment with knowledge-based nano content as evidenced also by recent markets analysis[3]:

[3] Lux Research: Nanomaterials State of the Market Q1 2009, January 2009

- In the period from 2009 to 2011, nanotechnology development will be characterised by nanotechnology entering new industries, and global economic collapse will force nanotechnology developers to aim at near- term applications.
- From 2012 to 2014, nanotechnology will start to affect the industries; it will penetrate in new ways, simplifying supply chains and making new industries.
- Beyond 2015, nanotechnology will become routine enough that the "nano" term will largely fade from view in many industries, while overall funding finally levels off.

The NANO-hub structure is the evolution of the role being played by MINAM within the N-IAG as backbone, or central core which collected and synthesized EU needs in nanotechnologies tracing the Europe's nano futures. NANO*futures* will work in close coordination with the Commission (Unit Nanoscience) within an intense program of coordination and concerted actions activities having the goal of building a Nanotechnology Action Plan for Europe for 2010-2015.

5.2 Initiative

To better follow and manage its continuous evolution towards the constitution of a work environment, NANO*futures* has to be open and flexible in order to get new inputs from any source and elaborate them in a collaborative cross-framework.

NANO*futures* will be instrumental in the industrialisation of nanotechnology by cross bridging the gap between research, technological innovation and company/market innovation aspects supporting nanotechnology industrialization to the benefit of European economy and its citizens. An important objective will be to connect and establish cooperation and representation of all relevant Technology Platforms that require nanotechnologies in their industrial sectors and products.

An important role of NANO*futures* will be also the linking and integration between nano-micro and macro technology based industries and the general manufacturing field ensuring timely provision of the at any time required state-of-the-art manufacturing technologies. To do so NANO*futures* will inevitably be dependent on foresights concerning challenges and technologies required by its "client communities". Therefore, its road mapping and development of its fields of cooperation and competence remain a continuous process, allowing for a permanent readjustment of priorities according to the requirements of the NANO*futures* environment and its related industrial areas. A multidisciplinary approach is needed to cross traditional boundaries between different fields and disciplines and forming a new methodology for understanding and decompose effectively, following the strategic approach, the shared nanotechnology challenges (key nodes).

The NANO*futures* initiative has the purpose to gather all the relevant stakeholders creating an integrating multi disciplinary and multi sectorial cross ETP having the following key success factors.

Openness
The initiative is clearly industry driven but NANO*futures* is open for any kind of stakeholders conforms to the EU given criteria. It brings together R&D-relevant stakeholders with various backgrounds (e.g. regulatory bodies at various geo-political levels, industry, public authorities, research institutes and the academic community, the financial world and civil society). Companies from all over Europe will participate which grants the most feasible efficiency and broadest knowledge base. Research institutes contribute but also profit from their commercial partners. This openness aspect ensures NANO*futures* to get connected to the policy members at every level. The work is supported by the contribution of Non-Governmental organisations and foundation members.

Transparency
NANO*futures* is an open initiative that gathers lots of people with different interest. To be effective, the platform needs to be transparent to all members and policy organs. The platform will be present in

the internet providing information about their members, activities, projects and partners plus having documents showing its further development. NANO*futures* will be present on fairs and will have a public interface to everyone through Newsletters, Mailings etc. All actions are going to be clearly assigned to specific organisational units and the connection and interaction between the units will be well described.

Accountability
This is a key topic at Nano*futures*. The clear structural assembly allows the members to define their respective self-conception and their role within Nano*futures*. Expert groups gather stakeholders concerning specific fields of interest, leaders warrant a working system. The MINAM association works as an overall coordination unit. The platform also has a mandate in helping to further mobilise private and public R&D investments.

The platform's driving forces, business needs and requirements behind the establishment are defined starting from the necessity to broaden the range of the micro systems-based products, and at the same time to multiply their capabilities by the introduction of new materials and processes.

5.3 Objectives

The main challenge is to establish a nanoscience and technology, European, multi-sectorial, cross-ETP integration Platform that will interact with the Community policies, giving through Nanotechnology a positive impact on a wide range of different sectors like industrial policy, sustainable development, economic and societal issues, regional policy etc.

Main objectives of NANO*futures* can be summarised as follows:

1. Addressing the shared need of existing ETPs for overseeing and implementing tasks of common interest, while observing the subsidiary principle
2. Contributing to the (joint) programming of European public nano-programmes, increasing cooperation and synergies between European and national funding mechanisms
3. Reducing fragmentation and increase synergies between the various European and national research and innovation activities
4. Addressing technical issues of common trans-sectorial/horizontal relevance such as safety, environment, metrology, standards etc.
5. Ensuring societal acceptance by addressing horizontal issues relating to safety and standards.
6. Communicating the potential of nanotechnology for increasing European competitiveness and sustainability simultaneously.
7. Establishing an accepted "nano-identity" with a single voice in the public debate (green nano), with the aim to overcome any reservations concerning "nano inside"
8. Increasing cooperation and synergies between the actors from the various industrial sectors, research and education communities addressing above objectives

5.4 Activities

Particular importance will have the existing ETPs because several European Technology Platforms are already operating in technology fields and sectors relevant to the Nanotechnology (i.e. NMP theme). Although the ETPs have been capable of addressing the specific needs and challenges of their technology areas effectively, issues such as broader socio-economic challenges going beyond the technological needs can only be tackled through a cross-platform, collaborative approach.

NANO*futures* will serve as a nano-hub for all relevant sectors:

- creating of synergies between the ETPs, and where appropriate, with national and/or regional programmes and platforms, ERA-NETS, and Networks of Excellence (Figure 11);

- identifying common elements between ETPs, and where appropriate, the initiatives mentioned above;
- being the driving gear for the correlated nanotechnology based initiatives
- promoting and developing joint programme of activities with the objective of meeting major challenges; e.g. clean and sustainable manufacturing, competitive and socially responsible commercialisation of nanotechnology, materials and "horizontal" technologies that will enable competitive and sustainable developments in a range of industrial sectors (ETPs).

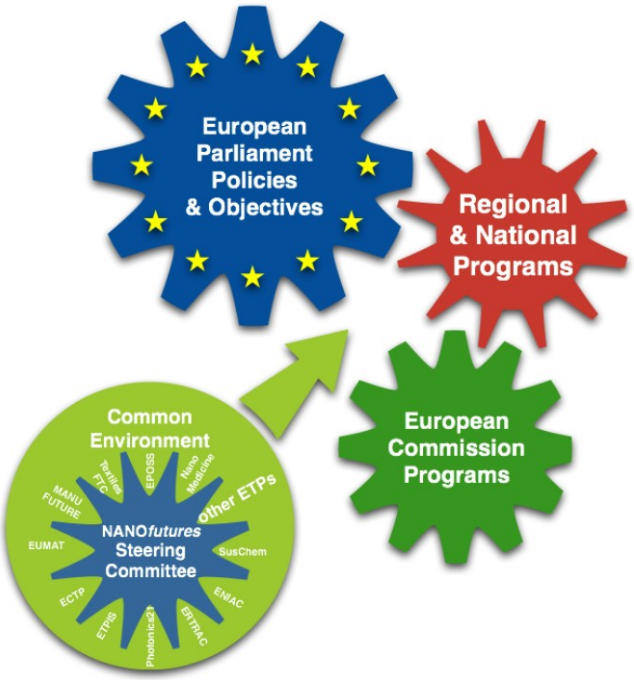


Figure 11: NANO*futures* connection diagram

In the frame of NANO*futures* specific activities aimed to launch and expand this initiative will be planned.

In particular:

1. Priority setting and contribution to individual and joint programming efforts of EU, National, regional and industry sector specific research and innovation activities.
2. Establishing commonly agreed industrial roadmaps and communicating these with the objective of having research activities aligned accordingly.
3. Identification of common generic nano-technology needs, such as design, modelling and simulation tools, metrology systems and standards, sharing of infrastructures for effective research and implementation.
4. Addressing social issues, such as safety and social acceptance, regulatory issues, standardization etc.
5. Communication and outreach activities towards.
6. public relations, online press release;
7. brokerage events open to other relevant sectors and areas
8. Involving NGO

5.5 NANO*futures* Boosting Nano Innovation

Aggressive revenue targets, shrinking product cycles, and the drive for efficiency have led large corporations to embrace open innovation - sourcing new technologies from external companies and labs- to be able to exploit technological and scientific advances. Nanotechnology's multi-disciplinary needs pose some new challenges for companies, which start to see open innovation a vital requirement rather than an interesting option.
The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (e.g. patents) from other companies or research centres. In addition, internal inventions not being used in a firm's business would find opportunities outside the company, for example through licensing, joint ventures or spin-offs. Figure 12 shows a schematic of the Open Innovation Model as defined by Henry W. Chesbrough (Berkeley University); this approach is currently adopted from leading industrial organizations as breakthrough instrument to boost results in the R&D processes.

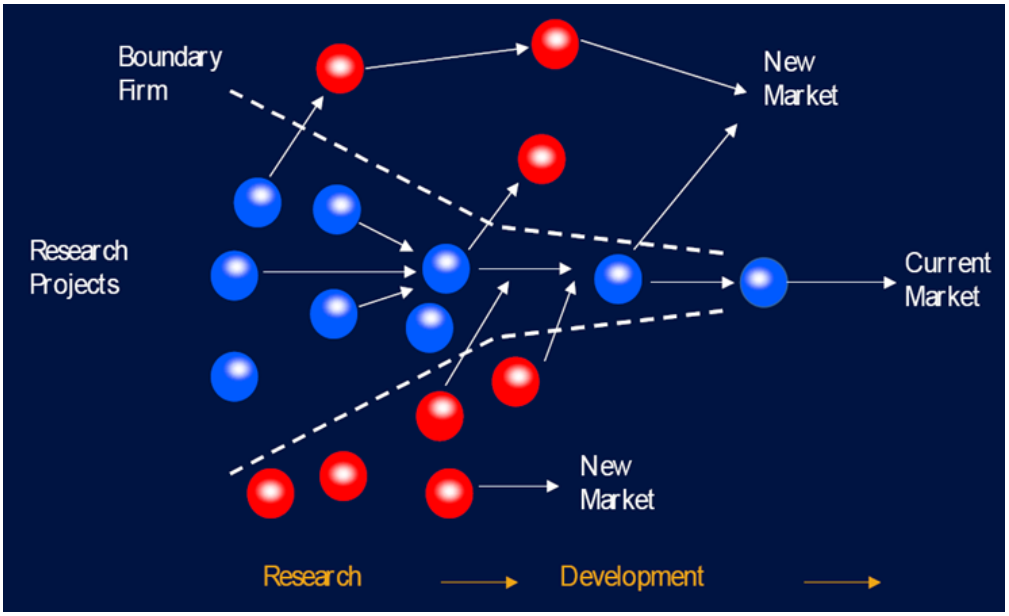


Figure 12: OPEN INNOVATION model, as defined by Henry W. Chesbrough (ref: Berkeley University)

Open innovation companies need to define and apply efficient business models to link their technical decisions regarding research and innovation to economic outcomes. The main functions of the business model are[4]:

- To articulate the value proposition, i.e. the value created for users by the offering based on the technology;
- To identify a market segment, i.e. the group of users to whom the technology is useful;
- To define the structure of the firm's value chain, which is required to create and distribute the offering;
- To specify the revenue generation mechanisms and estimate the cost structure and the target margins;
- To describe the position of the firm within the value network, linking suppliers to customers;
- To build the innovative strategy by which the company will gain and hold advantages over competitors.

[4] Chesbrough, Henry (2006) *Open Business Models: How to Thrive in the New Innovation Landscape.* Boston: Harvard Business School Press, 2006

In this contest, particular attention is paid to the IP management. In the historical model of vertically integrated research, new technologies were used mainly in the firm's core business. Other potential uses of the technology did not unfold. Under the model of open innovation, the same intellectual property can be applied to different markets. The firm creating the IP may license it to one organisation for use in one market, and other organisations for use in their respected markets.

As mentioned in paragraph 3.1, European and International Governments are developing initiatives to coordinate their nanotechnology work and move towards the application of open innovation schemes in nanotechnology. For example, the European Commission funded recently two Coordination Support Actions, namely nanoCom and proNano (name subject to change) to foster open innovation schemes and diffuse best practices including verification for commercialization of NanoTechnologies. These projects are committed to directly support NANO*futures* and will be fully integrated in the NANO*futures* platform and in its website.

Moreover, NANO*futures* will work towards an open, networked and adaptive nanotechnology innovation system by creating synergies between stakeholders from different sectors and regional, national and European and international bodies. In particular, NANO*futures* will foster nano innovation through the following steps:

- Clear identification of barriers for business growth, exploiting the different expertises of NANO*futures*' members and linking stakeholders from a broad range of sectors interested in nanotechnology. This activity will be based also on the information gathered from EC organisations, international, national and regional networks.
- Creation of a seamless link between research output and innovation needs: the activities of the working groups (paragraph 6.2.2) will enable the assessments of trans-sectorial industrial needs (Nano Needs).
- Identification of opportunities for European leadership, through market analyses and networking activities among industrial and research partners;
- Reduction of research fragmentation, by promoting and developing joint programmes of activities to address major challenges encountered by nanotechnology.
- Identification and dissemination of an agreed European innovation strategy.

The Open Innovation model adopted by NANO*futures* is innovative in comparison to a more traditional approach to innovation which is currently pursued by Technology Platforms focused on nano technologies in Japan and US, where, to our knowledge and understanding, the concept of open innovation is missing and innovation is more limited to a technology transfer process.

6 NANO*futures* Organisation (work in progress)

NOTE: NANO*futures* Organisation will be defined and discussed in details during the next meeting in Brussels (14/10/09) The present chapter is a preliminary overview of NANOfutures Organisation.

6.1 Memorandum of Understanding

A Memorandum of Understanding to plan the interaction to constitute NANO*futures* collaborative environment (having its initial backbone in MINAM platform) among the several ETPs having interest in Nanotechnology is stipulated or being stipulated by:

- SUSCHEM Sustainable Chemistry
- MANUFUTURE: Manufactoring Technology
- ENIAC: Nanoelectronics Initiative
- PHOTONICS21 Photonics
- ERTRAC: Road and Transport
- FTC: Future Textiles and Clothing
- ECTP Construction Tecnology Platform
- ETPIS Industrial Safety
- EUMAT Engineering Materials And Technologies
- FTP Forest Technology Platform

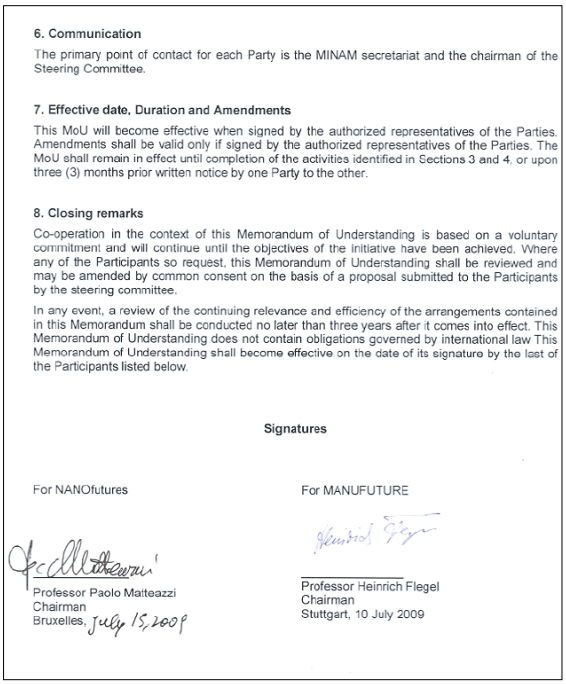
Under discussion is the participation of the following platforms:

- EPOSS Smart System Integration
- NanoMedicine Nanotechnology for Medical Application

The NANO*futures* environment will:

- Create an unique environment with the aim to select priorities for a nanotechnology futures
- Standardize a working methodology to select priorities and key nodes
- Identify common point of interest (key nodes), rising from the overlapping of Industrial needs, Nanotechnology solutions, ETPs visions and European policies
- Build up technical working groups focused on specific key nodes with defined periodical meetings.
- Enhance the capacities and key role of both platforms;
- Contribute to key policy objectives which are essential for Europe's future competitiveness
- Support EC in its Nano Action Plan and Nano policy and the ETP field together with members of other platforms and the N-IAG (Nano Industrial Advisor Group);

An example of Memorandum of Understanding stipulated and signed with SUCHEM for the NANO-*futures* is reported in Figure 13 **Fehler! Verweisquelle konnte nicht gefunden werden.**.



6. Communication

The primary point of contact for each Party is the MINAM secretariat and the chairman of the Steering Committee.

7. Effective date, Duration and Amendments

This MoU will become effective when signed by the authorized representatives of the Parties. Amendments shall be valid only if signed by the authorized representatives of the Parties. The MoU shall remain in effect until completion of the activities identified in Sections 3 and 4, or upon three (3) months prior written notice by one Party to the other.

8. Closing remarks

Co-operation in the context of this Memorandum of Understanding is based on a voluntary commitment and will continue until the objectives of the initiative have been achieved. Where any of the Participants so request, this Memorandum of Understanding shall be reviewed and may be amended by common consent on the basis of a proposal submitted to the Participants by the steering committee.

In any event, a review of the continuing relevance and efficiency of the arrangements contained in this Memorandum shall be conducted no later than three years after it comes into effect. This Memorandum of Understanding does not contain obligations governed by international law This Memorandum of Understanding shall become effective on the date of its signature by the last of the Participants listed below.

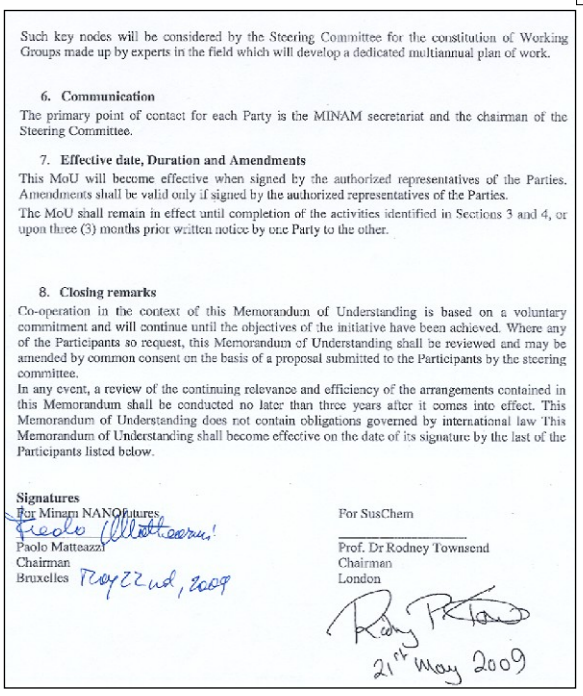
Signatures

For NANOfutures

Professor Paolo Matteazzi
Chairman
Bruxelles, July 15, 2009

For MANUFUTURE

Professor Heinrich Flegel
Chairman
Stuttgart, 10 July 2009



Such key nodes will be considered by the Steering Committee for the constitution of Working Groups made up by experts in the field which will develop a dedicated multiannual plan of work.

6. Communication

The primary point of contact for each Party is the MINAM secretariat and the chairman of the Steering Committee.

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Signatures

For Minam NANOfutures
Paolo Matteazzi
Chairman
Bruxelles 22nd May, 2009

For SusChem
Prof. Dr Rodney Townsend
Chairman
London
21st May 2009

Figure 13: MoU stipulated with SUCHEM (left) and MANUFUTURE (right)

6.2 Structure Overview

NANO*futures* is established on the basis of the shared need of existing ETPs for a "nano-hub" that will oversee issues of common interest, not sufficiently addressed under their existing activities (the subsidiarity principle will prevail).

It will therefore be organized in a different way to the existing ETPs:

1. Steering committee is composed by operational manager and a representative from each of the member ETP
2. Management will be performed in a lean structure adapted to the agreed activities
3. Members are the participating ETPs, and their individual members
4. Technical working groups are defined where existing ETPs share the need

Communication and outreach activities are fully shared with all participating ETPs where agreed as the unique voice of nano-S/T.

6.2.1 Steering Committee

One single Steering Committee, with a chairman and supported by a general secretariat, to be composed of high-level representatives of all ETP participants, will co-ordinate the joint work under this Memorandum of Understanding (Figure 14**Fehler! Verweisquelle konnte nicht gefunden werden.**).

Each participant should appoint one representative and one deputy representative to the Steering Committee and notify all other participants. The Steering Committee will meet as necessary, but at least twice a year. It should decide on its rules of procedure by unanimity.
Representatives from the involved ETPs, the private industrial sector, the social partners, other institutions, as well as experts, could be invited to its meetings as observers, when appropriate.

Figure 14: NANO*futures* environment

6.2.2 Working Technical Group

The Steering Committee will invite technical sessions, on a selected frame of needs, at least two times per year with the purpose of generating deep, cross linking horizontal thoughts between the various ETPs needs. Such sessions will involve technical representatives of the various ETPs having signed with MINAM the MoU on Nano*futures*, with at least half coming from industries. Such sessions have the goal to reveal intersectoral / interplatform key nodes in the space of nanotechnology and policy needs.
Identified key nodes will be considered by the Steering Committee for the constitution of Working Groups of experts in the field, with the objective to develop a dedicated multiannual plan of work.

6.2.3 Industry Advisory Council

6.2.4 Regional Advisory Council

6.2.5 Clusters

6.3 NANO*futures* – Manufuture Link: MINAM Association

MINAM, having its roots in MANUFUTURE and being strongly involved in the same time in the nanotechnology environment, is expected to contribute for the integration and linking of the several industrial sectors nano-needs and interests into the NANO*futures* initiative.
MINAM association is an example of already in place connection between the NANO*futures* environment and MANUFUTURE platform (Figure 15**Fehler! Verweisquelle konnte nicht gefunden werden.**). Similar links with other ETPs will be set up and activated.

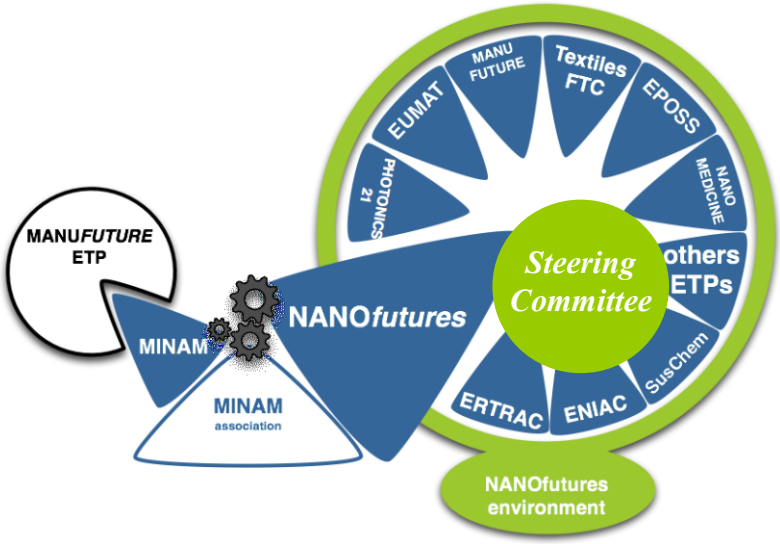


Figure 15: Example of NANO*futures* link with Manufuture

The MINAM association is a legal arm of the NANO*futures* and MINAM itself, providing entrepreneurial mindset and skills for knowledge transfer and industrial activities. It was established on November 14th 2008 in Belgium, as a non-profit organisation (ASBL - association sans but lucratif) governed by a strong industry-driven board of directors. The non-profit aspect is highly recommended by the European Commission. It enables MINAM to participate on funding programmes.
The Association is orientated to be a business network and provides a common, cohesive and unified voice on behalf of technology driven industries utilising nano- and micro-manufacturing technologies. It serves as a catalyst agency to connect, co-ordinate, facilitate, promote, educate, and unify the benefits in the area like a major economic engine.

On February 6th 2009 the founders' membership was concluded as per statue provisions.

The association main purpose is to gather industries, research institutions and any other legal body based in Europe involved or having interests in the area of nano- and micro- manufacturing. The activity of the association will be to represent the interests of its members providing an effective business network: attracting financial resources and institutional interest; creating business to business opportunities and associate these with its research members.

This will be pursued by several varied actions closely related with NANO*futures* activities such as:

- Business to business relations;

- attracting support and financial resources for a Joint Technology Initiative (JTI) or very large projects and research initiatives tailored to the needs and desires of micro- and nano- manufactures;
- advising on calls contents in EU and national research programs;
- information services to the members;
- networking and brokerage also by specific areas of interests;
- projects promotion;
- web services and public awareness;
- constituting national branches of the organization to promote national activities and attraction of financial resources;
- participating to calls of proposal for coordinated actions or similar in the framework programs.

The bodies of the association are the founders' council, the general assembly and the board as described in the statutes.

The association is seen like a legal arm of the NANO*futures* and consequently playing an important role both for the MINAM community and NANO*futures* programs as intended to be developed by EC DG RTD.

6.4 Nano*futures*: Financing Overview

Public support is foreseen through application to CSA, to cover costs from inter-ETP activities, such as the following:

1. Programming including preparation of joint roadmaps (presently by N-IAG with ETP input)
2. Relations with national, regional and other network and cluster activities:
   a. current N-HLG activities
   b. current N-IAG activities
   c. horizontal technology clusters, including safety, metrology, standards, sharing of infrastructures
3. Communication and outreach activities

6.5 Policy Group

6.5.1 Roadmapping

The development of the NANO*futures* strategic research agenda will be performend by ongoing coordinated roadmapping activities. These are aimed at providing holistic overview linking together the major driving factors, such as, applications, market requirements and technological capabilities of a highly interdisciplinary field where a lot of information on segmented aspects is available (Figure 16).

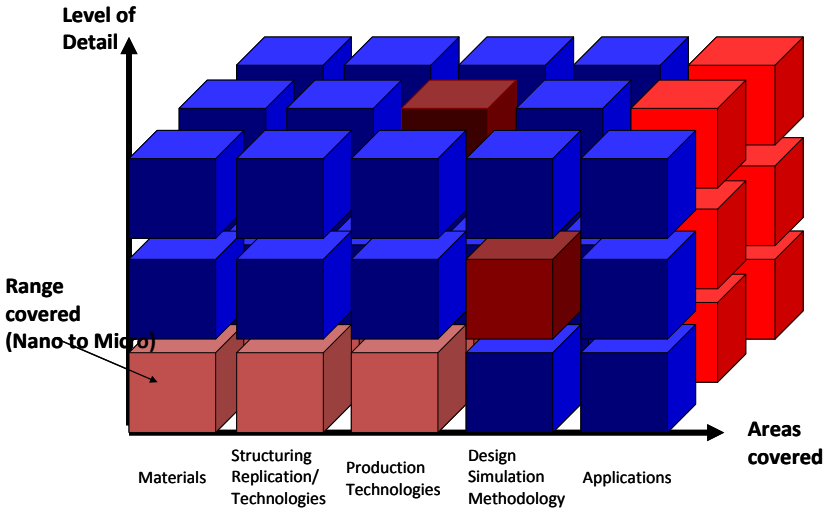


Figure 16: NANO*futures* road-mapping cube

Besides the feedback received through expert workshops, the MINAM survey 2008/2009 was the most prominent activity of the recent past. It underpins MINAM´s claim to provide substantial input for strategic decisions. More than 220 participants identified need and hurdles for more than 78 technologies in the field of Micro and Nano production. The results also showed the relevance of Nano- and Micro technologies for the further development of nano-/ micro enhanced applications. The outcome led to the identification of 11 partial roadmaps for key field of innovation in Europe. NANO*futures* roadmapping will build on the previously gained knowledge within the MINAM community and continuously analyse in detail the requirements of the European Technology Platforms related to Nano and report emerging trends to the NANO*futures* community

The outcome of this process leads to formulating a holistic view based on different roadmaps, studies, expert workshops and surveys making the partial results comparable. For NANO*futures* roadmapping a novel “meta”-methodology will be discussed to allow the combination of results from market and application driven information while focussing on technological aspects, addressing e.g. nano-techniques for production of parts and the assembly of Microsystems (Figure 17).
A comparison of information available from both, technology and application perspectives during the course of NANO*futures* roadmapping activities facilitates a more precise description of the technology-application push-pull link and facilitates the development of a common understanding of needs and barriers faced by the NANO*futures* community. It also strengthens the integration of the different positions (end-users, technologists and equipment providers) in the NANO*futures* process.

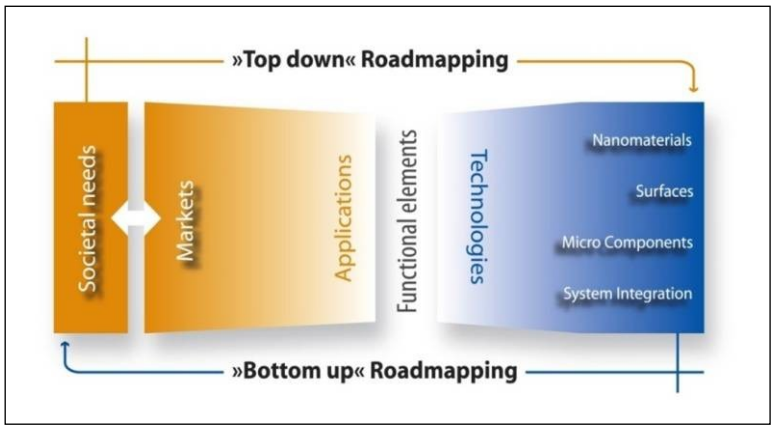


Figure 17: MINAM roadmapping methodology

With a view to creating excellence and enhancing industrial competitiveness in all areas which are of crucial relevance for the achievement of the European NANO*futures* vision, a number of activities have been initiated to identify key areas and topics on a detailed level.

6.5.2 Strategic Research Agenda (SRA)

Similar as in the Roadmapping process the Strategic research Agenda will build upon the gained experience within the Minam community. However , NANO*futures* SRA will focus on the Nano-Aspect and include the knowledge and requirements from the involved ETPs while the Minam SRA was a more direct approach focussing directly on the institutes, suppliers and OEMs. In the following the MINAM SRA is described in detail as it will be the basis for the NANO*futures* SRA.

The SRA outlines key challenges and research priorities with the objective of accelerating the development of new micro- and nano manufacturing technologies and their rapid transformation from laboratory based prototypes into volume manufacturing applications. Key objective is to identify emerging trends and provide strategic directions for future investments in R&D to accelerate the rapid transition of micro- and nano manufacturing technologies from laboratory based prototypes into volume manufacturing applications. Normally an ETP has to pass through three stages:

STAGE 1: ***Stakeholders getting together*** in order to establish their "vision" for the future development of the field concerned and to set up the technology platform;
STAGE 2: ***Stakeholders define a Strategic Research Agenda*** setting out their common views on the necessary medium to long term research, development and demonstration needs for this technology;
STAGE 3: ***Implementation of the Strategic Research Agenda*** - for which, in many instances, it is anticipated that significant public and private investments will need to be mobilized.

The research agenda considers the social impact concerning the environment, the potential benefits from exploitation of micro- and nano manufacturing technologies, the economical impact on the new speeding up markets, which call for a faster life cycle in combination with individual adapted mass products. Figure 18 shows Microsystems market per segments, to give an overview of the different industrial applications of micro and nano technologies.

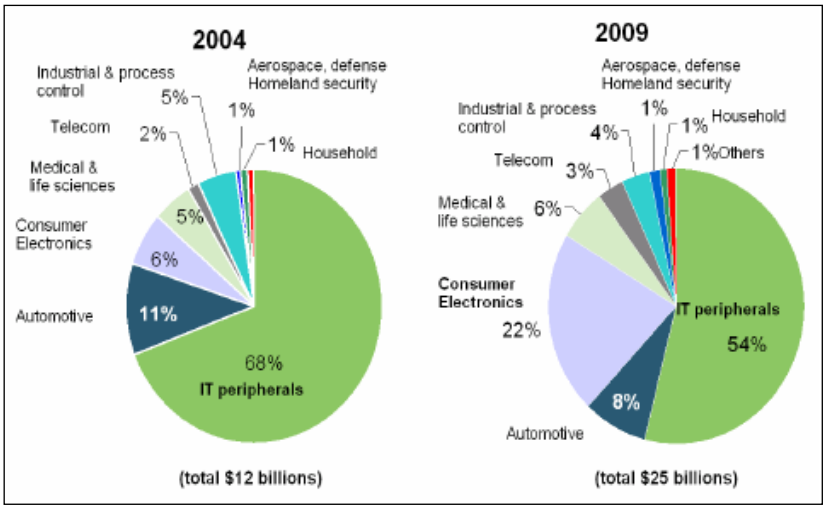


Figure 18: Microsystems market per segments; source: MINAM SRA

MINAM is dealing with four major groups of research, namely manufacturing of nano materials, manufacturing of micro and nano surfaces, manufacturing of micro components and equipment integration (Integrated micro and nano manufacturing systems and platforms). An agenda is important to share a common future perspective and build an effective plan. Figure 19 shows the expected time span in which nanotechnology impacts on society and industry.

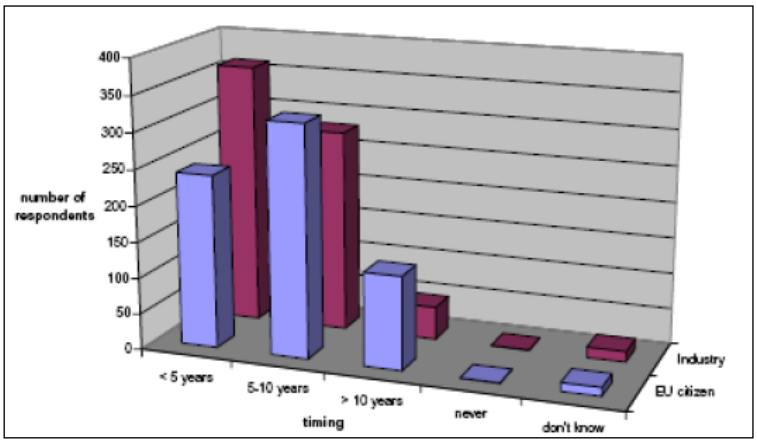


Figure 19: Expected time span in which nanotechnology will effect on society and industry

The task for NANO*futures* is now to develop a SRA. The SRA is being defined within technology platforms, which are expected to be suitable for support through the main, existing collaborative research instruments which will be maintained under FP7.

6.5.3 Vision Paper

The NANO*futures* initiative will start from previously gained knowledge within the MINAM community and produce a vsiosn paper for the NANO*futures* initiative.
The micro- and nanomanufacturing vision summarizes key points from the strategic research agenda (SRA) of the European Micro- and Nanomanufacturing technology platform MINAM. A key objective of the MINAM vision is to identify emerging trends and provide strategic directions for future investment in research and development aimed at sustaining and further enhancing the leading positions of the European industry in micro- and nanomanufacturing technologies. In particular, the MINAM vision addresses the strategic research priorities in four key areas: manufacturing of nanomaterials, processing of nanosurfaces, micromanufacturing processes and the development of integrated systems and platforms for micro- and nanomanufacturing. In the preparation of the document, members of µ-Sapient, IPMMAN and 4M worked alongside various industrial and voluntary contributors.

6.6 Public Relations

6.6.1 Website

6.6.2 Newsletter

6.6.3 Brokerage Events

7 Members and Networking

NANO*futures* is based on a broad range of industry, SMEs, NGOs, financial institutions, research institutions, universities, political parties and other elements of civil society with an involvement of Member States at national and regional level. This is done with the goal to bring together society needs under all aspects of sustainability (economics, education, environment, health, security) with dynamics of fast commercialisation in nano based solutions.

The applied networking strategy includes a fast penetration of nano interested groups all over Europe as well as the use of informal channels (e.g. social media like www.nanopaprika.eu, which accounts for 2000 members), linkedin, xing micro - nano group (> 900 members), twitter and the exploitments of structured development of the cross-sectorial NANO*futures* platform formal co-operations (with other European Technology Platforms) local and regional networks and projects, global industry associations like SEMI, local industry associations like IVAM, Veneto - nanotech, Scandinavian network and public private partnerships like www.zirp.de.

7.1 Partners

NANO*futures* partners are:

- MINAM ASBL and MINAM web portal members (see chapter 6 about NANO*futures* organisation);
- Industrial companies and research institutes active in nanoIAG;
- Prodintec. As partner in the inter - regio project “nano2market” will intensively continue to increase the database and communication with local and regional nano initiatives;
- Several former, running and recently started projects, which are committed to directly support NANO*futures* e.g. NanoCom, ProNano (name is subject to change) and will be fully inte-

grated in the NANO*futures* platform. Other projects like Nano-Device and EUMINA*fab* plan to use NANO*futures* for Dissemination & Exploitation;

- The 4M network project follower, which is a knowledge community in multi-material micro manufacture. The network acts as a knowledge resource to the research community and to industry in the development of micro system devices that provide new, enhanced, and multi functionality in tiny packages, integrating micro and nano scale features and properties into products and systems;

- Several ETPs (see MoU, paragraph 6.1) are committed to support Nano*futures*, e.g. Manufuture, SUSCHEM. Manufuture has a special collaboration with MINAM and MINAM has a chair in the high level group (HLG) of Manufuture, which will be used for also build a strong link with Nano*futures*;

- NANO*futures* and MINAM also interacts with the Enterprise Europe Network and the ERA-net initiative, both supporting sustainable joint and coordinated activities and cooperation all over Europe;

7.2 European Technology Platforms (ETPs)

As a cross sectorial platform NANO*futures* is in connection to Networks and European technology platforms in different fields. The micro and nano aspect touches nearly every technical industry. Therefore a good understanding with it is very important to define aims and common visions. The process to establish strong cooperations with selected ETPs is started (Memorandum of Understanding in section.

Examples for ETPs, NANO*futures* is connected to:

- EuMaT, deals with advanced engineering materials and technologies.
- ARTEMIS, specialised in embedded computing systems.
- ENIAC , the European nano electronics initiative.
- ESTP , the European space technology platform.
- EPoSS, the European technology platform on integration of smart systems.
- FTC, deals with textiles and clothing.
- HFP , for Hydrogen and Fuel Cell.

And many more, overall 20 ETPs, which share contacts with MINAM.

7.3 Regional Networking

NANO*futures* initiative intends to address actively the involvement of European regions in order to achieve a full spread of research and development policies in the field of nanotechnologies. This is one of the key issues within the regional working group of the platform, which will have, as main goal, to coordinate the activities of stakeholders at regional and national level. This should align financial institutions, industry, research institutions and universities and civil society with NANO*futures* objectives even though the strategies for each of them should be different.

This idea is particularly supported by the already on-going activities of regional governments which have developed mechanisms to promote interaction and collaboration between different agents. One clear example is the creation of numerous industrial clusters or networks of knowledge at regional and

national level (see Appendix A). Their intention has been to create an environment that stimulates innovation and to provide firms with the incentive to perform R&D and innovative activities at trans-national level in nanotechnology. These initiatives justify the importance of having a clear strategy for regional/national coordination within Nano*futures,* which should have as main target to overcome the main hurdles to transfer European policies and activities in nanotechnology to the interest groups (Figure 20).This task should be done in an adaptable manner and according to the particular needs of each region.

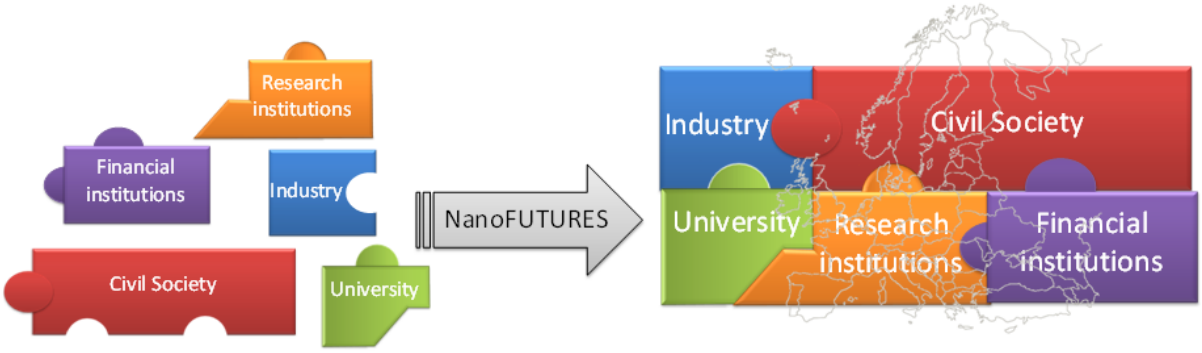


Figure 20 Schematic of the main objective of regional/national working groups

Based on this background, the regional working group of NANO*futures* will carry out the following main activities:

- Coordination of *regional/national industrial activities* (e.g. innovative clusters) to align them with NANO*futures* goals. This coordination might be implemented via the already identified regional industrial clusters and associations (see Appendix A). Main mechanisms will be the promotion and dissemination to stakeholders of NANO*futures* initiatives. For instance, this can be articulated by:

    i. Organization of international technology transfer events in different strategic locations of Europe where stakeholders can be aware of the last developments in nanotechnology field and of potential applications in lead markets. Promotion of face-to-face meetings between policy makers, researchers and industrialists for knowledge transfer.
    ii. Exchange and dissemination of good practises between regional clusters and associations.
    iii. Promotion of collaborative projects between stakeholders from different regions. This activity should be strongly linked with the NANO*futures* influence on regional financial institutions since they should run mechanism to pave the way for joint projects creating an innovation-friendly environment.
    iv. Promotion of training courses describing nanotechnology industrial applications particularly addressed to SMEs.

- Influence on *development agencies and financial organisms* responsible for the development and implementation of innovation policies at regional and national level. This task will be carried out via collaboration with European initiatives to promote networking of national/regional funding and innovation organisms (e.g. PRO-INNO EUROPE http://www.proinno-europe.eu).

- Promotion of basic knowledge exchange between researchers from *Universities and Research Centres* in different regions and support for technology transfer to the industry.

- Foster a cultural shift which celebrates innovation including promoting dissemination activities addressed to *civil society*. The aim is to increase the regional/national media coverage (newspapers, TV, radio, etc) on nanotechnologies. This task will be carried out in close collaboration with the NANO*futures* public relations group.

In order to fulfil the objective, NANO*futures* intends to establish a robust network of agents involved in R&D and innovation activities. Some of these agents have been already identified:

- High Level Group of European Technology Platforms (ETPs). Some of them are already mentioned in Chapter 2. Special attention will be paid to the establishment of a strong liaison with their regional/national working groups.

- Industrial regional/national clusters. Main clusters have already been identified (see Appendix 2). Particular effort will be also made to establish good coordination with other on-going European initiatives such as *The European Cluster Alliance* (http://www.proinno-europe.eu). This is an open platform that was established to maintain a permanent policy dialogue at EU level among national and regional public authorities responsible for developing cluster policies and managing cluster programmes in their countries. The Enterprise Europe Network is also expected to play a key role (http://www.enterprise-europe-netwok.ec.europa.eu). This network offers support and advice to businesses across Europe involving close to 600 partner organisations in more than 40 countries. In the same sense, the *European Cluster Observatory* (http://www.clusterobservatory.eu) should be a valuable information source to establish a solid network of industrial clusters at regional level.

- Regional/National financial institutions and Economic Development Agencies. Aside from the contacts of members of NANO*futures* in their respective countries, the regional working group intends to use additional channels in order to reach as many as possible stakeholders. Thus, it is worth to note the initiative *Pro Inno Europe* (http://www.proinno-europe.eu) from the Directorate General Enterprises and Industry. Special attention will be paid to their branch focused on "Policy Development" since they include the *Inno-Nets* programme (for linking industry, research and cluster policy cooperation, etc.) and *Inno-Actions* (for technology transfer in clusters, promotion of an innovative society, etc).

- Universities and Research Institutions. Common standard channels (e.g. ETPs, MINAM, EU projects, etc.) where these institutions are visibly involved, will be used. Moreover, several networks indexed in Appendix 2 also involved main Universities and research centers in their board (e.g. NanoSpain) and, hence, they should be utilized in order to attract the interest of researchers.

7.4 Projects

All partners of MINAM ASBL association as well as the most partners active in MINAM online platform are involved in a lot of national and international projects. An overview about the national projects can be seen in Figure 21. For each of the nine countries there are many projects MINAM members are involved in.

Figure 21: national projects structure; Source: MINAM web page

Additional projects are motivated and done in cooperation with the European research initiative **Eureka**, an open framework program with application oriented approach. Its main principle is the "bottom-up"-method, which provides the highest degree of freedom for the participating members.

7.5 Events

Beneath periodical OSG and IMG meetings, MINAM organises several events all over Europe, such as the last years international trade fair MINAT, the yearly held Euro-Nano-forum or yearly international conference on micro and nano engineering or the Nanotech, which is Europe's largest annual nanotechnology conference and exhibition. Those announcements are given on the web page and in the newsletters (Figure 22).

Figure 22: extract from the MINAM-web page-announcements

7.6 Integrating Services for Nano and Micro Community

NANO*futures* aims to integrate several services regarding business opportunities for nano-technology companies. This will strengthen the platform and attract industry stakeholders. E.g. the project ProNano (Name is going to be changed) will offer services to consult companies in the commercialisation of nanotechnology research. Another service will be the improvement of communication and dialogue between Research and Industry in the nano-sector implemented by the new projects NanoCom.

Appendix A: Regional Networks

FUNDACIÓN PRODINTEC
Centro Tecnológico para el Diseño y la Producción Industrial de Asturias

INTERNATIONAL MEETING OF THE MICRO- AND NANOMANUFACTURING EUROPEAN TECHNOLOGY PLATFORM (MINAM) (14-16 JUNE 2010 (to be confirmed)).

PLACE: GIJÓN (ASTURIAS, SPAIN)

OBJECTIVE

The main objective of this initiative is to have an international technology transfer event on micro and nanomanufacturing to allow industrial companies to extend their knowledge on the latest developments, new applications and possible new markets directly from experts on the topic. Therefore, the event will have a strong industrial involvement paying spetial attention to bring value to outcomes obtained from R&D Projects. Participants will have the opportunity to extend their knowledge on these topics and to establish new collaborations with companies and research centers working in the field with a view of creating business opportunities that take advantage of this exciting area of technology.

ORGANIZERS

The Management Board of the European Platform MINAM along with the Regional Government of Asturias (Spain) and the Spanish Technology Center PRODINTEC will host an international technology transfer event on the fields of micro and nanotechnology. This initiative is fully support from both the Regional and National Government of Spain (Ministry of Science and Innovation) and it will be included in the official calendar of activities held during the European Presidency in Spain (1st semester of 2010).

PARTICIPANTS (Who Should Attend)

-**Industrial companies**: that are currently applying micro - and nanotechnologies in their manufacturing processes and / or products or to companies that have interest and curiosity to know from the first hand the new developments that could enable them to find applications in their field of performance and to find new business opportunities or market niches.

Industrial Clusters: interested in establishing new lines of collaboration with their European counterparts

-**Research Centers and Universities**: have interest to show their research results, new developments, etc., that could be used and exploited by industrial companies.

-**Economic Development Agencies**: Interested in obtaining information of the state of the art in topics of micro- and nanotechnologies that could concern the definition of R &D policies

-**European Commission and National Contact Points**

REGIONAL/LOCAL

-Nanogalicia: Spanish network on nanomedicine

WEB	www.nanogalicia.net
Nº MEMBERS / Management	Research Group
Coordinator	No information available
SUPPORT	No information available
Country	Spain

- CTA: Andalucia Technological Corporation

WEB	www.corporaciontecnologica.com
Nº MEMBERS / Management	46 asociated companies
Coordinator	Javier Cañizares
SUPPORT	Board of trustees (public and private companies)
Country	Spain

- Free State of Saxony/Silicon Saxony

WEB	www.hermsdorfer.de
Nº MEMBERS / Management	Industrial Members
Coordinator/Contact	Thomas Hermsdorfer
SUPPORT	Regional Government
Country	Germany

- Piemonte Regional Network

WEB	www.regione.piemonte.it
Nº MEMBERS / Management	Regional Government
Coordinator/Contact	Mr. Andrea Bairati
SUPPORT	Regional Government
Country	Germany

NATIONAL

- NanoSpain: Spanish Nanotechnology network

WEB	www.nanospain.org
Nº MEMBERS / Management	273 (Industry, University and government)
Coordinator	Antonio CORREIA (Phantoms Foundation) antonio@phantomsnet.net Fernando BRIONES (CNM-CSIC) briones@imm.cnm.csic.es
SUPPORT	Co-Funded with public support
Country	Spain

- Ibernam: Spanish network in Microsystems and Nanotechnologies

WEB	www.ibernam.net
Nº MEMBERS / Management	>20 members
Coordinator	F.Javier Gutiérrez Monreal Instituto de Física Aplicada –CSIC
SUPPORT	No information available
Country	Spain

- Genesis Red: Spanish Technology platform on Nanoelectronics and integration of intelligent systems

WEB	www.genesisred.net
Nº MEMBERS / Management	40 (Industry, University. Technology centers government)
Coordinator	No information available
SUPPORT	Government support
Country	Spain

- **Prometeo:** Spanish Technology platform on Embedded systems

WEB	www.prometeo-office.org
Nº MEMBERS / Management	18 (University. Technology centers)
Coordinator	No information available
SUPPORT	Government support
Country	Spain

- **Nanomed**: Spanish Technology platform on Nanomedicins

WEB	www.nanomedspain.net
Nº MEMBERS / Management	No information available
Coordinator	No information available
SUPPORT	No information available
Country	Spain

EUROPEAN

- **Enterprise Europe Network:**

WEB	http://www.enterprise-europe-network.ec.europa.eu/
Nº MEMBERS / Management	600 Local Partners/3000 experienced staff
Coordinator	Anastasia G. Constantinou
SUPPORT	No information available
Country	European Commission

- **INA:** Irish Nanotechnology Association

WEB	http://nanotechireland.com/
Nº MEMBERS / Management	No information available
Coordinator	No information available
SUPPORT	No information available
Country	Ireland

- **Norwegian Nanomedicine network:** includes a number of companies, hospitals, universities and non-university research institutions

WEB	http://www.sintef.no/Projectweb/Nanomedicine/
Nº MEMBERS / Management	27
Coordinator	Sintef
SUPPORT	Industrial Sponsors
Country	Norway

- **Nanomednet**: UK nanotechnology and regenerative medicine network

WEB	http://www.nano.org.uk/nanomednet/
Nº MEMBERS / Management	No information available
Coordinator	No information available
SUPPORT	Inicitives from the US Government from the public sector, and Philips Healthcare, Siemens Medical Solutions, GE Healthcare, Astra-Zeneca and GlaxoSmithKline from the private sector.
Country	United Kingdom

- **FMNT:** Finnish Micro & Nano Technology Network

WEB	http://www.fmnt.fi/
Nº MEMBERS / Management	113 companies and 13University and Research Organisation,
Coordinator	Centre of Expertise for Micro & Nanosystems and Adaptive Materials
SUPPORT	No information available
Country	Finland

- **BioNanoNet**: Austrian bionanotechnology network involving companies, university and non-university research institutions

-WEB	http://www.bionanonet.com/englisch/index_en.html
Nº MEMBERS / Manage-ment	7 companies, 7 university research institutions and 2 non-university research institutions
Coordinator	Dr. Frank Sinner and Dr. Fritz Andreae
SUPPORT	No information available
Country	Austria

- **NANONET Styria**: Austrian nanotechnology network

WEB	http://www.nanonet.at/english/index.php
Nº MEMBERS / Management	numerous expert partners from the worlds of business, science and politics have joined NANONET-Styria.
Coordinator	No information available
SUPPORT	Zukunftsfonds Steiermark and Ministry of Economy and Labour
Country	Austria

- **PORTUGALNANO:** Portuguese Nanotechnology Network

WEB	http://www.portugalnano.net/
Nº MEMBERS / Management	193 persons of 43 different institutions
Coordinator	No information available
SUPPORT	Government support
Country	Portugal

- **NANONETZ BAYERN E.V**:

WEB	http://www.nanoinitiative-bayern.de/nanonetz.php
Nº MEMBERS / Management	No information available
Coordinator	Chairman: Prof. Dr. Alfred Forchel info@nanoinitiative-bayern.de
SUPPORT	?
Country	Gerbrunn, Germany

- **CC-NanoChem**: German network for innovative materials on the basis of chemical nanotechnology.

WEB	http://www.cc-nanochem.de/
Nº MEMBERS / Management	12 Industries and 8 Universities and Research Centers
Coordinator	No information available
SUPPORT	No information available
Country	Saarbrücken, Germany

- **NANOBIONET**: German network of universities, research institutes, hospitals, and private companies from the fields of technology transfer, business, and finances.

WEB	http://www.nanobionet.de/eng.htm
Nº MEMBERS / Management	40 Industries and 6 Universities and Research Centers
Coordinator	No information available
SUPPORT	No information available
Country	Saarbrücken, Germany

- **NANOMAT**: shared-interest network of nanotechnology.

WEB	www.nanomat.de
Nº MEMBERS / Management	29 member companies and research institutions Managing office at the Institute for Nanotechnology at the Forschungszentrum Karlsruhe
Coordinator	Dr. Regine Hedderich Phone: +49 7247 82-2630 Fax: +49 7247 82-6420 E-Mail: regine.hedderich@int.fzk.de
SUPPORT	No information available
Country	Karlsruhe, Baden Wurtenberg, Germany

- ESTONIAN NANOTECHNOLOGY Competence Center: Estonian Consortium of industrial and science partners

WEB	http://encc.com/
Nº MEMBERS / Management	7 industrial and science partners
Coordinator	No information available
SUPPORT	Funding: The Enterprise Estonia
Country	Estonia

-**Veneto Nanotech**: Italian network.

WEB	www.venetonanotech.it
Nº MEMBERS / Management	8 Public Institutions, 8 Universities and Research Centers, 19 Industrial and Commercial Organisations and 2 Metadistricts
Coordinator	No information available
SUPPORT	No information available
Country	Padova, Italy

-**Plastipolis**: Plastic Industry Competitiveness Cluster. More than 200 members: 150 companies (90% SMEs). R&D projects in micro and nano.

WEB	www.plastipolis.fr
Nº MEMBERS / Management	Management: 6 R&D centres, 3 Formation Centers , 12 Industries Monsieur Daniel GOUJON , 7 institutions and Scientific Committee president Office: 2 R&D centres, 5 Industries, 2 institutions and Scientific Committee president
Coordinator	Paul Deguerry paul.deguerry@plastipolis
SUPPORT	12 sponsoring partners
Country	France

- Interdisciplinary Nanoscience Center (iNANO): founded in January 2002 at the University of Aarhus, Denmark.

WEB	http://www.inano.au.dk/
Nº MEMBERS / Management	**Board:** Hans Jørgen Pedersen Charlotte Poulsen Ole Jensen Bjerne Clausen Ove Poulsen Erik Meineche Schmidt Søren Mogensen Frede Blaabjerg **Director:** Flemming Besenbacher
Coordinator	Flemming Besenbacher fbe@inano.dk (+45) 8942 3604
SUPPORT	63 industrial partners
Country	Denmark

1. **Involving research groups only:**

- RO-NANOMED: *Romanian Nanomedicine network, i*ntegrated research network *in the field of* nanobiotechnology for health

WEB	http://www.imt.ro/ro-nanomed/en/index.htm
Nº MEMBERS / Management	13
Coordinator	National Institute for R&D in Microtechnologies (IMT-Bucharest)
SUPPORT	No information available
Country	Romania

- NANOMAT: French National network for the study of functional nanomaterials

WEB	http://nanomat.u-strasbg.fr
Nº MEMBERS / Management	network is funded by the French programme on nanosciences, involving the French Ministry of Research, CNRS and CEA
Coordinator	No information available
SUPPORT	No information available
Country	France

- Fundation Nanonet: Considering current education, economic development in 2006 and the need of raising the standards of life, Nanonet created a portal, NanoNet.pl, an independent, non profit and non governmental portal-fundation aiming to serve everyone who is interested in nanotechnologies

WEB	www.nanonet.pl
Nº MEMBERS / Management	20 members
Coordinator	Jacek Doskocz ul. Stabłowicka 147/149 54-066 Wrocław (Poland)
SUPPORT	No information available
Country	Poland

- Nanonet Greece: Thematic Research Network, with three different clusters: Nanotechnology in Energy&Environment, Nanometrology&Tools at Nanoscale and Computacional Modelling at the Nanoscale

WEB	www.nanonet.gr
Nº MEMBERS / Management	20 members
Coordinator	Professor Stergios Logothetidis Aristotle University of Thessaloniki, Physics Department 541 24 Thessaloniki (Greece)
SUPPORT	Postgraduate Program "NanoSciences&Nanotechonologies" Lab for Thin Films Nanosys-tems&Nanometrology Research Committee of Auth
Country	Greece

- Centre for Research & Technology Hellas (CERTH): has been involved in a large number of collaborative R&D projects in the areas of energy, environment, advanced functional materials, informatics, multimedia and internet technologies, e-commerce, bio-informatics, transportation, agrobiotechnology, etc.

WEB	http://www.certh.gr/root.en.aspx
Nº MEMBERS / Management	no information available
Director	Professor Costas Kiparissides cypress@certh.gr 6th Klm. Charilaou - Thermi Road P.O. BOX 60361 GR - 570 01 Thermi, Thessaloniki
SUPPORT	no information available
Country	Greece

- Nanovalley: cooperation of businesses, institutions and research laboratories in the area of nanotechnology situated along the Rhine or close-by.

WEB	http://www.nanovalley.eu/
Nº MEMBERS / Management	No information available
Coordinator	Dr. Sven Dierig (sven.dierig@int.fzk.de)
SUPPORT	No information available
Country	Germany

- Bayern Innovativ, publicly held company initiated by the Bavarian State Government, is a centre for technology transfer and management of cooperation networks

WEB	http://www.bayern-innovativ.de/
Nº MEMBERS / Management	57 members. Chief Executive: Prof. Dr.-Ing. habil. Josef Nassauer
Coordinator	No information available
SUPPORT	Financed by the privatisation revenues generated by the Bavarian State Government
Country	Germany

- IVAM: international association of companies and institutes in the field of microtechnology, nanotechnology and advanced materials

WEB	http://www.ivam.de/
Nº MEMBERS / Management	279 companies and institutes
Coordinator	Dr. Christine Neuy cn@ivam.de
SUPPORT	No information available
Country	Germany

MULTINATIONAL/GLOBAL

- Phamtoms Foundation: European Foundation to foster European excellence and enhance collaborations in nanotechnology

WEB	www.phantomsnet.org
Nº MEMBERS / Management	No information available
Coordinator	No information available
SUPPORT	No information available
Country	Europe

- **Nano2Life**: European Network of Excellence in nanobiotechnology

WEB	http://www.nano2life.org/
Nº MEMBERS / Management	23 major European organizations within the field of nanobiotechnology.
Coordinator	Contact Patrick Boisseau CEA-Leti Grenoble, France
SUPPORT	6th Framework Programme
Country	Europe

❖ NANOTECHNOLOGY INITIATIVES

GERMANY
-Cluster Nanotechnologie: http://www.nanoinitiative-bayern.de
SWITZERLAND
-Nanocluster Bodensee: http://www.ncb.ch/en/index.html
AUSTRIA
-Austrian nano Initiative: multi-annual funding programme for Nanoscale Sciences and Nanotechnologies. http://www.nanoinitiative.at/evo/web/nano/390_EN.4F52583911351
ITALY
-NANOTEC IT: http://www.nanotec.it/eng/index_eng.html

THE NETHERLANDS
http://www.onderzoekinformatie.nl/en/oi/nod/clastech/d14/C60000/

- **NANOTECHNOLOGY WEB PORTALS**

-NANOWERK: nanotechnology and nanosciences portal http://www.nanowerk.com

POLAND

-Nanonet.pl: Nanotechnology & Nanoscience & Nanoengineering http://www.nanonet.pl/

Others

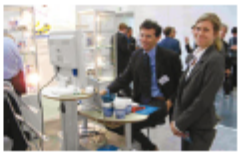
-**DSP Valley**: German Technology network for embedded systems. More than 30 companies.

WEB	www.dspvalley.com
Nº MEMBERS / Management	36 Companies, 17 R&D Organisations, Universities and High Schools and 8 Associated menbers
Coordinator	
SUPPORT	Pladers investment & Teade and IWT
Country	Belgium / Netherlands

Appendix B: Latest MNT Newsletter

MNT roadmapping: results of the survey

Report from MINAM at the MiNaT 2008



MINAM Micro- and NanoManufacturing

MNT FUTURE VISION

Mapping the future of Micro and Nano Manufacturing in Europe

February 2009

A bulletin produced by MicroSapient with contributions by IPMMAN and MINAM

MINAM'S NEXT CHALLENGE: PREPARING FOR A $2.6 TRILLION GLOBAL MARKET

Micro- and nanotechnologies have the potential to create economic growth in every geographical area of Europe and among almost every industry sector leading to new product innovations, new companies and new jobs. Over the next 10 to 20 years, projections anticipate that micro- and nanotechnologies will change almost every product on the market today and result in an estimated $2.6 trillion global market.

Launched as a working group for micro- and nanomanufacturing, MINAM developed very fast with the help of the supporting partners 4m, Ipmman, MicroSapient, Euspen, IPA, VDMA, the operational support groups and the members of the MINAM industrial board into a very active community.

Surveys and industry workshops were organised to get a clear picture about state of the art and understand needs for future research and its industrial implementation. Results were presented into the Strategic Research Agenda and the Vision Paper, both published on the MINAM website (http://micronanomanufacturing.eu). Two brokerage events attracted industry and academic research and contributed to the creation of successful teams for FP7 funded research projects.

The MINAM community today counts around 600 members from 36 countries with a strong industry involvement. MINAM and its members cooperate in ongoing research projects, local and regional networks and platforms like Manufuture, ENIAC, SusChem, Photonics21. MINAM has a strong presence at events like Euronanoforum, MiNAT and Manufuture.

The MINAM Association was recently founded as a legal entity with the objective to further strengthen the influence of MINAM, including developing MINAM as a European Technology Platform. Founders are Umicore Belgium, ASM Netherlands, MBN Nanomaterialia Italy, microelectronica Romania, microTEC Germany, Fraunhofer IPA Germany, Obducat Sweden and supported by Euspen.

The goal of this association is to be an active partner in the development of the European Research Area and the industrialisation of the emerging micro- and nanomanufacturing technologies. This will be done through active co-operation with industries, research organisations, regional, national agencies and the European Commission., in a joint effort to identify industry needs for the orientation of future European, national and regional research and innovation activities.

INSIDE THIS ISSUE!

If you would like to learn more about MINAM and become a MINAM member, please contact Dr. Jalba on jaliv@jaclyn.ro or Prof. Matteazzi on matteazzi@mbn.it.

You can also download the statute and other information from the MINAM web member area at www.minamwebportal.eu.

Results of the online survey for MNT roadmapping

The MINAM Survey 2008/2009 ended mid February with a respectable number of participants out of the MINAM community. More than 220 participants out of 28 countries expressed their interests. This is even more remarkable, as more than 60% of the feedback came from industry or industrial groups. This significant industrial feedback underpins the evident interest of Europeans industry to express their ideas through a European (Sub-) Technology Platform in the field of Micro Nano Manufacturing.

Furthermore a first evaluation of the survey results approved, that the MINAM community meanwhile covers a broad, representative range of production technologies for key application fields (Figure 1)

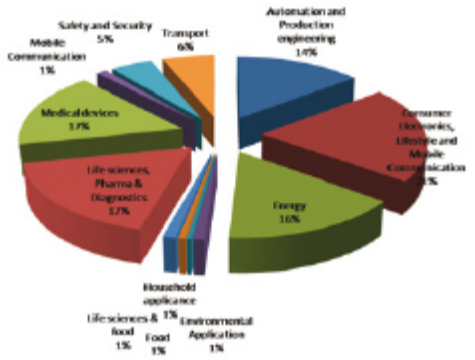


Figure 1: Distribution of Application Fields

The balanced distribution of corresponding production technologies being identified (Figure 2) also shows that meanwhile the MINAM platform is a true representative for both, the Micro and Nano manufacturing community.

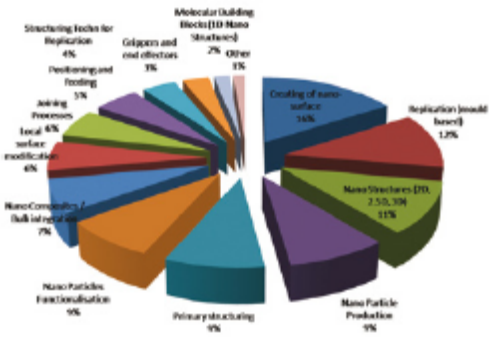


Figure 2: Distribution of Technologies

The collection of information was carried out in accordance to the MINAM roadmapping philosophy to identify relationships between application, functional elements and technologies. The huge attendance of the survey participants to support this approach (several thousands of data sets) now will enable the MINAM roadmapping team to pin down a more differentiated picture of what MINAM industry and R&D institutions have identified as to be worth working on within the next five to seven years. In the survey analysis functional elements and applications for each technology sector and also the results of our technology assessment will be elaborated by the MINAM roadmapping team.

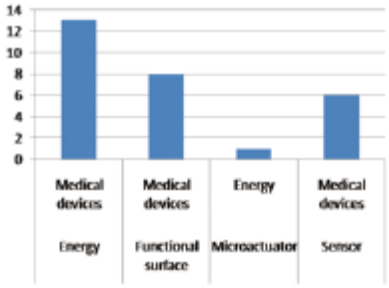


Figure 3: Key Application Fields and Functional Elements for "Creating of Nano Surfaces"

As a first outlook to this detailed evaluation figure 3 shows in a condensed manner for the "Creating of nano surface" technology section key application fields (row 1) and corresponding functional elements (row 2). In addition to this in-depth evaluation the MINAM roadmapping team will provide a summary to the technology assessment and a short report for each industrial sector. The results will be presented in an update of the MINAM roadmap and the MINAM SRA end of March 2009.

Industries discussed new trends in Micro- and Nano Technologies

Report from the participation of MINAM at the MiNaT 2008

MiNaT, the international trade fair for precision mechanics and ultra-precision, micro- and nanotechnologies, took place at the new trade fair in Stuttgart in October 2008. MiNaT gave a comprehensive overview of innovative developments in Micro- and NanoManufacturing. Renowned experts from industry and science discussed at the accompanying congress MiNaT Hot Spots Industry – Science Dialogue key aspects of micro and nano technologies in different fields like new applications and products in precision, ultraprecision, micro handling and laser; energy systems like micro fuel cells; new production technologies and new high-tech ideas for spin-offs.

During the opening ceremony of the MiNaT trade fair, Hans Hartmann Pedersen, representative of the European Commission (Directorate-General for Research and Directorate G Industrial Technologies) emphasized the relevance of research and innovation in manufacturing in general and in micro- and nano technologies in particular, in order to achieve the vision of future manufacturing industry in Europe.

MINAM joint booth

For the first time, partners from industry and research presented their current European and National research and development results at a joint booth. MINAM exposed their ongoing activities: new functionalities of the MINAM web platform, survey function with a computer-based questionnaire for experts and brokerage activities.

Active industrial members of MINAM like efm-systems GmbH, PROFACTOR GmbH, and MBN Nanomaterialia SpA exhibited successfully their expertise, typical products as well as their involvement and engagement in the community of MINAM. An outlook on future EC-funded projects like EUMINAFab - Integrating European research infrastructures for micro-nano fabrication – was also given.

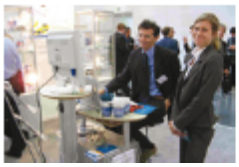
Twelve German joint research projects with more than 90 partners presented their work entitled "Production Research for Micro- and Nanotechnologies" funded by the German Federal Ministry of Education and Research at the joint booth.

Congress MiNaT Hot Spots Industry –Science Dialogue

Representatives from industry and science discussed new trends in micro- and nanotechnologies at the congress MiNaT Hot Spots Industry –Science Dialogue.

MINAM organised an industrial session part of the MiNaT Hot Spots with well-known European experts from industry and research. Fraunhofer IPA presented the activities of the European Technology Platform MINAM. Bosch presented their way from Micro-Electro-Mechanical Systems (MEMS) to smart system integration and FIAT gave an overview of the various opportunities for sustainable mobility.

The dialogue was also nano oriented, with MBN Nanomaterialia SpA discussing their ideas about manufacturing of nanomaterials for tailored micro/macro products. IonBond Ltd emphasized the needs for and status of standardization for nano technologies and BASF SE presented their integrated process technology for multifunctional nanomaterials.



Finally new trends in micro technologies were presented like ASM Assembly Products with a contribution about advanced 3D TSV through silicon via micro manufacturing. Carl Zeiss AG presented their activities about high performance micro-optics and Forschungszentrum Karlsruhe GmbH gave an view on aspects of future micro manufacturing. The 4M Network of Excellence hold an industrial workshop on integration in micromanufacturing.

The programme and proceedings of the MiNaT HotSpots are available on: http://www.minamwebportal.eu

The MiNaT Hot Spots were organised by VDMA Micro Technology with support from the European Commission (EC), the Federal Ministry of Education and Research (BMBF) in Germany, and the Project Management Agency Forschungszentrum Karlsruhe (PTKA).

Contact:

Dr.-Ing. Matthias Gebauer

Forschungszentrum Karlsruhe GmbH, (PTKA-PFT)

E-Mail: Matthias.Gebauer@ptka.fzk.de

A strong MINAM builds on the success of 4M, MicroSapient and IPMMAN

MINAM has received strong support during its initial phase from European activities such as the 4M Network and the Coordination Action projects MicroSapient and IPMMAN. Members of these activities were the backbone of MINAM activities in expert groups and during the drawing of the Strategic Research Agenda and Vision documents. 4M, MicroSapient and IPMMAN projects are now coming to an end and MINAM, strong of its 600 members, is ready to continue its mission.

To support its expansion, the MINAM association was founded in Brussels at the end of 2008. It will serve as a bridge from a voluntary-based group of interest (the platform of today), to a lean, self-supporting organization with an increasingly higher impact in all its areas of activities.

The MINAM association will further continue to drive the establishment of a MINAM European Technology Platform as an instrument to coordinate and promote EU and national policies in the area of primarily Industrial Nanotechnologies and Micromanufacturing, as illustrated above. The MINAM association will assist in defining the future direction of nanotechnologies in industry for the next decade: our "NANOfutures".

The MINAM platform will act as a "nano-hub" for other European Technology Platforms needing "nano" inside their products, by providing the proper scenario from science to manufacturing. The structure is also foreseen to extend into national mirrors, creating a concerted action and a common policy on nanotechnologies at Regional, National and European level.

MINAM planned activities in the first semester of 2009 are:

- To recruit members in the Association and constituting its organizational and governance bodies;
- To contribute to the Manufuture Joint Technology Initiative topics;
- To continue participating to the activities of the EC nano-industrial advisory group;
- To establish national mirrors;
- To contribute to Euronanoforum 2009;
- To officially establish MINAM as a European Technology Platform.

www.minanmwebportal.eu

Conclusions of the MicroSapient project

The FP6 Coordination Action project μSAPIENT started in March 2006, bringing together a consortium of 16 academic, research and industrial institutions, all experts in the field of MNT.

The overall aim of the project was to create a sustainable European-wide infrastructure for the coordination of research activities, linking relevant national and international projects, organisations and initiatives, and dissemination and promotion of results, thereby facilitating a new level of synergetic integration of micro- and nano-manufacturing technologies in support of a number of European industrial sectors.

Here are some of the key successes of the project:

- The 1st Stage Roadmap that aimed to develop a long term EU vision for micro- and nano-technologies. This directly informed the EC's plans for the relevant sections of the FP7 work programme and the subsequent calls for proposals.
- The recent launch of the MINAM survey, the results of which have fed into the 2nd Stage Roadmap
- A leading role in the establishment of the MINAM ETP
- A functional and informative web portal http://www.microsapient.org/
- The MINAM newsletter published jointly with other consortia and widely distributed
- Successful events organised and sponsored e.g. an industrial brokerage in Karlsruhe (November 2006), and workshops at HARMST/07, ANTEC 2008 Milwaukee and Plastipolis Oyonnax (November 2008)
- Special Interest Groups in Micro- and Nano-Manufacturing established
- The MINAM Strategic Research Agenda and Vision documents presented at the MINAM Launch in Brussels in January 2008. An updated version is currently being prepared and is due to be launched at the EuroNanoForum, Prague in June this year.

For further information, email: svetan.ratchev@nottingham.ac.uk

Conclusions of the IPMMAN project

The Final Meeting of the FP6 European Project IPMMAN – Improvement of Industrial Production Integrating Macro-, Micro- and Nanotechnologies (http://www.ipmman.eu/) took place in Vienna, Austria (28-29 January 2009).

The Project coordinator Dipl. Christian Woegerer, from PROFACTOR and the activity leaders presented the activities reports and deliverables for the last year. Also general discussions and conclusions were presented by the Project coordinator and by Project Officer, Kai Peters. All partners participated at fruitful discussions about the results of the project and future work to be done for the MINAM Platform.

IPMMAN project contributed to the strength of different links between the European Manufacturing Industry and research initiatives (regional and Commission RTD Projects, EUREKA, etc.), leading to the improvement of competitiveness and sustainability of the European manufacturing community, merging macro-, micro- and nano-tech to foster industrial innovation.

Collaborating with other projects (CA MicroSapient and NoE 4M), IPMMAN, which was a coordinated action project, played an active role and contributed to the:

- Establishment of the European Micro and Nanomanufacturing Platform- MINAM (sub-platform of MANUFUTURE);
- Vision Paper and Strategic Research Agenda for Micro- and Nanomanufacturing, contributing to the definition of topics in FP7- in a longer term, highlighting the industrial development in the next years.

The work within IPMMAN project was focussed on:

- Establishment of expert group covering specific topics: Nanoparticles, Nanosurfaces, Microproduction and Equipment integration. Key stakeholders, people from industry, technology providers, people from academia, decision entities were actively involved;
- Dissemination as special dedicated sections, organised in close cooperation with most relevant European Events in micro-nanomanufacturing, focused talks on micro and nano-manufacturing within a great number of conferences, workshops, exhibitions;
- Exploitation of technologies and industrial potential through improved production methods, micro- and nanotechnologies, novel products and processes;
- Communication and advisory role to technology policy making bodies, funding organisations and related platforms (EC, national ministries, Eureka, Manufuture).

IPMMAN project looked out to the communication strategy of for the whole community of Micro- and Nano Manufacturing (MINAM) and prepared and supported the development of the common IPMMAN web portal , as well as the web-portal of the MINAM community, by exchanging ideas about different solutions, by conceptual work. IPMMAN also contributed to the MINAM newsletter.

All the objectives of the project were successfully fulfilled and the work of the 13 partners involved contributed to the establishment and support of the MINAM Platform for Micro and Nanotechnology manufacturing.

Dr. Helmut Ramp - IPMMAN Final Meeting

Project coordinator, Dipl. Christian Woegerer from Profactor Produktionsforschungs GmbH

The 7-th The Coating's and the 3-rd ICMEN-Kassandra-Chalkidiki, Greece, October 1-3, 2008

The 7-th The Coating's and the 3-rd ICMEN Conferences took place on October 1-3, 2008 in Kassandra-Chalkidiki, Greece and was organised by the Laboratory for Machine Tools and Manufacturing Engineering - Aristoteles University of Thessaloniki.

A special MINAM session was organised at this occasion. Main goals of both conferences were the technological transfer and the collaboration stimulation towards the development of innovative products and services. A EUREKA brokerage event, focused on Innovation in Small-Medium Enterprises was held in the last day.

A project meeting of IPMMAN-CA FP6 Project was organized in conjunction with the conferences.

The International Conference on Manufacturing Engineering (ICMEN) was initiated during the Hellenic Chairmanship of EUREKA 2001-2002, to reinforce synergies between people involved in scientific research and those having to meet the rapidly increasing demands of industrial applications.

The Conference was supported by the Fraunhofer "Project Center Coatings in Manufacturing" and by the Hellenic EUREKA office, by various authorities of the Aristoteles University of Thessaloniki and by the Gas Supply Company of Thessaloniki S.A.

Prof. K.-D. Bouzakis

Special MINAM session

IPMMAN meeting

MANUFACTURING 2008 Conference at Budapest from 5-7 November 2008

Dr. Geza HAIDEGGER, MTA SZTAKI

Christian WOEGERER, PROFACTOR Austria

The conference brought together researchers from the academic sector and participants from the industry and provided a platform to report recent advances and developments in the emerging areas of manufacturing technology, new organizational forms as well as actual and potential applications to industrial and factory automation.

A stronger Hungarian National MANUFUTURE Technology Platform will provide benefits for both the national participants and also for the other EU member state's delegates enabling the formation of new collaborations and partnerships, resulting in new joint projects and industrial project-participations.

A session on EU technology platforms was organized and within that MINAM platform and IPMMAN results were presented. In addition, Rodica Voicu, from IPMMAN Partner IMT Bucharest presented a design study of a polymeric microgripper for micromanipulation.

FP7 Project: Carbon nAnotube Technology for High-speed nExt-geneRation nano-InterconNEcts CATHERINE

The continuous miniaturization of electrical and electronic devices, together with the high integration level and the increase of the working frequencies and power density require the use of innovative solutions for the production of on chip interconnections and vias in order to avoid in the near future a technological bottleneck.

Traditional interconnect technology will no longer satisfy future performance requirements. Unconventional interconnects and innovative materials are being studied as replacements for copper interconnects. Because of their exceptional and unique physical properties, carbon nanotubes (CNTs) have created a lot of research interest making them promising candidates as nano-interconnects for future high-speed electronics.

Main objectives

CATHERINE will develop an innovative cost-effective and reliable technological solution for high-performance next-generation nano-interconnects beyond the limit of current technology. The new approach, which exploits the carbon nanotube (CNT) technology, will enable the production of interconnects with high-transmission speed, high current density, exceptional mechanical and thermal properties, optimum signal and power integrity. CATHERINE project is focused on delivering cost-effective solution to the ITRS roadmap for late CMOS and post-CMOS systems, requiring continuous miniaturization of electrical and electronic devices (down to 22 nm node in 2011), high integration level, increasing working frequency and power density, reduction of global interconnection delay.

Expected results

- Definition of all causal relations within the design-chain "microstructure characteristics – fabrication process – functional properties";
- Development of multiscale multiphysics simulation models for the prediction of the multifunctional performance of the interconnect and for the EMC analysis;
- Development of electromagnetic and multifunctional test procedures and experimental characterization methods;
- Manufacturing and testing of proof-of-concept samples of nano-interconnects at laboratory level.

Final CATHERINE products will be:

- Integrated data-base for nano-interconnect design;
- Proof-of-concept nano-interconnect.

A multiscale design tool of the new nano-interconnect, implementing advanced multifunctional simulation models at different scale, will be developed and experimentally validated. The electromagnetic compatibility (EMC) aspects related to the integration of the nanointerconnect in complex systems are analysed in the frequency range up to 100 GHz in order to demonstrate the feasibility and concrete advantages of the new technology.

First Annual Meeting took place at IMT - Bucharest (21-23 January 2009). Research partners presented simulations and experimental results. Fruitful discussions were focussed on the future research, innovative solutions and dissemination activities.

For further information, visit: www.catherineproject.eu

This project is coordinated by Sapienza Innovazione. Scientific coordinator: Sapienza Università di Roma - CNIS, Prof. Maria Sabrina Sarto.

Prof. Sabrina Sarto, Scientific Coordinator presenting the EM simulation results at the first annual meeting

MASMICRO Technology Outcome

By the end of the MASMICRO project (Sept. 2008), it had produced 48 exploitable results, over 130 publications, 3 spin-offs, 3 awarded patents, 5 patent and 1 trade-mark applications. A number of the results were already at an industry-ready stage.

The first machine for high-volume hydroforming of tubular miniature/micro-parts has been built, featuring an active hydraulic drive and a new dynamic sealing concept. This is capable of forming tubes with dimensions as small as 0.8 mm diameter and 40 μm wall thickness. A new desktop, linear-motor-driven machine has been developed for the micro-forming of thin metal strips/parts with thicknesses below 100μm, at rates up to 1000 parts/min. The modular machine has a maximum working space of 400 x 400 mm, and a choice of set-up options for flexibility in handling and tooling.

One more result is a linear-motor-driven press for high-throughput cold forming of miniature components. It incorporates an innovative parts-handling system and control strategies, together with the first mass-production system for extruding micro-parts. It is again equipped with a flexible tool system to permit deployment for various micro-forming processes. Another development is the 'Ultra μ-Mill': a bench-top five-axis ultra-precision machine for CNC-controlled micro-milling, drilling and grinding of 3D mechanical components and micro-featured surfaces. The compact machine has a resource/energy efficient design giving submicron precision and nanometric surface finishes.

More key advances include design advisory and analysis systems, new miniature/micro-materials and testing facilities, a laser system and laser-assisted forming tools, optimised micro-EDM, photo-chemical etching and electro-forming processes, new micro-parts handling and inspection systems, and more. System integration is effected with a Manufacturing Execution System, a Knowledge-based Decision Support System and a Robotic Handling system.

Taken together, these developments reflect a 'life-cycle' concept for implantation in future miniature/micro-products industries. Europe-wide implementation of the knowledge and technologies generated within the project has been actively promoted via MASMICRO's demonstration, training and SME take-up programmes.

Coordinator: Dr Yi Qin,
University of Strathclyde, UK

More information: www.masmicro.net

Next MINAM event

EuroNanoForum 2009 - „Nanotechnology for sustainable economy" 2-5 June 2009, Prague

The Forum is offering the visitors an overview of the state-of-the-art of nanotechnology research and applications, especially in the field of energy-efficient industrial production, electricity storage, water and air cleansing, nanomedicine and nanoelectronics. The forum will also address: standardization, security, education, research infrastructures and integration activities within the European Research Area (ERA). 1000 participants are expected. The conference shall give inputs which will serve as a preparation for a new Action Plan for Europe in the field of nanoscience and nanotechnology, and many other strategic documents to the European Commission.

MINAM participation is expected at the EuroNanoForum 2009:

Tuesday 2nd June: Workshop on "Industrial Nanotechnologies", from 9.00-13.30.

Wednesday 3rd June: Plenary session on "Eco- & Energy-efficient industrial production", from 11.00-13.30 and "MINAM IMG/OSG Meeting"

Friday 5th June: Horizontal activities - European Technology Platforms session, from 8.30-10.30

For more information please refer to website www.euronanoforum2009.eu

Disclaimer

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Appendix C: Worldwide Nano Initiatives

US International Cooperation in Nanotechnology

http://www.oecd.org/dataoecd/28/32/43277615.pdf

Introduction of the Progress in Nanotechnology in China

Chen Wang
National Center for NanoScience and Technology, China
Beijing 100190, China

http://www.oecd.org/dataoecd/28/60/43277072.pdf

Korean Experiences in the International Scientific Cooperation in Nanotechnology

http://www.oecd.org/dataoecd/28/14/43277262.pdf

Brazils Cooperation Initiative in NanoScience and Nanotechnology

Ministério da Ciência e Tecnologia

BRASIL UM PAÍS DE TODOS GOVERNO FEDERAL

http://www.oecd.org/dataoecd/28/61/43277038.pdf

Appendix D: List of Figures