Welcome to Nanotech Germany

M. Rieland*, V. Müller**, F. Sicking*** and G. Bachmann***

*Federal Ministry of Education and Research, BMBF, Dept. 511, Nanomaterials, New Materials
53170 Bonn, Germany, martin.rieland@bmbf.bund.de
**International Bureau of the BMBF, DLR, Bonn, Germany, verena.mueller@dlr.de
***VDI Technologiezentrum GmbH, Duesseldorf, Germany, sicking@vdi.de, bachmann@vdi.de

ABSTRACT

Key technologies are "tickets" to the future. Nanotechnology is one of the most important key technologies. Nearly all branches of industry profit from the progress being made in nanotechnology research. And still, nanotechnology has a great wealth of innovative potential to exploit. Germany has set itself the goal of becoming a pacemaker for nanotechnological innovations. German researchers are right up front in third place in the international league table for patent applications. In 2008 and 2009, Germany is showcasing its nanotechnology performance internationally by the initiative "Welcome to Nanotech Germany - Research in Germany-Land of ideas". This initiative aims at stepping up cooperation between German and international research establishments and enterprises.

Keywords: nanotechnology, government funding, nano initiative, networks and infrastructure,

1 GENERAL DESCRIPTION OF R&D IN GERMANY

Germany is meeting the challenges of globalisation and international competition by investing in education and research. The Federal Government is determined to provide as much support as possible in this area – and has already been visibly successful. It's a fact: the High-Tech Strategy initiated by the Federal Ministry of Education and Research (BMBF) is having an impact. Targeted funding is to ensure that new impetus is given to turning research results into products, services and processes much more quickly, and thus creating new jobs. Up to 2009, altogether 15 billion euros of the budget have been earmarked for this investment programme in R&D. By 2010, state and private investment in research and development is projected to rise to three per cent of gross domestic product. Companies are counting on a growth rate of more than seven per cent for research and development in comparison with previous years. And the number of employees in companies involved in research and development has increased by 3.5 per cent. Cutting-edge research is not a prerogative of firms or the numerous universities in Germany; it also takes place at roughly 257 non-university research establishments, employing more than 70,000 staff. These establishments are incorporated in large organisations such as the Max Planck Society, the Helmholtz Association, the Leibniz Association and the Fraunhofer Society. This is where researchers find optimum conditions matched only at very few other institutions around the world. Which all goes to show: Germany puts strong efforts in R&D in order to meet future social and economic challenges.

2 GERMAN NANOTECH

One of the engines for future innovations is undoubtedly nanotechnology. Being a classic cross-cutting technology, nano developments build the starting point for progress in many economic sectors. The automotive industry, energy and environment, the health sector – in all these fields lessons learned from nanotechnology research set the trend for technological improvements. And the nano sector creates wealth: according to prognoses, a global market potential of up to a trillion euros in 2015 can be expected.

Self-cleaning windows, higher-performance tumour markers or miniature hard discs which can store just as much data as traditional hard discs – nanotechnology opens up manifold new opportunities. Indeed, our everyday lives have become unimaginable without nanotechnology.

Whether in sun creams, drinking water treatment plants or automotive paintwork, the tiny particles unfold their enormous potential with just the same degree of efficiency. Nearly all branches of industry profit from developments in nano research. Possible applications can be found in the optics sector, as well as in mechanical engineering, medical technology, and the chemical, electronic, textile and construction industries.

In the context of the "Nano Initiative – Action Plan 2010", the Federal Government has introduced a national funding concept spanning all policy areas. Part of the High-Tech Strategy for Germany, the Nano Initiative contributes to opening up new leading markets, networking business and science, and creating leeway for researchers and entrepreneurs.

Our main target is to expedite the transformation of ideas into new, marketable products, processes and services.

NSTI-Nanotech 2008, www.nsti.org, ISBN 978-1-4200-8503-7 Vol. 1

Germany must remain amongst the world's most research- and innovation-friendly nations. This holds true especiallay for the field of nanotechnology. By means of specifically created funding programmes the Federal Government is helping to establish Germany as leading nano location. 350 million euros public funding were invested in 2007 in R&D for this upcoming technology field. Only the USA and Japan invest more state funding in nanotechnology. Today, more than 650 companies in Germany with more than 50,000 employees are already developing, using or selling their nano products.

Today, Germany is right at the forefront of international nanoscience, not at least due to the fact, that the Federal Government realised the potential of this relatively young field of research very early on and systematically funded its development. For example, the amount of funds earmarked for nanotechnology by BMBF has increased more than five-fold since 1998.. In parallel, centres of competence have been established as supportive infrastructure. Therefore, the German research landscape offers students, academics and companies from home and abroad the best possible prerequisites for success.

2.1 Nano-Life in Germany

Anyone, who is interested in doing nanotechnology research in Germany is highly welcome. Students and experts from abroad will profit not only from the most generous financial support for nanotechnology in Europe, but also enjoys a high standard of living. In the "country of poets and thinkers" the great philosophical and literary tradition continues to this day. The world's largest book fair takes place in Frankfurt am Main, with about 1,800 publishing houses presenting their works every year. And Germany also has a vast music and theatre scene. 135 publicly funded orchestras perform on 80 stages in the land of Bach and Beethoven. Cultural visitors come to Kassel for the "documenta", one of the most important exhibitions of international modern art worldwide, to Bayreuth for the "Richard-Wagner-Festspiele", or to Berlin for the International Film Festival, the "Berlinale".

German countryside is surprisingly varied. There are 15 national parks and 90 natural preservation areas to investigate. Holidays in Germany might mean mountaineering in the Alps, walking in the legendary Black Forest or along the Wine Trail through the Palatinate or Baden, or simply relaxing on the white beaches of the Baltic or North Sea. And sport is a major feature, too. No other country has as many sports clubs as Germany – roughly 90,000, all told. In the big cities, major sporting events like inline skating or marathons take place regularly.

The society researchers experience in Germany is multicultural and cosmopolitan: more than seven million foreigners originating from all over the world live here. Duesseldorf at the Rhine River is the European centre Japanese companies have chosen – there are Japanese restaurants, book shops and schools. In Hamburg, the Portuguese feel at home, and Berlin is the favourite adopted home town for Turkish immigrants in Germany. An estimated 25,000 Chinese study at German universities across the country, while amongst Polish students, Viadrina European University in Frankfurt/Oder is particularly popular. And more than 22,000 companies with foreign participation have successfully established themselves in Germany.

By comparison with the rest of the world, Germany, with its stable, democratic, constitutional state, is one of the safest countries of all – in which to live, to invest and, of course, to do research.

2.2 The Federal Government´s Nano-Initiative

Being a cross-sectional technology, the nano sector enjoys a special status in this context: on the basis of the "Nano-Initiative –Action Plan 2010", the Federal Government wants, above all, to improve the interface between basic research and rapid implementation. Comprehensive measures are on the drawing board which should help to improve the exploitation of nanotechnology in Germany – and meet the new challenges. Eight ministries, each with its own nano representative, have put together the package of actions. The sooner a good idea makes the transition from laboratory scale to a ground-breaking product the better.

There's lots to be done: apart from expediting the process from idea to product, one major task is to introduce nanotechnology to more new sectors and companies. Branch-level industrial dialogues between representatives from politics, the economy and associations help to find areas of application for economic areas not covered so far. In order to introduce nanotechnology to new fields of applications special funding measures have been implemented. The action plan promotes so-called leading innovations which the Federal Government hopes will generate a high degree of growth and employment. For example, in the field of lighting technology, these include the "NanoLux" project and the OLED Initiative: whereas NanoLux is essentially preparing the way for energy-efficient lightemitting devices in the automotive industry, the OLED Initiative wants to create the technological basis for organic light-emitting devices as a cheap, large-scale lighting option.

Small and medium-sized enterprises in particular often prove to be especially innovation friendly. They receive support from the action plan by means of funding and structural measures, such as the "NanoChance" programme for start-ups. And the Federal Government is also pooling its activities with regard to potential risks. A steering group under the direction of the Federal Ministry for the Environment is assessing the chances and risks involved in dealing with nanomaterials. In the context of this national nanodialogue, experts from industry and society evaluate dangers as well as perspectives and also discuss tomorrow's research needs.

Alongside excellent basic research, innovation-friendly industry, and well trained young personnel, Germany can

rely on its internationally oriented technology networks and centres of competence – for yet more new, cutting-edge achievements "made in Germany".

2.3 Talented People and Networking

Expertise is the key to economic success. And innovation often begins with shrewd promotion of young talents. Targeted support already kicks in at school where nano topics and experimental learning arouse the curiosity of even the very young. In addition to this, the Federal Government's measures include science competitions in the nano field as well as information aimed at young people, telling them about promising new fields of employment and new educational opportunities. These are coordinated with the needs of industry. Fairs, workshops and surveys also help to identify new qualification trends and integrate them into tailored educational opportunities in higher and vocational education.

Success is usually a question of good teamwork and optimum communications. Thus, as a further measure in addition to promoting research, industry and young people, the Federal Government is pooling specialised knowledge in nanotechnology and also accelerating innovative processes by strategic information exchange. A network of so-called centres of competence, currently comprising nearly 500 participants, links universities, research institutes, companies, financial service providers, consultants and associations. These networks work in different subject areas both at the national level and in regional clusters. Apart from trends and current developments, these centres also focus on training and further education.

Currently, there are several centres of competence in the field of nanotechnology in Germany working along the value-added chain. In addition, a number of clusters have established themselves which bundle their activities nationally, regionally or even locally. A number of largely independent university networks complement the excellence teams at the local level. Examples of the largest networks are:

CC-NanoChem / NanoBioNet – Networks for Chemical Nanotechnology / Nanobiotechnology

The CC-NanoChem centre of excellence started up in 1998 at the Institute for New Materials in Saarbruecken, specialising in chemical nanotechnology. This is one of the decisive key areas needed for new materials and products as well as for new manufacturing and processing technologies. New processes make it possible to shape materials precisely at the level of atoms and molecules: the physical properties of materials can be tailored for change, for example. The NanoBioNet network followed in 2002. It focuses on nanobiotechnology – the interface between nanostructure science and biology. Both networks offer their members a forum for exchange between universities, research centres, small, medium-sized and large enterprises, as well as consultants and venture capitalists. And there is expert assistance for start-ups, too. Even school students can come here to experience the things nanotechnology can do. Experimental kits and nano nights familiarise young people with this future technology.

Nanotechnology Centre of Competence "Ultrathin Functional Films"

Ultrathin films are often a key element in nanotechnology. Their field of use ranges from microelectronics and optics via medicine to wear protection. In Saxony, 51 companies, ten university institutes, 22 research establishments and five associations have bundled their know-how and got together to form a network. They have one common goal: to exploit industrial application potential. The Fraunhofer Institute for Material and Beam Technology (IWS) Dresden coordinates this network, which was chosen as the National Centre of Competence for the field of ultrathin functional films by the Federal Ministry of Research.

ENNaB – Excellence Network NanoBioTechnology

Gifted junior researchers and industrial enterprises working in the nano- and biotechnology fields are the groups targeted by ENNaB – Excellence Network NanoBioTechnology - at the university in Munich. The network understands its role as the link between university and industry – between basic research and industrial application. Its aims include training competent research and management personnel for universities and industry, and thus creating a solid basis for the commercial implementation of new, innovative applications in the field of nanobiotechnology.

HanseNanoTec Competence Centre

The HanseNanoTec competence centre is the point of contact for all researchers, entrepreneurs, financial service providers and funding organisations in the Hamburg region working in the field of nanotechnology. It bundles the Hanseatic city's expertise in this sector and initiates and promotes cooperation with supraregional and international partners. The objective is to optimise efficient acquisition of basic insights and swift transformation of nanotechnology knowledge into products, manufacturing processes and services.

UPOB – Ultraprecise Surface Figuring

The Brunswick nanotechnology competence centre is a cluster amalgamating production technologies, machines and machine components, metrology, sensor technology and materials. As the respective methods used differ significantly, the network is divided up into four core areas: mechanical/chemical processing, ion beam and plasma processing, optical processing and related topics, and characterisation of surfaces. This is a perfect way of bundling capabilities and presenting them to the public.

CCN – Competence Centre for Nanoanalytics
The main tasks of this network at the Centre for Nanotechnology in Muenster include the continued development of nanoanalytic measuring methods, their adaptation to technological demands and their standardisation. Special probe and raster scan techniques are amongst the network's methodological focus areas.

NanoMat
Nanotechnology materials are the focus of NanoMat, coordinated by the research centre in Karlsruhe. They coordinate research projects on "the synthesis and study of nanostructured metals and ceramics and the functions resulting from their nanoscale nature". Three research centres of the Helmholtz Association, ten universities with natural science and engineering departments, a Max Planck institute, a Leibniz institute, a Polish Academy of Sciences institute, three Fraunhofer institutes, the Society for Chemical Engineering and Biotechnology (DECHEMA), and four large corporate groups participate in the network.

NanOp – Competence Centre for the Application of Nanostructures in Optoelectronics
The NanOp centre of competence in Berlin, a network comprising universities, research establishments for applied and basic research, industrial enterprises, and banks as well as venture capital firms, is engaged in research and development in nanotechnologies for application in new and revolutionary products based on nanooptoelectronics. Close cooperation between all the partners involved in the network and fast transfer of know-how produce synergy effects.

3 ACTING RESPONSIBLE

Progress opens up enormous opportunities but might also incorporate inherent dangers. It is important not to play down these risks without actually exaggerating them. Germany puts strong efforts to investigate, to assess and to monitor possible toxic potential in nanomaterials. Results are discussed with the public in an open discourse.

Within the "Nano Initiative – Action Plan 2010" BMBF has started a funding initiative called NanoCare, which addresses this issue in a very efficient and exemplary manner. Here, the Federal Government, academia and industry are developing new, standardised procedures to improve assessment of the danger potential of nanoparticles. The public is actively involved.. The NanoCare cluster is combining the projects NanoCare, INOS and TRACER:

- The NanoCare project focuses on examining primary particles and agglomerates and the way they behave in biological media and systems. State-of-the-art analytical methods from the most diverse institutes are used to characterise the nanoparticles.

- The INOS project is geared to developing methods based on in vitro testing to evaluate the danger potential of engineered nanoparticles. The hazard analysis is based on a comprehensive investigation of the behaviour of nanoparticles in various cell culture media and the changes they undergo.

- Carbon nanotubes (CNT) and carbon nanofibres (CNF) are already considered to be some of the 21st century's key materials. In central fields of technology, such as chemistry, the automotive industry, aeronautics and aerospace, they are achieving technological breakthroughs. Emerging industrial manufacture of carbon nanotubes is likely to open up other fields of technology and pave the way for a multitude of mass applications. The objective of the TRACER project is to draw up recommendations for handling potential end products during manufacture, processing and use.

Dealing so openly with the opportunities and risks inherent in these miniscule particles is creating a positive climate in Germany which favours nanotechnological developments. On the basis of such social approval, the huge potential of this cross-discipline technology can be exploited to the full – which puts wind in the sails of researchers in their everyday work. And this is necessary, because nanotechnology is needed to face the new challenges of the 21st century. Climate change is a prominent example. There is a strong and further increasing demand for new energy technologies in order to meet the CO_2-emission reduction goals. Innovations in fields like energy production, energy efficiency or energy storing heavily rely on nanotechnology. Furthermore, new, workable solutions also have to be found for the continuing pollution of the earth by industrial society's waste products.

Thus, nanotechnology is one of the most promising pacemakers for the future. From 2025, at the latest, the vast majority of all significant new developments will be related to this field of technology. There are not a few people who think the tiny particles with the big impact will point the way out of today's technological cul-de-sac. But, at the same time, there is the need to make the risks associated with the particles calculable. This is the only way of ensuring that the future dividends inherent in the nanocosmos will pay off one day.

WEB LINKS

www.research-in-germany.de/nano
www.bmbf.de/en/nanotechnologie