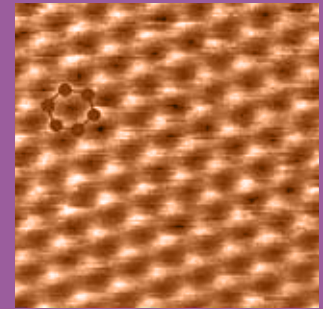
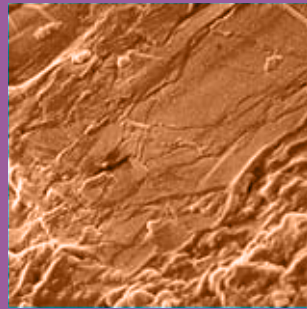
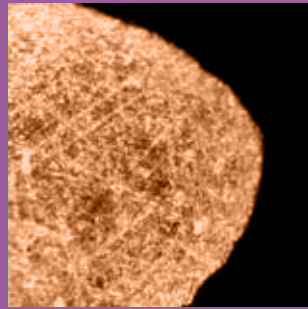
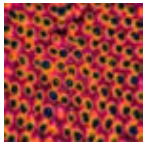


Think small, look deeper!



Enormous potential for industry



Nanoscience is exploring physical, chemical and biological properties and phenomena in the tiny length scale of 1 to a few hundred nanometres. Nanotechnology is concerned with the engineering tools that make this exploration possible and with the development of useful applications.

Nanotechnology offers an enormous potential for all industrial sectors, in terms of products with superior properties compared to what is available now, as well as products with features and capacities that today only exist in our imagination. This will have a great impact on our lives already in the near future – some examples:

- Very light and extremely robust materials, one hundred times stronger than steel, can be produced
- Scratch resistant varnishes and ultra-light body parts are already being used in the automotive industry
- The medical sector profits from modern diagnostics and implants being developed with the aid of nanotechnology
- Minute data memories with enormous storage capacity
- Highly efficient filters for sewage treatment
- Hydrophobic glazing and coatings being already used in sanitary products

Inspiration from nature

Nature is an important source of knowledge and inspiration to the nano researchers. Cell biology has already taught us about the way evolution has created functional systems at molecular level to enable living cells to multiply or communicate. ■



A nano biologist can study these systems, e.g. receptors, cell skeletons or ion channels, from two different angles: on the one hand to learn how the cells work, on the other hand for inspiration to innovations which eventually might find their industrial applications. The researchers in the picture are studying nanoturbines as energy sources of the cell, using atomic force microscope (AFM). ■



Where nothing else is indicated, all pictures belong to © NCCR Nanoscale Science

The future is not far away!

The technology already exists, here and now. Nanoscience and Nanotechnology (N&N) can be applied to achieve technological progress in most areas of industry. Over the coming decades the outcome of present research in N&N will manifest itself not only in a deeper understanding of nature but also in everyday life. Our electronic and photonic gadgets will become ever more useful with novel functionalities thanks to nanostructured materials, nanoscaled devices and quantum computers.

N&N are unique in the way they bring together basic scientific disciplines. The field is truly cross disciplinary, connecting basic physics with modern chemistry and novel electronic, biotech and life science applications. The key issue is the possibility to achieve new properties and functionalities by controlled structuring of materials, devices and systems at the atomic and molecular level. To be able to routinely control and predict behaviour with this precision requires a very significant and challenging extension of existing synthesis techniques, characterization tools and theoretical models. Such work is now intensively pursued in all major developed

countries, and leading universities have this area high on their agenda.

Especially promising are applications of nanotechnology in biology and medicine, so called life science. Biology is built up of a large spectrum of nano-sized structures and phenomena, such as the DNA helices of the genetic code, cell membranes, peptides and folded peptide chains (proteins) with a manifold of functions, including enzymes, antibodies, ion channels and molecular motors. At higher hierarchical levels they build up sub cellular, cellular and tissue components and whole organisms.

The rapid development in molecular biology during the last couple of decades has created both new demands on and new opportunities for the physical and engineering sciences, and successively creates more and more bridges between them, biology and biomedicine. The integration of nanoscience and biology covers a variety of nanoscale structures, processes and phenomena, where biological and biomedical aspects are connected at the nanoscale. ■

Nanoscience & Nanotechnology in Life sciences

- Biochips and bioarrays for accurate detection of genes (gene chips) or proteins (protein chips) with applications in drug screening, clinical diagnostics and forensics, among others.
- Biosensors able of recording, e.g. one or a few key components in real time (such as glucose sensors for automated insulin administration).
- Regenerative medicine includes both very mature sub-areas, such as bone-anchored implants (dental implants, artificial hip joints, intraocular lenses), and very immature, emerging areas, such as stem cell based tissue engineering.

- Targeting of drugs by employing tailored nano-particle carriers that can carry a drug without undesired side effects to its final "destination" and allow the drug to be released selectively there, even to pass biological barriers like the blood-brain barrier to treat brain tumours.

The market volume of applications based in the Life science sector was about \$ 269 Million in 2002 and is expected to increase to about \$ 1.2 Billion in 2007.*

* Source: Business Communication Company (BBC), 2003

Three examples of "applied" nanoscience & nanotechnology



Degussa Advanced Nanomaterials combines the attributes of a small start-up and a well-established global enterprise.

The company was founded with the target to produce innovative nanomaterials and to tap into new business segments in attractive markets. In close cooperation with its customers Degussa Advanced Nanomaterials develops nanostructured materials and disperse systems, including indium tin oxide (ITO), zinc oxide, ceria, and various composites.

Today Degussa Advanced Nanomaterials is active on several markets such as UV-protection for coatings, transparent and antistatic coatings, CMP (chemical mechanical polishing) or adhesives (bonding on demand). Growing sales and a constantly increasing number of strategic cooperations show the market potential for new products and new customer-oriented solutions.

<http://www.advancednanomaterials.com/webapps/adnano.nsf>



Nanoxis AB is a nano-bio-technology company focused on developing technologies for analysis of molecules. The main purpose is to develop

platforms for analysis of molecules, especially membrane proteins. These platforms are in chip formats and can separate, identify and analyse membrane proteins.

The company currently provides CRO services to pharmaceutical customers in identification and characterization of membrane proteins using its platform, and a chip consumable product integrated to mass spectrometry is planned to be launched in 2006.

<http://www.nanoxis.com>



MagForce Nanotechnologies AG is the leading company in Europe in the area of nanotechnology-based cancer therapy (Acc. Frost&Sullivan

Award 2005). After 18 years of R&D, MagForce patented therapy allows the targeted destruction of tumours using specifically coated magnetic nanoparticles. MagForce's nanotechnology represents a revolutionary and cost effective system of medical devices, nanoparticle formulations and planning software to treat solid tumours.

At the Charité University Hospital in Berlin (Germany) this therapy is successfully evaluated in several clinical trials studies since 2003. Most patients did not exhibit any side effects from this new therapy and most patients had a survival benefit in comparison to conventional treatment.

<http://www.magforce.com>

European business ready for nanotechnology

There is total agreement within the business world in Europe: nanotechnology is about to make a breakthrough! In the annual survey by ENA, European Nanobusiness Association, 90% of the companies stated that they believe that nanotechnology will have an influence on their business. On the question "when?"

more than half of the respondents (55%) stated "within three years". Furthermore, 84%, or six out of seven, estimate that nanotechnology will have a significant effect on their competitiveness. (For more information, please visit <http://nanoeurope.org/survey.htm>)

What is Frontiers?

Frontiers is a Network of Excellence supported by the Sixth Framework Program (FP6) from the European Commission, which aims at establishing leadership in research and innovation in life sciences related Nanoscience and Nanotechnology.

Frontiers represents twelve nanotechnology institutes scattered over Europe. Jointly about 200 researchers with varying backgrounds bring together a considerable knowledge pool in Europe.

The large emphasis on nanotechnology worldwide requires a strong ambition and focus, in order to achieve the leadership needed. We believe this can only be done by leveraging and focusing existing strength, expertise and investments within Europe through a network. The critical mass hence obtained is expected to lead to the development of marketable new technologies, processes, tools and devices that will in turn have great impact on science, industry and society. ■



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Specialized lab environments

A substantial part of the development work with nano materials has to be carried out in an extremely controlled environment, without such disturbances as whirling dust particles, sudden vibrations or unwanted magnetic fields. Cleanrooms and special labs – with advanced analysis equipment – are currently being established in European centres for nano research.

The inserted picture shows a self-assembled molecular layer of DMP (monoporphyrin), a system which is very promising as “molecular building blocks”. The picture is produced with a method called scanning tunnelling microscopy (STM) – a method which enables the study of electrically leading materials with a resolution high enough for single atoms to be visualized. ■

Working together with the Frontiers network

The network can offer you:

- Access to the leading nanotechnology institutes in Europe
- Know-how about technology development
- High-tech facilities, equipment and expertise
- Potential partners for collaborations
- High level conferences, workshops and education
- Social, health, environmental, ethical and safety issues
- Solutions to your technical problems



© IBM

Well-established science

The encyclopedic definition of “nanotechnology” is “technology for the production of objects in the size of 1–100 nanometres (1–100 millionth of a millimetre)”. Considering that a water molecule is approximately 0.3 nanometres across, the conclusion is obviously that these dimensions are in fact beyond human comprehension.

The picture shows a classic experiment performed as far back as in 1989, where the letters IBM were formed with 35 individual xenon atoms. Today many nanolaboratories are able to move individual atoms routinely. ■



More information and contact

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