

TECHNISCHE FACHHOCHSCHULE BERLIN
University of Applied Sciences

Sprachenpreis Nanotechnology



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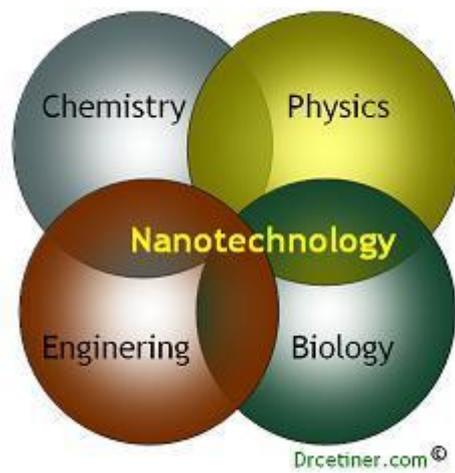
Course of study: industrial engineering and management

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1) Introduction

The term „nanotechnology“ is derived from the Greek word “nanos” which means „dwarf“ translated into English. Nanotechnology combines cognitions and terms of many different kinds of sciences like physics, chemistry, biology and engineering which complement each other. Therefore nanotechnology has to be seen as one of the most important future technologies.



Picture 1: Overview¹

It deals with atomic structures which are smaller than 100 nm. One nanometer corresponds to 10^{-9} meter.² The ambition of nanotechnology is to influence and to manipulate nanostructures in a specific way so that special properties can be used to create new materials and to make surfaces more resistant against damages like scratches or solar irradiation.

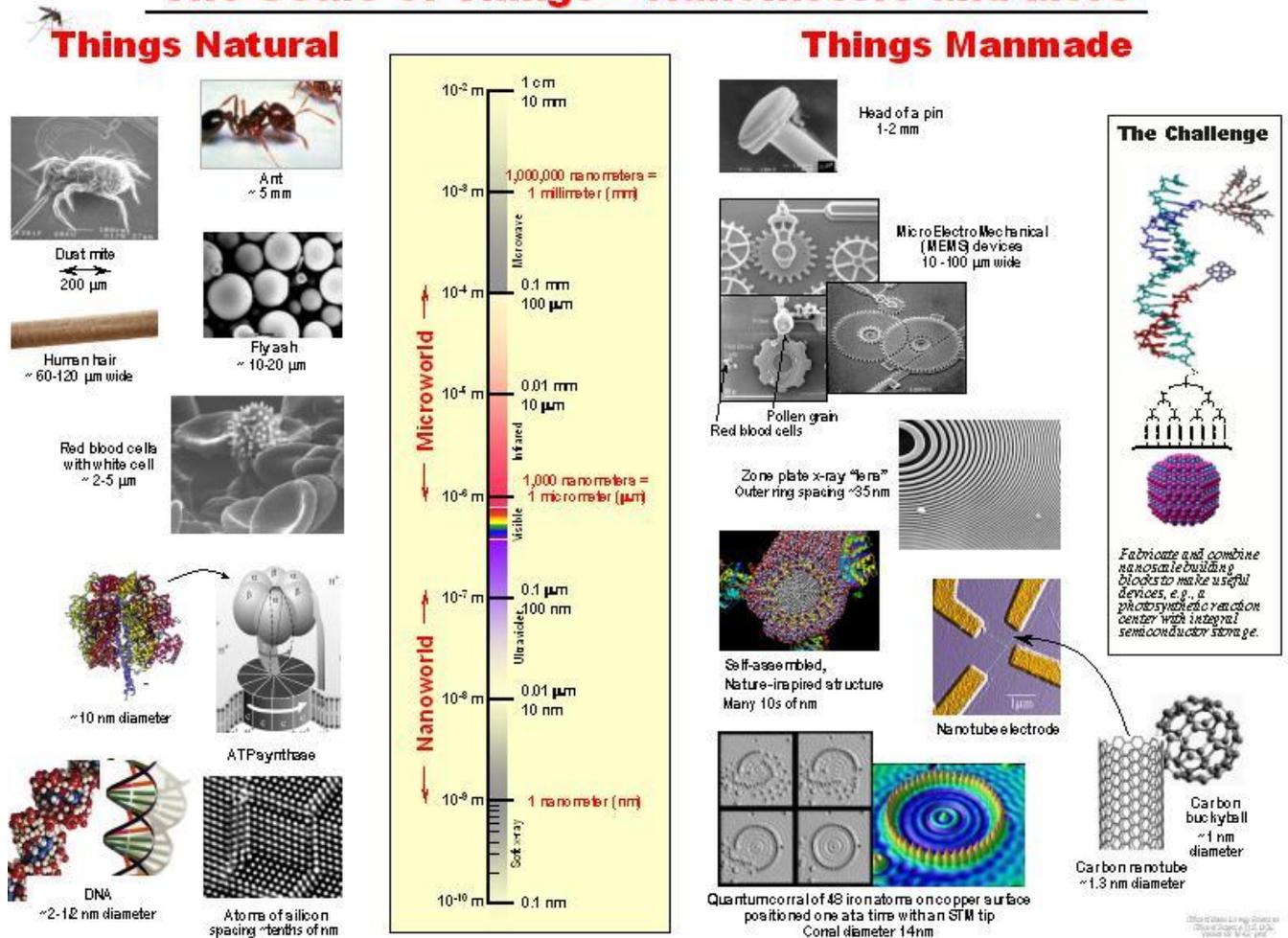
¹ <http://www.drcetiner.com/images/nanotechnology.JPG>

² <http://de.wikipedia.org/wiki/Nanotechnologie>

<http://www.br-online.de/wissen-bildung/thema/nano/index.xml>

<http://www.tab.fzk.de/de/projekt/zusammenfassung/ab92.htm>

The Scale of Things – Nanometers and More



Picture 2: The Scale of Things ³

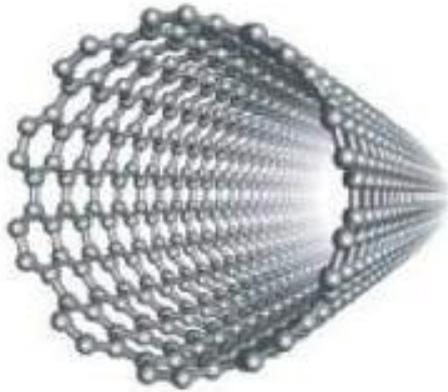
There are two different basic approaches to enter the “nano-dimension”. The first one is the “Top-down” approach which is mostly used in physics. The idea is to minimize complex structures and components into smaller parts. The second approach is called “Bottom-up” and is often used in chemistry. Its idea is to build complex structures out of atomic elements.⁴

³ http://www.nano.gov/html/facts/The_scale_of_things.html

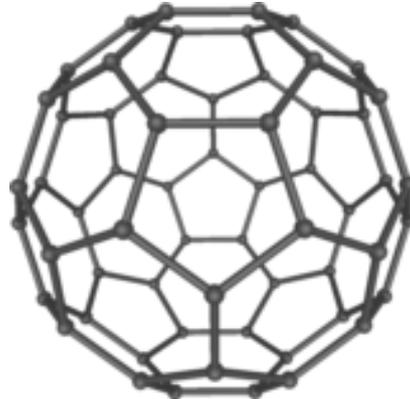
⁴ <http://de.wikipedia.org/wiki/Nanotechnologie>

<http://www.tab.fzk.de/de/projekt/zusammenfassung/ab92.htm>

Two basic structures have to be distinguished in nanotechnology. Pointed-shaped structures known as fullerenes and stretched structures like carbon nanotubes.⁵



Picture 3: carbon nanotube⁶



Picture 4: C₆₀ fullerene / Buckyball⁷

The best explored fullerene is the C₆₀ fullerene. It is called Buckyball after the famous architect Richard Buckminster Fuller who constructed a lot of geodesic domes.

These are buildings which possess the structure of the C₆₀ fullerene like the Epcot Centre at Disney World for example.⁸

2) History of nanotechnology

The official beginning of the idea which is known today as nanotechnology took place in 1959 when Richard Feynman (1918 – 1988) published his dissertation "There's Plenty of Room at the Bottom" even if Max Planck cleared the way for this idea by his quantum theory before. In his work Richard Feynman described the idea of creating things out of tiny pieces instead of making things smaller as so far at that time.

⁵ <http://www.tab.fzk.de/de/projekt/zusammenfassung/ab92.htm>

⁶ http://www.bfr.bund.de/cm/213/molekulare_nanoroehre.jpg

⁷ <http://en.wikipedia.org/wiki/Image:C60a.png>

⁸ <http://en.wikipedia.org/wiki/Buckminsterfullerene#Buckminsterfullerene>

His main idea was to structure atoms as it is useful although he never used the word nanotechnology.⁹

The term “nanotechnology” was established by Norio Taniguchi in 1974. He represented the idea that this new technology is some kind of production technology with extreme high precision in a small dimension.¹⁰

Because of the high precision that was needed and the tiny pieces which had to be structured, new tools had to be invented. Gerd Binnig and Heinrich Rohrer faced up to this challenge and invented the scanning tunnel microscope in 1981. Therefore they obtained the Nobel Prize in physics in 1986.¹¹



Picture 5: Scanning tunnel microscope¹²



Picture 6: Transmission electron microscope¹³

Inventions like the atomic force microscope followed in the middle 80's. Today there are high performance transmission electron microscopes which can also be used to monitor single atoms.

In the year 1985 the first solid carbon molecules called fullerenes were discovered.

⁹ <http://www.nano-polis.de/nanotechnologie.htm>

¹⁰ <http://www.nano-polis.de/nanotechnologie.htm>

¹¹ <http://sebi.name/~olga/geschichte.php>

¹² <http://images.google.de/imgres?imgurl=http://www.weltderphysik.de/>

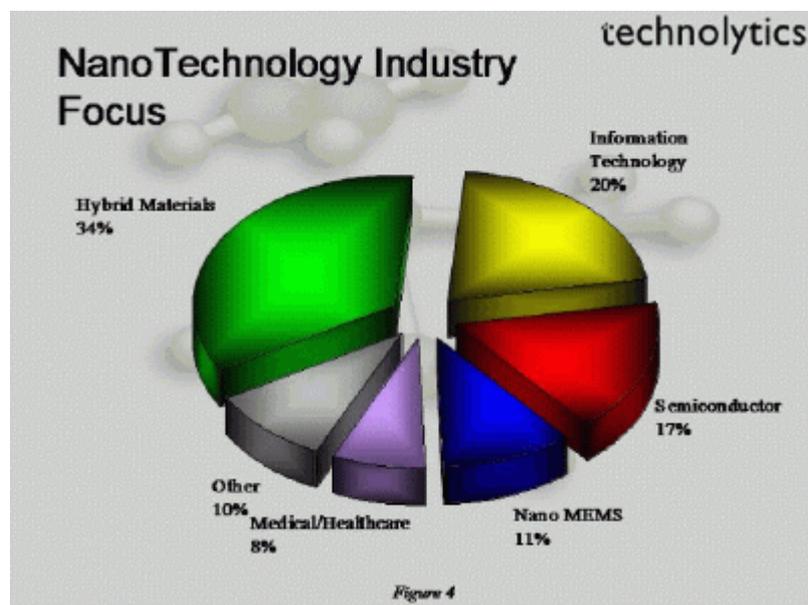
¹³ <http://www.fz-juelich.de/portal/datapool/presse2/2004-01-27-ERC-SATEM3.jpg>

Independent from Taniguchi's idea of nanotechnology Eric Drexler published his perception in his book "Engines of Creation" in 1986. His definition of nanotechnology was much closer to the idea of constructing complex machines and materials out of single atoms.

In 1991 the first fullerenes were produced artificially.¹⁴

Today nanotechnology is used in different sectors of the industry and can be found in a wide range of products.

3) Applications of nanotechnology



Picture 7: Product Categories¹⁵

As mentioned before nanotechnology can be used in various ways. The automobile industry uses this technology to make varnish resistant against scratches and solar irradiation. It is also used to avoid abrasion to wheels by creating a new mixture of materials that reduces friction.

¹⁴ <http://sebi.name/~olga/geschichte.php>

¹⁵ http://www.directionsmag.com/images/articles/nano_tech/nano0a.gif

Nanotechnology makes it feasible to seal car windows to protect them against dirt and mud. In the future nanotechnology will be used in nearly every part of a car.¹⁶

Civil industry uses nanotechnology to impregnate windows and roofing tiles so that rain water can roll off and wash dirt away. This is called "Lotus effect". Even structural damages caused by microorganisms can be avoided by sealing building facades with the appliance of nano-particles. A new important aspect is the creation of high performance concrete. This special kind of concrete enables building enterprises to construct buildings faster and more efficient as ever before. High performance concrete is much more solid and hardens much faster than conventional concrete so that less material and time is needed to finish construction projects.¹⁷

Medical science avails itself of nanotechnology to fight against cancer. A new method has been developed in the "Charité of Berlin". The fundamental idea of this new method is to inject metallic nano-particles directly into the ulcer. These particles are excited in vibrancy by a magnetic field and heat occurs. If the heat exceeds 70°C the tumor dies. The clue is that healthy body tissue is not influenced or even damaged by the use of this method. Nano-particles are also used as a contrast medium in radiography. This technique makes an early detection of bodily changes in complex body parts like lymph nodes feasible.¹⁸

Even cosmetics are produced by the use of nanotechnology. Nail polish is getting scratch resistant and producer of sun cream replace chemical parts of their products by nano-particles which have the same characteristics like transparency and ultraviolet filtering.¹⁹

¹⁶ http://www.nanoscience.de/group_r/ausstellung/anwendungen/auto.shtml

¹⁷ http://www.nanotruck.net/pdf/nanotechnologie_architektur_und_bauwesen.pdf

http://www.vdi-nachrichten.com/vdi_nachrichten/aktuelle_ausgabe/akt_ausg_detail.asp?source=volltext&cat=2&id=34137

¹⁸ <http://www.br-online.de/wissen-bildung/thema/nano/medizin.xml>

VDI Nachrichten 29. Juni 2007 „Mit Nanotechnik Menschen heilen“

¹⁹ <http://www.3sat.de/3sat.php?http://www.3sat.de/nano/astuecke/20835/index.html>

Scientists at the “Helmholtz-Zentrum” for environmental research developed a new method to clean polluted ground water by using carbon and iron nano-particles. Thereby charcoal is reduced to small pieces of about 1000 nm. These particles are mixed with the polluted ground water so that the pollutants can be absorbed by the charcoal particles. The charcoal acts like a binder. Furthermore iron particles with a size of 10 nm are needed to let a chemical reaction take place. The benefit of this method is that it is much cheaper and less harmful to the environment like the use of chemicals. Further on it is all-purpose applicable for plenty of pollutants. But this process is still in development. Scientists try to make it capable for an easy use. Therefore they look for a partner company in Germany that produces patented reagents.²⁰

4) Chances and risks of nanotechnology

Although nanotechnology has partly entered our all day's life with a range of consumer goods, it is still at the beginning of its development. The most important effects have already occurred in the sections of medical science and environment. Diseases like cancer can be detected and fought against much more effectively by the help of new healing methods based on nanotechnology like the hyperthermia method.²¹ Furthermore a lot of materials can be saved by the use of nanotechnology especially in the civil industry.

But there are also risks we are faced with. Cognitions about the long term behavior of nano-particles especially in consumer products like deodorants, sun cream or other cosmetic products are still rare. Uncontrolled release of nano-particles could cause serious danger for users of nano-treated products. In a lot of application areas of nanotechnology nanotubes crop up. These nanotubes have nearly the same effect like asbestos fibers. Infiltrated into the human lung they will cause latent diseases.²²

²⁰ VDI Nachrichten 13 Juli 2007 „Nanopartikel reinigen stark verschmutzte Grund- und Abwässer“

²¹ <http://www.br-online.de/wissen-bildung/thema/nano/medizin.xml>

²² <http://www.tab.fzk.de/de/projekt/zusammenfassung/ab92.htm>

Insurances like the “Allianz Versicherungs-AG” already have realized the risks of this new technology and demand further researches into nanotechnology from industry and research to make the risks more calculable.²³

5) Resumé

I think that nanotechnology is one of the most important future technologies. I am convinced that there is high potential in this technology.

Diseases like cancer or even AIDS can be fought against in the future by the use of new methods using nanotechnology.

Our lives get simpler and more comfortable because of developments like self-cleaning varnishes or cosmetics based on nanotechnology.

The environment can be saved by replacing chemicals with nano-particles in new products.

But this is not the only aspect. It is also a very important economic factor. There can be added a lot of new jobs in this sector of industry. As one of the leading nations in nanotechnology Germany will have great economic perspectives for the future.²⁴ To extend the lead it is important to invest more in this technology and to advance research.

Also important is not to disregard the risks of nanotechnology. Only if the risks are calculable and the benefits preponderate this technology will have a great future in a large amount of application areas.

²³ http://de.wikipedia.org/wiki/Nanotechnologie#Risiken_und_Gefahren

²⁴ http://www.bmbf.de/pub/nanotechnologie_erobert_maerkte.pdf

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