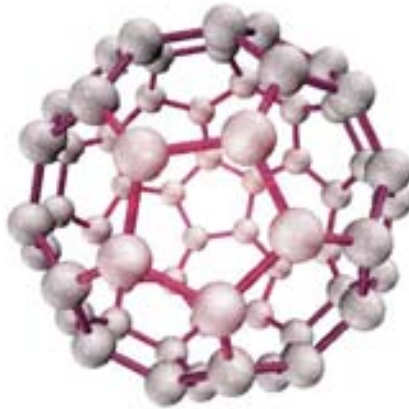


Outstanding
Opportunities in
the Nano-Universe



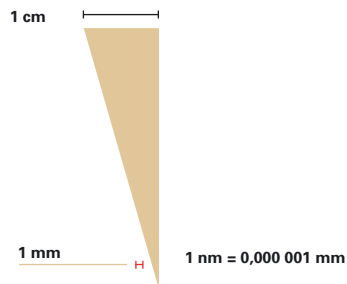
Nanotechnology
in Hessen





Examples of pioneering discoveries in nanotechnology: The 'football molecule' which is composed of 60 carbon atoms, and its structurally related compounds, the carbon nanotubes, have unique chemical and physical properties that can make them applicable as catalysts, semiconductors or superconductors in the electronics industry as well as optical components in flat screens.

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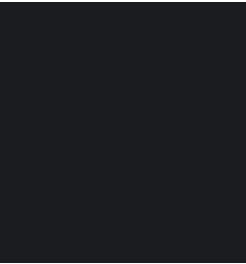


A nanometer is to a millimeter what the distance from Kassel to Frankfurt is to the distance from the earth to the sun.



“The state of Hessen is internationally competitive in nanotechnology and its associated disciplines. There is a strong link here between tradition and and future technologies. Global players with long traditions such as Degussa, Heraeus or Merck as well as promising new companies all do research, develop and manufacture in our state. This often takes place in close cooperation with the excellent Hessen universities which recently formed the NanoNetzwerkHessen. In order to maintain our leading position, the state government supports a wide range of activities in this fascinating technology. Taken together, this has created first-class conditions for the companies and academic researchers in nanotechnology which makes Hessen very attractive for domestic and international investors.”

**Dr. Alois Rhiel,
Hessen Minister for
Economics, Transportation
and Regional Development**



Nanoanalytics: Research and testing of materials and construction components in the nanoscale.

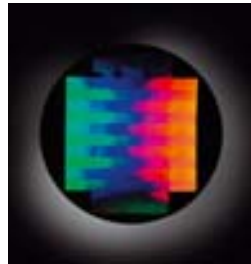
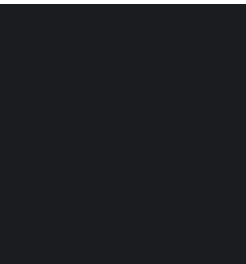
Nanochemistry: This field of nanotechnology creates and changes chemical systems, often with new results.



Nanooptics: Research and production of the smallest optical components and structures for light sources, lenses and much more.



Nanomaterials: Nanoparticles, powders or layers create completely new applications for materials.



Nanoelectronics: This is focused on all areas of electronics in which nanostructures are relevant.



Nanofabrication: Ultra-precise production and processing in the nanometer scale.

Nanobiotechnology: It gains insight into the structures and functions of life and transfers this knowledge into technical systems.



Tiny Dimensions – Enormous Opportunities

Advances in the nano-universe – a world of unimaginably small dimensions – have had a huge impact on many business sectors in Hessen. Application-oriented research will result in products with significant importance for our society.

Those who analyse, produce or use structures under 100 nanometers are active in the field of nanotechnology. A nanometer is one billionth of a meter. The word nano is derived from the Greek word Nanos which means dwarf. In this world of small proportions, the scale of measure is the level of single atoms or groups of atoms. And it is precisely at this level that materials can have completely different chemical and physical properties, as compared to the 'big' world. Nanotechnology opens up new possibilities to significantly reduce the size of technical systems and to manufacture products with special attributes at the highest level of precision.

Because nanotechnology has an impact on nearly all business sectors, it is considered as an interdisciplinary technology and one of the key technologies in the 21st century. It is considered an indispensable tool for companies and research institutes active in the fields of optics, electronics, telecommunications, chemicals, biotechnology, pharmaceuticals, medicine, environmental technology and energy technology.

Hessen is an excellent location for research as well as for multinational companies and start-up companies in all of these sectors. There are currently more than 70 companies in Hessen which offer only nanotechnology. And more than 200 additional companies are active in the fields of materials technology, optical technology and micro-systems technology.

'Nano-products' can already be encountered in our everyday life. For instance, in ultrafine carbon particles which are used as fillers for automotive tires with excellent road-handling characteristics. Other products include scratch-resistant car paint, water- and dirt-resistant exterior paints, stabilizers in loud speakers, read-write heads for computer hard drives, and light diodes for traffic management systems.

Nanometer size carbon particles in industrial carbon ('carbon black') give tires excellent road handling qualities on wet streets and also reduce friction. Degussa's division Fillers and Pigments, with subsidiaries for instance in Frankfurt and Hanau, is the world's second largest producer of carbon black.



In the Middle Ages glass-makers unwittingly created nano-fine particles by melting small amounts of gold into the glass. This resulted in gold particles which measured only a few nanometers and gave objects a bright red color, such as this cup at the Hessen State Museum in Darmstadt.



Dr. Wolfgang Vollrath,
Leica Microsystems AG, Wetzlar
at the Frankfurt Airport

“Leica Microsystems is an international company based in Wetzlar. With its technologically-advanced products, the company focuses on the markets and applications of optical, measurement, structuring and analyzing micro- and nano-structures. Many of the products from Leica Microsystems, such as those for the semi-conductor or life science industries, are market leading.”

Leica is a highly-innovative company from Hessen whose globally known brand name is a synonym for the highest standards of quality in German optical technology.



For the invention of the scanning tunneling microscope, Frankfurt's nano-scientist Gerd Binnig received the 1986 Nobel Prize for Physics. This device allows scientists to precisely perform research and quality controls on nanostructures – down to a scale of one atom.



A scanning tunneling microscope from Omicron NanoTechnology GmbH: since 1984, this company has worked in the area of surface analysis and is one of the oldest companies in the field of nanotechnology. From its humble beginnings, the company has developed into a continually growing international player.



Norbert Nold, managing director of Omicron NanoTechnology GmbH in Taunusstein

Particles for Products

The special optical qualities of nano-products create new possibilities for design and visual effects. The interplay of colors has great visual appeal and arouses distinct emotions.

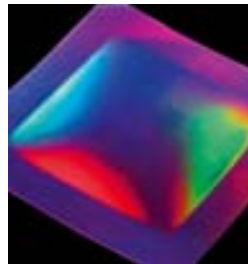
The Darmstadt-based Merck KGaA, the oldest chemical and pharmaceutical company in the world with a history that dates back to 1668, unites both tradition and innovation. Merck highly values research and that enables the development of nanotechnology products. The use of nanotechnology enables the production of materials with amazing chemical, physical and biological qualities. This opens the door to innovative products, such as optical displays or special car paint. Already in 1998, Merck created an internal nanotechnology platform which allowed experts from different departments to exchange information and ideas. The goal is to encourage interdisciplinary developments and new business areas. Merck's nanotechnology experts use this platform not only internally but also externally with partners such as research organizations and industry trade associations.

In the area of nanotechnology, Merck has successfully developed and brought to market numerous interesting products. This includes pearlescent pigments which create new color designs in car paint, plastics and cosmetics. These pigment particles are composed of plate-shaped nano-layers which create deep and soft colors when interacting with light. In

the cosmetics industry, round particles – much like a nano-ball bearing – are used because they are more comfortable to the skin. Specially-coated microballs "fool" light rays into thinking that an uneven surface is actually smooth. This quality is used in the cosmetics industry where such particles are used to mask wrinkles.

In many projects, Merck developed photonic crystals. This new nanomaterial is known for its shimmering color effects which are dependant on the viewing angle and are similar to those of a natural opal. This has also enabled more functional applications. Researchers are currently working on concepts in which photonic crystals can influence light much like today's semiconductors influence electric currents. This would enable complete, integrated optical components with enormous increases in performance.

Color is in the eye of the beholder: depending on the angle, the CECOS color effect composite from Merck KGaA in Darmstadt can change in color. This nanomaterial is composed of large-scale photonic crystals, which were developed by Merck and the German Plastics Institute.





Christian Hockemeyer,
Managing Director of
NaWoTec GmbH, Roßdorf

“NaWoTec develops and builds equipment for three-dimensional nano-structuring. Our core competency is in the structure modification of surfaces. Our products are focused on the critical needs of the semiconductor, biotechnology and medical technology sectors but also offer solutions for other industrial applications. Our vision is to become one of the global leaders in the field of surface structuring.”



Repairs in the Nanocosmos: An instrument made by NaWoTec removes excess material (left) from the mask (right).

Opportunities for Startups

"Nothing ventured, nothing gained!" is also true for nanotechnology. For many nanotechnology researchers in companies and universities, the possibility of founding a new startup firm is attractive and is often very successful.

Basic research and product development are closely intertwined in nanotechnology, unlike many other future technologies. Already in the laboratory, researchers recognize that the fruits of their labor will be commercial products with great benefits to customers. Many researchers have therefore taken the courageous step to start their own business and develop products for international markets. These entrepreneurs must conduct further years of application-oriented research, have the right strategy and be patient. Numerous hurdles must be cleared, such as choosing the right business model, financial model, and cooperation partners as well as marketing and sales issues. This goal is best achieved if many different types of support and infrastructures are available.

Hessen has the right climate for startups. Industrial parks enable companies to be located near excellent universities, leading companies and nanotechnology networks. In addition, there is a wide range of startup programs and subsidies. The success of companies like NaWoTec GmbH in Rossdorf near Darmstadt is a good example. NaWoTec, a spin-off from Deutsche Telekom AG, received the 2003 Ger-


man Business Innovation Award in the category "Startup" for a new machine used to repair masks in semiconductor chip manufacturing. Masks are similar to the templates for electronic chip components. Every chip needs up to 30 masks, at a cost of 100,000 EUR each. Because the masks cannot be produced without errors, they must then be reworked. The equipment used for such jobs are not precise enough for today's chips, which have structures not of 100 nanometers but 65. In fact, this equipment can even destroy the delicate masks. Not so, with the new machine from NaWoTec, which was developed together with LEO Elektronenmikroskope (today Carl Zeiss SMT AG). It combines a Scanning Electron Microscope with a gas injection system. The electron beam in the microscope is like a very fine pointer, which uses energy to make the gas molecules interact with the surface. It is then possible to remove any excess material from the mask, much like an eraser, or to fill any gaps with a type of molecular putty. This represents a real technological advancement for chip manufacturers all over the globe.

The nano-gripper from the Kassel-based Nascatec GmbH, seen in comparison to an ant, can be used to manipulate smallest components



Mid-sized
companies

9



**“We want to continue to expand
Industriepark Wolfgang into an
internationally-active and attractive
location for high-tech companies
and thus contribute to the economic
success of the Rhine Main Region.”**

**Dr. Wolfgang Minnerup,
Managing Director of Industriepark
Wolfgang GmbH and head of
Industriepark Wolfgang**



Industriepark Wolfgang is a wholly-owned subsidiary of Degussa AG and has developed over the past three years into a modern service company and professional service provider for high technology companies.

It is also the operating company of the Industriepark Wolfgang, Europe's only operating industrial park with a complete infrastructure for materials technology and materials science. Surface and layer technology, nanotechnology and microtechnology all play an important role.

Room for Success

Growth needs space and a strong foundation. Hessen's industrial parks as well as technology-oriented business incubators in Kassel, Marburg, Gießen, Frankfurt, Fulda and Darmstadt offer ambitious nanotechnology companies an ideal combination of infrastructure, services and proximity to strong partners.

Small and medium sized companies grow faster in a climate that guarantees fast and uncomplicated processes in all relevant fields. There is a considerable advantage when a company is located in an area with production facilities, laboratories, warehouses and technical buildings. There is an even greater advantage when strong partners with specialized skills are also available, for example, in questions of research, to reduce costs by improving production processes or in such important areas such as work safety, fire safety and environmental protection. All of this is provided at industrial parks in Frankfurt-Höchst, Hanau and Wiesbaden, as well as by their operating companies. Another positive factor is the proximity to large companies and well-known research institutions. Degussa Advanced Nanomaterials in Hanau-Wolfgang benefits from this scenario. Following three years of successful research, the internal start-up from Degussa AG has spun off from the Degussa project platform for nano-materials. It is focused on custom-made nano-products for the cosmetics, elec-

tronic, optical and surface industries. Its first product to market was a nano-structured zinc oxide. Many tons of this material have already been mass produced. This product is used as UV protection in sunscreens, not only because it has a high level of sun protection but also because it is comfortable on the skin and transparent. But zinc oxide can also be used for UV protection for technical surfaces, such as paint.

Blue Membranes GmbH, located in the Kalle-Albert Industrial Park, Wiesbaden, is focused on the development of medical products. This includes mesh tubes to expand blood vessels (stents) with a porous carbon ceramic surface. They are very compatible with human tissue and can be loaded with nearly every type of medicine, which it can then release in a controlled fashion. Frankfurt-Höchst is also one of the leading centers for nanotechnology, in particular in the area of surfaces. The cooperation project Smart Surface offers a wide range of services in the area of surface analysis. In addition, the Frankfurt-Höchst based company PEMEAS and Infra-serv are focused on the area of fuel cell technology, an important field of applications for nanotechnology.



This flame reactor from Degussa Advanced Nanomaterials can create large amounts of nano-structured metal oxides with a high-level of purity. The manufacturing process is based on so-called gas phase synthesis.



In the new Stock Exchange building in Frankfurt am Main: Marco Beckmann, managing director of Nanostart AG (right), converses with Rainer Riess, Managing Director of Deutsche Börse AG (left)

“Nanostart AG is one of the world's leading investors in the area of nanotechnology. We invest in young and dynamic high-growth companies, and also advise financial companies about such investments. Our work helps to show investment companies how to profit from nanotechnology's enormous potential. In addition, our location in Frankfurt has an excellent infrastructure for investors in this new technological sector.”

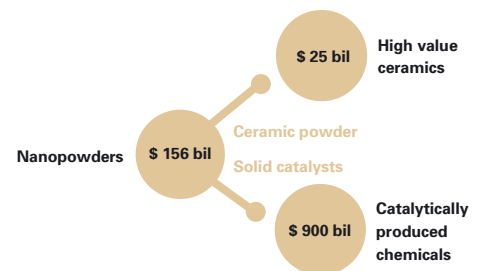
Future Investments

The German poet and philosopher Johann Wolfgang von Goethe wrote: "Everything depends on money, and everyone pursues money." In today's globally competitive markets, major industrial countries are investing heavily in nanotechnology.

In order to guarantee Germany's competitiveness in the field of nanotechnology and to create new jobs, investments in future technology are critically important. Germany has taken a leading position in the field of nanotechnology, thanks in part to forward-looking subsidy programs. The number and importance of German companies in this field has increased significantly in recent years. The USA and Europe have roughly the same number of nanotechnology companies, according to recent estimates. But about half the European companies are based in Germany. Among the 450-500 German companies involved in nanotechnology, more than 70 are based in Hessen. These companies range from global players such as Merck, Heraeus or Degussa, to small and medium sized enterprises. Investment companies, venture capital firms and private investors are increasingly interested in nanotechnology. Nanotechnology firms are particularly attractive to investors when their business concept is based on a concrete product which can be quickly brought to market. Money and nanotechnology are also intertwined in another way. New and more accessible technology

has made it easier to counterfeit money, credit cards and documents. To help fight this problem, the task force headed by Prof. Dr. Norbert Hampp at the University of Marburg has developed a new security system based on nanobiotechnology. This system is based on nanopigments consisting of protein bacteriorhodopsin. This protein can be found in certain bacteria that live under high salt conditions and use bacteriorhodopsin to generate energy from sunlight. The protein changes color from purple to yellow when exposed to bright light. If a bank note is photocopied, then the counterfeit note turns yellow and is unusable. By using this and other innovations from nanotechnology, security authorities will maintain a technological advantage over counterfeiters.

The economic potential of nanotechnology in the chemical sector:



Security is an important issue in Frankfurt am Main, which is an international financial center, headquarters for the European Central Bank and home to Europe's largest trade fair center. Nanotechnology's contribution to security technology is also valued by the Frankfurt Airport as well as the Federal Criminal Police Agency in Wiesbaden.



Prof. Dr. Norbert A. Hampf,
Institute for Physical Chemistry
at the University of Marburg

"Marburg's high academic standards in the field of natural science are recognized both in Germany and abroad. Both here and in the surrounding communities, it is possible to work together with many first-rate researchers. In my research group, we are focused on applications for biological materials and have developed applications for security technology, optical data storage, non-chlorine bleached paper and for the medical field. We work very closely with industrial companies on these projects."

Room for Discovery: the Kubacher Crystal Cave near Limburg is Germany's only crystal cave and has the highest ceiling of all publicly-accessible German caves. Surrounded by 350 million year old limestone, the cave is a unique natural wonder.



The bio-pigment bacteriorhodopsin is a protein found in certain bacteria as two-dimensional crystals. Using a diode lamp, it is possible to write on a film made of bacteriorhodopsin (right). This principle of optical data storage opens numerous applications, such as creating counterfeit-proof documents (left).

From Ideas to Partnerships

The saying “Together we are strong” is not only true for friends, but also for the collaboration of science and economy in nanotechnology. Different disciplines and intellectual approaches complement each other and increase the rate of innovation.

When universities and business work together, both profit. Business can transfer part of their research projects to the university. Instead of creating their own R&D infrastructure with personnel, time and money, companies can effectively outsource these activities. Many of these joint research and development projects are publicly financed. Universities, on the other hand, receive financial support from the private sector which takes the strain off their public budgets and enables first-rate international research projects. And finally, many of these research results are quickly developed into products and then brought to market.

Prof. Dr. Andreas Greiner at the University of Marburg knows from personal experience about such cooperative projects and would like to see more in Hessen. Together with his colleague Prof. Dr. Joachim Wendorff, he further developed a fast, simple and cost-effective method to produce plastic nano-fibers: electro-spinning. A solution of plastic material is placed under voltage and accelerated in a thin stream between two electrodes. The fibers form a fine mat at the opposite pole. They can be extremely long and very thin –

a hundred or thousand times thinner than a human hair. In addition, the surface of the nano-fibers can be increased significantly through pores. It is also possible to make adjustments to the process so that certain chemical, physical or biological qualities are added. This, in particular, is highly valued by industrial partners such as the tradition-bound paper manufacturer Papierfabrik Binzer in Hatzfeld, which is part of the market-leading Hollingsworth & Vose group today.

Hollingsworth & Vose is one of the world's leading manufacturers of industrial filter materials. This cooperation has already yielded its first product (Nanoweb). The market potential is many hundreds of millions of euros. The electro-spun nano-fibers are also well suited for medications, catalysts or biological pesticides. They open up a fascinating new area for products which can be found in our everyday lives.



Tiny, hollow, porous, and incredibly varied: nano-fibers from the University of Marburg under an electron microscope (horizontal) as compared to a human hair (vertical)



Prof. Dr. Robert Tampé,
Institute for Bio-Chemistry at
the Johann Wolfgang Goethe-
University in Frankfurt am Main

“Nanobiotechnology promises to provide new tools in bio research over the medium- and long-term. Among these innovations are the so-called protein chips. These are microscopic ‘laboratories’ in which proteins are placed on the surface in high amounts and density so that they can be studied. The applications range from environmental analysis to medical diagnosis and therapy. We have developed these chips in my working group to study the interaction of proteins in the dimension of the nano-universe.”

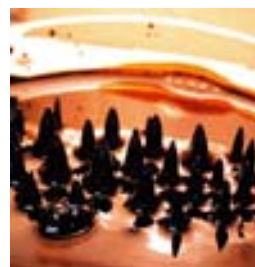
A Touch of Nano

The exact study of the nano universe reveals the natural laws and interdependency on a scale of single atoms and molecules. The better one understands the qualities of nano-materials at this dimension, the faster it is possible to transform research discoveries into technical applications.

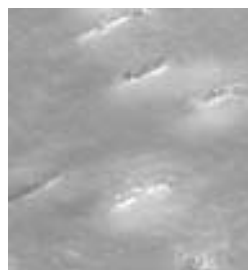
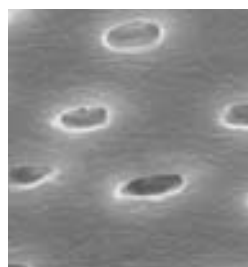
The Institute for Materials Research at the Technical University of Darmstadt uses the most modern analysis methods to explore the world of smallest dimensions. CVD, RHEED or AFM/STM are some of the many abbreviations for the more than 20 processes used by Prof. Dr.-Ing. Horst Hahn and his colleagues daily. They create and describe nanomaterials and determine their optical, electrical, catalytic or mechanical qualities. Together with the working group of Prof. Dr. Karsten Albe, researchers use high-performance computers and programs to simulate the chemical and physical behavior of many millions of atoms. Nanomaterials can be composed of particles, thin layers, multi-layer systems or nano-crystals. Each structure has advantages for certain application areas: layers for electronics or optics, crystals for ceramics or filters. Nanoparticles are used as catalysts or polishing agents. Such particles are a specialty of Sus-Tech GmbH in Darmstadt. Professor Hahn and five other nanotechnology experts as well as the TU Darmstadt and Henkel were involved in the foundation of this company.

This task force looks after research projects and gives support with nanotechnology concepts. One of SusTech's products contains nanoparticles from iron compounds, which act like a liquid magnet. It can be used as a fuel additive, in microwave receivers or in shielding layers. An additional product was developed together with Henkel for dental medicine. If the gums begin to recede, it exposes the root of the tooth. The tooth loses a protective layer of dental cement, exposing the underlying dentin with its small openings, the tubuli. This can cause a toothache when exposed to hot-cold or sweet-sour stimulus. Previous methods to treat this condition focused on the closing of the tubuli. However, this uses mostly materials that are not natural to the tooth and therefore cannot be permanently connected to the natural tooth. But the product from SusTech is different. It is composed of the same material as a tooth and is already working very effectively in testing.

Iron compound nanoparticles in solution create a prickly structure in a magnet field. In this way, magnets can be used to direct abrasive materials to the place where they are needed most.



Dentin with tubuli magnified using an electron microscope before and after a treatment with nanomaterial that is identical with tooth materials.





Networks create the right conditions for research groups to work together, despite physical distances. In addition, the network makes the research results accessible to other members, thereby accelerating the development of new products, processes and services.

The university coordinators of the NanoNetworkHessen (from left to right and from top to bottom):

Prof. Dr. Andreas Greiner (Philipps-University Marburg),
Prof. Dr. Robert Tampé (Johann Wolfgang Goethe-University, Frankfurt am Main),
Dr. Beatrix Kohnke (University Kassel),
Prof. Dr. Matthias Rehahn (TU Darmstadt),
Prof. Dr. Bruno K. Meyer (Justus-Liebig-University Gießen),
Prof. Dr. Hartmut Hillmer (University Kassel)

Clusters and Networking

A network is not only found in the information and communication technology sectors. The word also stands for the intense information exchange and cooperation among scientists but also between researchers and industry. Only through networks that connect different disciplines and sectors is it possible to exploit the unique potential of nanotechnology.

In order to be successful in nanotechnology, scientists from different disciplines must work hand in hand. For that reason, the NanoNetworkHessen was established in early 2004. The presidents of the five universities in Hessen in Darmstadt, Frankfurt am Main, Gießen, Kassel and Marburg as well as the Universities of Applied Sciences in Darmstadt, Fulda, Frankfurt am Main, Gießen-Friedberg and Wiesbaden agreed to work more closely together. The goal is to communicate more intensively about the research and study of nanotechnology, to share infrastructure and equipment, and to present a unified appearance to other experts in the field as well as to the general public. In addition, the NanoNetworkHessen is a platform for technology transfer between researchers and industry. Many of its members, for instance the university in Marburg, are also involved in German and European networks. The main point of coordination is located at the University of Kassel. Following the concept of interdisciplinary studies, the university established the

CINsaT (Center for Interdisciplinary Nanostructure Science and Technology) in 2002. In this center, researchers from the departments of natural sciences and the Institute for Microstructure Technology and Analysis (IMA) collaborate with task forces from the departments of electrical engineering, construction engineering and mechanical engineering on manufacturing and characterization of structures measuring less than 100 nanometers. The Kassel-based company Nascatec develops and produces sensors and components to support this technical process. Research is also closely related to teaching. As a result, CINsaT and the departments of natural sciences created an interdisciplinary degree program for young engineers entitled Nanostructure and Molecular Sciences. In addition to the academic network, there are also networks for industry such as the Materials Valley e.V and the expert network Optence.

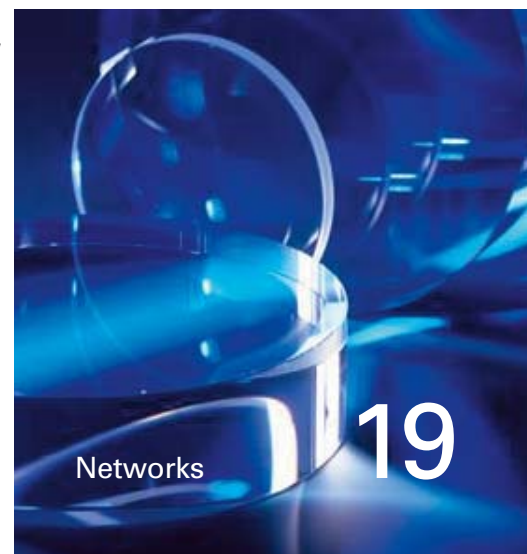
“The goal of the non-profit organization Materials Valley e.V. is to create a higher profile for the Rhine Main Region as an area for high-tech materials research and technology. Material research is focused on both base sciences as well as applied research. The results of this research can be applied directly to products, which has a positive effect on the Rhine Main Region as a business location, but also on the labor market.”



Dr. Wulf Brämer,
managing director of
Materials Valley e.V.

The members of the network include leading industrial companies, universities, research institutes, state institutions and private individuals.

Nanotechnology has a large influence on optical technology. Optence, the regional expert network for optical technology in Hessen and Rhineland-Palatinate combines research, production and applications. Over 160 companies in the region are active in this area, including 60 firms in the Wetzlar region.





If you want to scale the heights, you must rely on teamwork, safety and dialogue. The 20 meter high Hohenstein cliff can be found south of Reichenbach in the idyllic Odenwald forest, and is an ideal practice area for climbers.

“The promises of nanotechnology are so great that all of its benefits cannot be completely envisioned with our current powers of imagination. Which doors do we want to be opened by this key technology? The answer to this question can only be found together with nanotechnology scientists and social scientists, producers and consumers, and philosophers and politicians.”

**Prof. Dr. Alfred Nordmann,
Institute for Philosophy at
the Technical University of
Darmstadt.**

Safety and Dialogue

Whenever new technological territory is reached, it is important that scientists and industry conduct an assessment of both the risks and opportunities. In Hessen and elsewhere, there is great optimism about nanotechnology but reason to be prudent and forward-thinking.

The fast developing nanotechnology sector is being closely accompanied by technological assessment. Risks and opportunities are accessed based on scientific results, so that the current and future development of products are safe and environmentally-friendly.

Nanotechnology opens completely new perspectives for business and society. Numerous products are already available today. Their value to medicine, biosciences, information technology and telecommunications is undisputed. In order to encourage the discussion of the risks and opportunities, the Society for Chemical Engineering and Biotechnology (DECHEMA) and the German Chemical Industry Association (VCI) in Frankfurt am Main have established a working group entitled 'Responsible Production and Use of Nanomaterials.'

Members of this task force include representatives of industry, environmental scientists, materials researchers, physicians, toxicologists, supporting organizations and work safety groups. Together they identify common areas of the research of risk assessments, initiate application-oriented research projects and exchange information with international experts. Another important area of their work is to support the dialogue with the general public, interest groups and journalists. This exchange of information is not only about the latest research results, but also encompasses the necessary dialogue about economic, environmental and social effects of nanotechnology.

"The commercial success of nanotechnology and its acceptance among the general public is dependant on the safe production, application and disposal of its products. As is the case with other future technologies, there is already a public debate about the benefits and risks. Our task force accepts the challenge to create an interdisciplinary dialogue about the safe use of nanotechnology among scientists and industry, but also with the general public."

Dr. Markus Pridöhl, chairman of the DECHEMA/VCI working group 'Responsible Production and Use of Nanomaterials'

The DECHEMA building in Frankfurt am Main



Contacts

Further information can be received from the following universities, associations and institutions in Hessen:

Expert Centers

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Heinrich-Plett-Strasse 40
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Institute for Microstructure Technology and Analysis (IMA)
Technische Elektronik
Heinrich-Plett-Strasse 40
34132 Kassel
www.uni-kassel.de

Research Center for Material Science (WZMW)
Hans-Meerwein-Strasse
35032 Marburg
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<http://dki-online.de>

Universities and technical colleges

Technical University Darmstadt
Karolinenplatz 5
64289 Darmstadt
Tel.: +49 (0) 6 15 1 / 16 1
www.tu-darmstadt.de

Johann Wolfgang Goethe-University Frankfurt am Main
Senckenberganlage 31
60325 Frankfurt am Main
Tel.: +49 (0) 69 / 79 81
www.uni-frankfurt.de

Justus-Liebig-University Gießen
Ludwigstrasse 23
35390 Gießen
Tel.: +49 (0) 6 41 / 99 0
www.uni-giessen.de

University Kassel
Mönchebergstrasse 19
34109 Kassel
Tel.: +49 (0) 5 61 / 80 40
www.uni-kassel.de

Philipps-University Marburg
Biegenstrasse 10
35032 Marburg
Tel.: +49 (0) 64 21 / 28 20
www.uni-marburg.de

University of Applied Sciences Darmstadt
Haardtring 100
64295 Darmstadt
Tel.: +49 (0) 61 51 / 16-0
www.fh-darmstadt.de

University of Applied Sciences Frankfurt am Main
Nibelungenplatz 1
60318 Frankfurt am Main
Tel.: +49 (0) 69 / 15 33-0
www.fh-frankfurt.de

University of Applied Sciences Fulda
Marquardstrasse 35
36039 Fulda
Tel.: +49 (0) 6 61 / 96 40-0
www.fh-fulda.de

University of Applied Sciences Gießen-Friedberg
Wiesenstrasse 14
35390 Gießen
Tel.: +49 (0) 6 41 / 30 90
www.fh-giessen.de

**University of Applied Sciences Wiesbaden
Forschungsanstalt Geisenheim**
Von-Lade-Strasse 1
65366 Geisenheim
Tel.: +49 (0) 67 22 / 50 22 01
www.forschungsanstalt-geisenheim.de

Interesting Links about Nanotechnology:

www.nanonetzwerk Hessen.de
www.techportal.de
www.nanoforum.org
<http://nano-invests.de>
www.cordis.lu/nanotechnology/
www.nanotruck.net

Associations

**The Association of Engineers (VDI)
State Representative Office in Hessen**
Biebricher Allee 58
65187 Wiesbaden
Tel.: +49 (0) 6 11 / 34 14 76 0
www.vdi.de

**German Chemical Industry Association (VCI)
State Representative Office in Hessen**
Karlstrasse 21
60329 Frankfurt am Main
Tel.: +49 (0) 69 / 25 56 0
www.vci.de

Society for Chemicals Engineering and Biotechnology (DECHEMA)
Theodor-Heuss-Allee 25
60486 Frankfurt am Main
Tel.: +49 (0) 69 / 75 64 0
www.dechema.de

Others

State Initiative hessen-nanotech
HA Hessen Agentur GmbH
Abraham-Lincoln-Str. 38-42
65189 Wiesbaden
Tel.: +49 (0) 6 11 / 7 74-86 14
www.hessen-nanotech.de

IHK Technology Advisory Service Hessen
Börsenplatz 4
60313 Frankfurt am Main
Tel.: +49 (0) 69 / 21 97 14 26
www.itb-hessen.de

**TTN Hessen –
TechnologieTransferNetzwerk Hessen**
HA Hessen Agentur GmbH
Abraham-Lincoln-Strasse 38-42
65189 Wiesbaden
Tel.: +49 (0) 6 11 / 77 4-86 91
www.ttn-hessen.de

**Hessen Ministry for Economics,
Transportation and Development**
Kaiser-Friedrich-Ring 75
65185 Wiesbaden
Tel.: +49 (0) 6 11 / 8 15-0
www.wirtschaft.hessen.de

Hessen Ministry for Science and Art
Rheinstrasse 23-25
65185 Wiesbaden
Tel.: +49 (0) 6 11 / 32-0
www.hmwk.hessen.de

Association of Hessen Chambers of Commerce and Industry
Börsenplatz 4
60313 Frankfurt am Main
Tel.: +49 (0) 69 / 21 97-13 84
www.arbeitsgemeinschaft-hessischer-ihks.de

Association of Hessen Chambers of Crafts
Bierstadter Strasse 45
65189 Wiesbaden
Tel.: +49 (0) 6 11 / 13 6-1 74
www.hessen.handwerk.de

**Business location advisory services
and international cooperations**

Business location advisory services

The business location advisory service team supports local and international companies interested in investing in Hessen to find the right location as well as cooperation partners.

HA Hessen Agentur GmbH

Abraham-Lincoln-Strasse 38–42
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heike.mueller-sedlacek@hessen-agentur.de
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Euro Info Centre (EIC)

The EIC serves as a guide through the diverse range of legal requirements and subsidy programs from the European Union and also provides advisory services for cross board business contacts.

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**More information and brochures
about Hessen as a business
location can be found at:**

www.invest-in-hessen.de
info@hessen-agentur.de
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Source diagram on page 13:
Weltmarkt 2001, BCC; Weltmarkt 1999,
Source: Chemical Institute Canada;
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**Hessen Ministry of
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