Europäische Akademie

zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen
Bad Neuenahr-Ahrweiler GmbH

Direktor:
Professor Dr. Dr. h.c. Carl Friedrich Gethmann

Newsletter

Akademie-Brief · No. 61 (March 2006)

Editorial

Die Europäische Akademie GmbH wurde am 11.3.1996 im Rathaussaal von Bad Neuenahr gegründet und begeht somit in diesen Tagen ihr zehnjähriges Bestehen. Im Vergleich mit vielen universitären und außer-universitären Einrichtungen ist dies keine Zahl, von der eine besondere Ehrwürdigkeit ausgeht. Wissenschaftlichen Einrichtungen, die sich vor allem die interdisziplinäre Forschung auf ihre Fahnen geschrieben haben, scheint jedoch in Deutschland kein langes Leben beschieden, wie das Schicksal des Max-Planck-Instituts zur Erforschung der Lebensbedingungen der wissenschaftlich-technischen Welt (1970–1981, Starnberg), der Akademie der Wissenschaften zu Berlin (West) (1987–1990) oder der Akademie für Technikfolgenabschätzung in Baden-Württemberg (1992–2003, Stuttgart) zeigt. Die Gesellschafter, Mitarbeiter und Mitglieder des Wissenschaftlichen Beirats und des Kollegiums der Europäischen Akademie können deshalb mit Stolz auf diese zehn Jahre blicken, vor allem angesichts der Tatsache, dass die Weiterexistenz bis wenigstens 2010 gesichert ist. Die Zehnjahresfeier wird mit Rücksicht auf die Landtagswahlen in Rheinland-Pfalz im Spätsommer stattfinden. Darüber wird der Newsletter rechtzeitig berichten, der dann ebenfalls auf sein zehnjähriges Jubiläum zurückblicken kann (die erste Ausgabe erschien im September 1996).

CFG

Focus

Nanotechnology – Why?

Günter Schmid

Grammatically, the prefix "nano" means nothing but a dimension. However, it is much more than this. Meanwhile it has become a symbol for a change of paradigm in natural sciences: the classical disciplines such as physics, chemistry, biology and to some extent medicine loose their significance, since it can no longer be distinguished between them when arriving at the nanoscale. "Nano" is linked with the appearance of new properties of well-known materials. If a material is reduced in size to a critical point on the nanoscale and – exactly there – exhibits other properties than before, or if some simple molecular building blocks get arranged in a special manner to re-appear in a nanosized construct with a hitherto unknown physical or chemical behaviour, the present excitement about "nano" can be well understood. Therefore, nanotechnology is much more than the simple continuation of microtechnology which exclusively aimed at the reduction of materials or tools, not at the creation of novel abilities. However, based on this fact, nanotechnology obtains its exceptionality.

From a technical point of view, the last century was definitely determined by microtechnology. The continuous reduction of tools has enabled an overwhelming progress on so many fields of mankind's life. Microsurgery allows medical operations reducing risk and pain for the patient. Speed and capacity of modern computers exceed all expectations, just to mention two examples. Nanotechnology, in a first assumption, might be understood as the logic continuation of microtechnology, when moving from the micro- (10^{-6} m) to the nanoscale (10^{-9} m = 1 nanometre, nm, a billionth of a meter). To some respect, this is correct. However, nanotechnology is much more than this. The reason is that in the nanoregion matter can change properties dramatically so that not only the progress in reduction is to be considered, but spontaneous new physical and chemical properties come into play. This opens an almost infinite field of novel applications of, in principle, well-known materials. Nanotechnology, and to a considerable aspect still nanoscience, is dealing with these new perspectives. The dimension itself is, apparently contradictory, not the only factor. Rather it is what we call the spontaneous appearance of a "nano-effect". This usually happens in the region below 100 nm, but can also be observed at much larger dimensions. In so far, it makes no sense to define nanotechnology only by a dimension. Most of the definitions found in literature are based on a length scale only. This does not meet the focus of nanoscience and nanotechnology. The simple reduction of a material even down to a few nanometres without generating a new property is nothing but a scaling effect that is not worth being linked with the terminus "nanotechnology". This is an important presumption which automatically excludes numerous processes that were wrongly announced as "nanotechnology" in the course of the last few years.

Why does a material at all exhibit new properties only by reaching a size below a distinct dimension? The reasons are usually based in fundamental physical events and cannot be explained in detail here. They can be very much different, depending on the corresponding material: everybody knows

and likes the beautiful colour of the noble metal gold. However, if a gold particle is reduced in size down to 50 and less nanometres, its colour turns blue first, then purple and finally bright red. The impressive red colour of ruby glass is due to the presence of about 15–20 nm sized gold particles. Where does this change come from? The so-called metallic properties of a macroscopic (or even a microscopic) piece of metal are determined by the special metallic electronic situation. Parts of the electrons (building blocks of atoms) are delocalized, i.e. they are freely mobile in all directions in the material and so, by the way, they are responsible for the typical electric conductivity and for the typical lustre of metals, too. In particles of less than about 50 nm in diameter, the electrons are increasingly "fenced" in the extremely small volume. In case of gold they then interact in a different way with visible light than they do in the macroscopic state. Visible light induces a collective vibration of the particles' electrons, called plasmon resonance, the wavelength of which is in visible region. If the colour is blue, purple or red mainly depends on the particle's size.

Meanwhile hundreds of other size-dependent nano-effects are known. Most of them are still deeply involved in fundamental research, but will, no doubt, at least partially end up in future high-level technologies. Since all known nano-effects result from basic physics and chemistry, it is decisive for any further progress to continue fundamental research by all means. Typical nano-effects can also originate from atomic or molecular building blocks which are arranged in a way that defined nano-objects with new properties result. Nature has developed such systems in a perfect manner. One of the most impressive examples is DNA. Its famous double helix results from the intelligent combination of only four rather simple molecules (adenine (A), cytosine (C), guanine (G), thymine (T)) to so-called base-pairs. With the help of a phosphate backbone, linked to the base pairs via sugar building blocks, an almost infinite number of base-pair sequences can be built up, storing the specific characteristics of any kind of living beings. Here, the nano-effect consists in a long, but only 1.2–1.5 nm thick intelligent chain, made of "innocent" molecules. Nature works in a manifold manner with nano-effects, for instance when structure proteins, enzymes or viruses are constructed, muscles are working or cell-cell interactions occur. The better understanding of these and many other natural nanotechnological principles is an absolute need to further improve medical diagnosis and health care. It is one of the great challenges in nanosciences to combine natural and artificial building blocks intelligently in order to create novel hybrid systems working on many different fields of application. Such realistic ideas, and partially still dreams, have absolutely nothing to do with science fictional scenarios drawn by irresponsible writers and pseudo scientists.

The forward-looking relevance of nanotechnology shall be further elucidated by means of two examples, described in more detail: storage systems and medicine.

Future storage systems will become necessary since the present technology, mainly based on the use of silicon structure units, will physically fail when the size of the structure units (transistors) reaches an underlimit not yet precisely known. The reason is a classical nano-effect: silicon looses its typical semiconductor behaviour and turns into an insulator which is no longer able to work as a transistor. (The famous "Moore's Law" has been predicting this fact since the early 1970s). There is a world-wide search for a substitute of silicon assuming that the development of faster and faster computers will be continued. Indeed, there are some promising developments to be registered, for instance by using magnetic nanoparticles, organic molecules that can be "switched" by applying a voltage, or by very small metal nanoparticles which can work with single electrons. Today, the most modern chips are still built up by transistors working with some hundred thousands of electrons per calculation step, i.e. to say "yes" and "no" or "0" and "1". Building blocks working with only one electron would definitely represent the ultimate end of electrically based systems. In addition, such systems would save enormous amounts of energy. How can that high goal be reached?

The aforementioned special electronic situation in a blue or red gold particle of a few dozens nm in diameter is still further dramatized if the particle's size is below 2 nm. Then, the electrons are no longer acting collectively, and so they are energetically not to be distinguished, but characterized by distinguished energy levels. Such particles can be loaded by one additional single electron and thus become negatively charged. In this state a charge blockade prevents the transfer of a second electron (Coulomb blockade). Only by applying an increased voltage, the additional electron leaves the particle and makes it neutral again. The charged and the non-charged state correspond to the situation "1" and "0" or vice versa. Particles of that ultimate size with such special electronic behaviour are also called "quantum dots" or "artificial atoms". The reason is that particles of that size no longer follow classical physical laws, but quantum mechanical rules as they are used to describe the situation in atoms. Principally, atoms could be used as single electron switches or transistors. However, their size of about 1–2 tenth of a nanometre makes practical handling almost impossible. Quantum dots of similar properties consist of 4–5 dozens of metal atoms and thus can be imaged, handled or contacted much easier. Of course, there are still lots of difficulties to be overcome. Quantum dots have not only to be organized on appropriate surfaces, but must be connected electrically with the macroscopic world. The development from a fundamental scientific effect to a technological device is often linked with enormous difficulties which cannot be foreseen in detail. However, the need to create new generations of storage systems and computer generations will finally end up with a success story.

Tumour cells are characterized by accelerated growth. On the one hand, this makes them so dangerous; on the other hand, this opens the chance to transport drugs into tumour cells faster than into healthy cells. However, healthy cells are at least partially also damaged and thus are responsible for the many attendant symptoms of a chemotherapy. It is therefore a long-known challenge to exclusively attack tumour cells. Indeed, nanotechnology offers a series of novel aspects to improve the situation. For instance, it is known that tumour cells die at slightly elevated temperatures (42°C). How can tumour cells exclusively be warmed up? The so-called hyperthermia treatment of tumours has meanwhile reached clinical standards and is based on a typical nano-effect: nanoparticles, consisting of magnetic iron oxide (magnetite), warm up if positioned in a magnetic field. Therefore, if they are transferred in appropriate concentrations into tumour cells, they damage them if the patient (or part of his body) is positioned in a magnetic field of appropriate strength. To transfer them into the tumour before, the surface of the magnetite nanoparticles can be decorated with appropriate biomolecules in a way that they are quickly moving into the critical region after injection. If not too deep in the body, they can also be moved magnetically from outside to the place where they are needed without any risk for the patient. Iron oxide nanoparticles can also be used as carriers to transport drugs into tumors.

In view of the state of the art and the brilliant future perspectives of nanotechnology, Richard Feynman's famous statement of 1960, "There is Plenty of Room at the Bottom", might be changed into "There is Plenty of Future at the Bottom".

Professor Dr. rer. nat. Günter Schmid, Dipl.-Chem., holds a chair for chemistry at the Universität Duisburg-Essen. He is chairman of the Europäische Akademie's project group "Nanomaterialien, Nanodevices, Nanocomputing. Standortbestimmung und Perspektiven", which has recently finished its work.

Working Groups

"Elektrische Netze"

On 10th February 2006 the project group "Societal Implications of Electrical Power Grids" held its second meeting at the premises of the Europäische Akademie. The project group discussed further specifications of its working programme, also with respect to the potential addressees of the future report. In the course of the work it is planned to prepare a comparative study on the European states´ level with respect to the focus of the project group's work on de-/re-regulations of necessary expansion, maintenance and repair of power grids. A preliminary contribution to this issue was made by Professor Feess (Aachen), who gave a lecture on "interruption contracts", which may be – among others – an adequate alternative to the extensive and pricy upgrading of electrical power grids. However, the usefulness of this option will have to be proved by the project group. Recently, Dr. Ruth Klüser (Europäische Akademie) has been nominated as project coordinator.

Contact: Dr. rer. nat. Stephan Lingner, Dipl.-Geol./
Dr. rer. nat. Ruth Klüser, Dipl.-Chem.
ruth.klueser@ea-aw.de
Phone +49(0)2641-973 312

News

Book Presentation "Nanotechnology. Assessment and Perspectives"

On 24th April 2006 the Europäische Akademie GmbH will present its study "Nanotechnology. Assessement and Perspectives" at the German Aerospace Centre (Deutsches Zentrum für Luft- und Raumfahrt, DLR) in Köln-Porz. The study is the result of the academy's interdisciplinary project on "Nanotechnology. Assessment and Perspectives."

This book is dedicated to nanotechnology, considered by many as a key to the 21st century. This interesting field of research and development is driven by inputs from different academic disciplines. Accordingly, conformal with its acknowledged work principle, the Europäische Akademie set up an interdisciplinary project group of recognised scientists from various European universities and other institutions to tackle the issue.

Publication: G. Schmid, H. Brune, H. Ernst, W. Grünwald, A. Grunwald, H. Hofmann, P. Janich, H. Krug, M. Mayor, W. Rathgeber, U. Simon, V. Vogel, D. Wyrwa (eds), *Nanotechnology. Assessment and Perspectives.* (Vol. 26 of the series: C. F. Gethmann (ed) Wissenschaftsethik und Technikfolgenbeurteilung. Springer, Berlin 2006. ISBN-10 3-540-32819-X)

For further information see Professor Schmid´s article „Nanotechnology – Why?" in this issue and www.europaeische-akademie-aw.de

New Staff Members

The Europäische Akademie welcomes its new staff members: Kristin Hagen, PhD, cand. mag. *(project group: Pharming);* Dr. phil. Georg Kamp, M.A. *(project group: Verantwortung für zukünftige Generationen. Schulische Umsetzung von Nachhaltigkeit* – Responsibility for future generations. Implementation of sustainability in schooling); Dr. rer. nat. Ruth Klüser, Dipl.-Chem. *(project group: Die gesellschaftliche Bedeutung elektrischer Energieversorgungsnetze* – Societal implications of electrical power grids); Katharina Mader, M.A. (editing and public relations) and Dipl.-Ing. Anja Schlochtermeier, M.A. (funding expert).

Vernissage Barbara Kroke

Am 2. Februar fand die Eröffnung der Ausstellung "Chiffrierte Botschaft" von Barbara Kroke in der Europäische Akademie statt. Kroke bezieht sich in ihren Werken auf die Tradition der informellen Malerei, die die Welt sehr abstrahierend darstellt. Ihre Bilder vermitteln dem Betrachter, dass sie Themen wie Träume oder Schatten reflektiert und verarbeitet. Daher tragen die Bilderreihen auch Titel wie „Spurensuche" oder „Verschlüsselte Träume".

Die Ausstellung ist zu den Bürozeiten der Europäischen Akademie geöffnet (Montags bis Freitags zwischen 9 und 15 Uhr) und wird bis September 2006 gezeigt.

Scientific Advisory Board

On 16th February the Scientific Advisory Board of the Europäische Akademie held its 22nd meeting in Bad Neuenahr-Ahrweiler. Main topics were the final reports of the project groups "Incentives for Organ Donation" and "Environmental Noise. Risk Assessment and Regulation for the Case of Traffic Noise". Both reports were approved by the Board members and will be published and presented to the public in May and June, respectively. The newsletter will regularly report on these topics.

Conferences

Expert Talk "Medizinethik und Recht"

From 16th to 17th February 2006 an expert talk took place at the Europäische Akademie GmbH in Bad Neuenahr-Ahrweiler concerning the issue ´ethics in medicine and law`. Participants were lawyers, physicians and philosophers. The colloquium was introduced by a lecture of Professor Dr. Huster (Ruhr-Universität Bochum) about allocation of health care resources in old age. In his opinion it is not excluded that 'chronological age' might be used as a transparent and just standard for allocation of health care resources.

The evening lecture – a joint event with the "Arbeitskreis Medizinethik" of the Europäische Akademie – was given by Professor Dr. Dr. Hilgendorf (Universität Würzburg). He focused on a critique of what he diagnosed as inconsistencies in the current legislation and jurisdiction on abortion and euthanasia. The next day, Dr. Thiele (Europäische Akademie GmbH) talked about the impact of the ever increasing juridification of medicine on the physician-patient relationship. He proposed a reconstruction of this relationship in terms of a (moral) contract, that allows to protect the peculiar features of the special relationship between doctor and patient while meeting the apparent need for regulation. Finally, Susanne Beck (Universität Würzburg) considered the possibilities of using penalty law as means for regulating biomedical research and practice. She proposed that civil and public law may be better instruments for shaping the biomedical area than penalty law.

Contact: Dr. med. Felix Thiele, M.Sc.
felix.thiele@ea-aw.de
Phone +49(0)2641-973 304

"Experimental Animal Models in Musculo-Skeletal Research"

On 2nd and 3rd February the Europäische Akademie co-organised with the AO-Foundation a workshop on *Experimental Animal Models in Musculo-Skeletal Research* in Davos.

The participants of the meeting shared the view that using animals as experimental models in biomedical research is both in principle morally acceptable and accepted by the general public in gross. However, supporting the use of animal models for musculo-skeletal research does not amount to an excuse for neglecting welfare needs of the animals utilised. Though animal welfare issues are becoming (slowly) a customary part of designing, licensing, funding, performing, and publishing animal research, it turned out that more could be done in terms of specifying the guidelines for animal research by empirical data. An important area for further research is, for example, anaesthesia and pain-management. In addition, increasing animal welfare is

likely a prime means for improving research results.

Another main topic of the meeting has been the fact that there is a currently insurmountable plurality of administrative guidelines for animal research that constitute varying animal protection-levels. Many participants shared the opinion that this plurality does not justify researchers to practice "regulation-hopping", i.e. to adjust their research efforts to the lowest standard within their reach. Instead, it was claimed that it should be part of any researcher's ethos that one endeavours to actively find solutions for those moral problems that have been generated or intensified through a field of research.

It is intended to publish a position paper that sums up the meeting's conclusions. It will be addressed towards funding bodies and journal editors and it is hoped that this position paper may serve as basis for funding- and publishing-decisions in the future.

Contact: Dr. med. Felix Thiele, M.Sc.
felix.thiele@ea-aw.de
Phone +49(0)2641-973 304

Poiesis & Praxis

The most recent and upcoming issues of the "International Journal of Technology Assessment and Ethics of Science" are dedicated to specific foci on *Human Nature and the Sciences* (Vol. 3 (3) July 2005); on *Infectious Disease* (Vol. 3 (4) December 2005) and on *IT & Society* (Vol. 4 (1)). The latter is scheduled for March 2006. Guest editors of these issues were F. Thiele (Europäische Akademie), M. Selgelid (University of Sydney) and B. Lutterbeck (TU Berlin). The articles aim at interested parties from relevant research and policy making areas.

Publications

Carl Friedrich Gethmann

"Argumentationstheorie", in: J. Mittelstraß (ed) *Enzyklopädie Philosophie und Wissenschaftstheorie* (Band 1), Stuttgart, 2005², 203–206

Carl Friedrich Gethmann/Felix Thiele

"Bioethik", in: J. Mittelstraß (ed) *Enzyklopädie Philosophie und Wissenschaftstheorie* (Band 1), Stuttgart, 2005², 470–474

Stephan Lingner

"'Master' für das Treibhaus. Reaktion auf H.-J. Luhmann: Wie Desaster ihren Master finden (2005)", in: GAIA 15/1, 2006, 14–15

Book Review: Pablo Benitez-Ponce "Essays on the economics of forestry-based carbon mitigation", in: *Poiesis & Praxis* (Vol. 4, No. 1), 2006

Lectures

Carl Friedrich Gethmann

18.1.2006: "Rationalität – mit Blick auf die Ökonomie": Institut für Angewandte Informatik und Wirtschaftsinformatik der Universität Duisburg-Essen

7.2.2006: "Energie und Ethik", Book Presentation, Ch. Streffer/C.F. Gethmann/K. Heinloth/K. Rumpff/A. Witt, Ethische Probleme einer langfristigen Energieversorgung, Berlin 2005 (Berlin-Brandenburgische Akademie der Wissenschaften)

Stephan Lingner

1./2.2.2006: "Technikfolgenbeurteilung. Zur kulturellen und gesellschaftlichen Funktion bemannter Raumfahrt." DLR-Autorenkonferenz "Luft- und Raumfahrt in Deutschland", Deutsches Museum, München

Felix Thiele

17.2.2006: "Die Verrechtlichung der Medizin als Problem? Zur Auseinandersetzung mit Wolfgang Wieland." Medizinethik und Recht, Expert talk (Europäische Akademie and FernUniversität Hagen), 16th–17th February 2006, Bad Neuenahr-Ahrweiler

Personalities

Dipl.-Ing. Anja Schlochtermeier, M.A., studied geography, political sciences as well as town planning and regional planning at the University of Oldenburg. Main focuses of her studies were both European policy and cross-border- and interregional structural development. After her university studies she worked at the European Commission in Brussels in the Directorate General "Regio" as a *stagiaire* where she was responsible for the mid-term evaluation of INTERREG II-A-projects carried out in German border regions (cross-border-cooperation). Since 2000 she worked at the EU-Bureau of the Georg-August-University of Göttingen as EU-research adviser which she finally headed from 2001 on. Her main responsibility was ensuring the participation of researchers at the University of Göttingen in the Research Framework Programme of the EU. This included tailor-made information to the scientists, proposal writing and submission, project and financial management as well as project reporting. In addition, she coordinated a European educational project with twelve partners from four countries. After a parental leave, Anja Schlochtermeier joined the Europäische Akademie Bad Neuenahr-Ahrweiler.

Dipl.-Ing. Anja Schlochtermeier, M.A., is responsible for acquisition and administrative support of external funded, in particular EU-funded, research projects at the Europäische Akademie.

Publisher: Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH, Wilhelmstraße 56, D-53474 Bad Neuenahr-Ahrweiler
e-mail: europaeische.akademie@ea-aw.de, Internet: www.europaeische-akademie-aw.de

Director: Professor Dr. phil. Dr. phil. h.c. Carl Friedrich Gethmann (V.i.S.d.P.)

Editing: Katharina Mader, M.A., Phone +49 (0) 26 41-973 313, Fax 973 320, katharina.mader@ea-aw.de

Print: Warlich Druck Ahrweiler GmbH, Bad Neuenahr-Ahrweiler
ISSN 1432-0150, frequency of publication: 6–8 times per year, 2.700 copies, reproduction is permitted with reference to the source, please send two voucher copies.

Nanotechnology, the manipulation and manufacture of materials and devices on the scale of atoms or small groups of atoms. The â€œnanoscaleâ€ is typically measured in nanometres, or billionths of a metre (nanos, the Greek word for â€œdwarf,â€ being the source of the prefix), and materials built at this.Â { "962484": { "url": "/technology/nanotechnology", "shareUrl": "https://www.britannica.com/technology/nanotechnology", "title": "Nanotechnology", "documentGroup": "TOPIC PAGINATED LARGE" ,"gaExtraDimensions": {"3":"false"} } }. Nanotechnology ("nanotech") is manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnology as the Context - Nanotechnologies refer to technologies which exploit the unique properties of tiny particles of nanometre size (millionths of a millimetre). Nanotechnologies represent a fast-growing market; they are already being used in a variety of technologies and consumer products. (Click here for a list of such products). However, materials containing nanoparticles may be of concern for human health and the environment, and the risks of these recently developed materials need to be assessed.

Nanotechnology, the manipulation and manufacture of materials and devices on the scale of atoms or small groups of atoms. The â€œnanoscaleâ€ is typically measured in nanometres, or billionths of a metre (nanos, the Greek word for â€œdwarf,â€ being the source of the prefix), and materials built at this.Â nanotechnology: food processing Learn about the use of nanotechnology in food processing, including the possible health issues.