Hessian Ministry of Economics,
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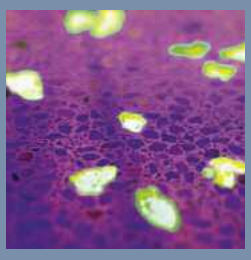
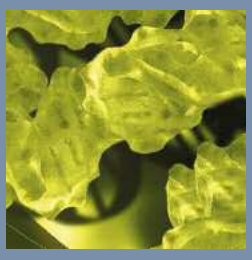
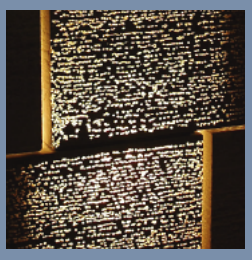
HESSEN

Materials shape Products

Increase Innovation and Market Opportunities with the Help of Creative Professionals







Hessen – there's no way around us.

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Volume 18 of the Hessen-Nanotech Initiatives Series

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Materials shape Products – Increase Innovation and Market Opportunities with the Help of Creative Professionals

Volume 18 of the Hessian Nanotech Initiatives Series of the Hessian Ministry of Economics, Transport, Urban and Regional Development

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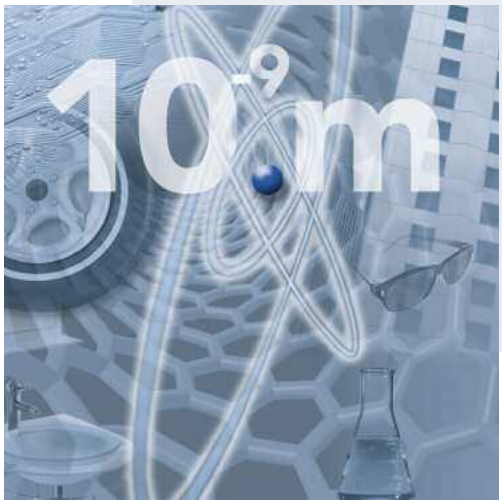
Increase Innovation and Market Opportunities with the Help of Creative Professionals

Dieter Posch

There are many facets to economic success. However one of them is certainly the further development of technologically competitive products, which is of vital importance, particularly in view of the promising future markets. The global product environments are changing ever more rapidly. Only those economic regions that manage to expedite the conversion of technological innovations into marketable products and to adjust development processes to meet customer demands in a timely manner can assert themselves. This is especially true of the innovative materials and nano-technology sectors in which Hessian companies and researchers are taking a leading role. The engineers, physicists, chemists and materials scientists have driven outstanding developments over the past several years, which have led to a great variety of novel materials and new production engineering possibilities.

It is now time to convert the successes achieved in the field of fundamental research and the new technological opportunities swiftly and efficiently into marketable products to secure the economic success of companies and their employees. In this context, branches of the creative sector play a key role in Hessian economic policies. The still noticeable effects of the economic crisis and the increasingly stronger competition from threshold economies such as those of China, India and Brazil force us to call upon all of our potential, to network among ourselves and develop a new culture of innovation. This must not only concentrate on the development of technical excellence but rather, must maintain a focus on customer requirements and social aspects to achieve sustained growth. In the first instance it is representatives of the creative industries, who can provide a decisive impulse to make a marketable product from a technological innovation. According to a study carried out by the 'Research Union Economy Science' there just so happens to be a deficit in terms of inter-discipline collaboration in the materials sector, primarily due to the low level of inter-faculty orientation in the training of young materials researchers.



However, the opportunities for innovative materials and processing methods that would result from a timely cross-linking of technological fields with the creative disciplines such as design and architecture are readily apparent. The world of materials for use in vehicle construction, aviation, machine engineering, the construction industry as well as in sport and the field of consumer products has been developing at a rapid rate over the past few years. Mutual interdependencies between the functional and emotional aspects are becoming ever more evident and therefore companies are increasingly dependent upon collaboration between technological disciplines and creative professionals for material development processes. With the current brochure we want to improve the collaboration between the traditional industries and the creative professionals.

By highlighting the research possibilities in terms of materials and process engineering we wish to simplify the exploitation of innovative materials and technologies by construction engineers, designers and architects. The showcasing of successful collaborations between creative professionals, product manufacturers and producers of raw materials based in Hessen is designed to provide inspiration for inter-disciplinary innovation processes and to increase the willingness to co-operate between the various fields. The assistance provided is intended to make it easier for companies to select suitable creative service providers. At the same time we want to use these activities to promote the creative industries as an important building block for our economic and social development and help it to achieve lasting growth.

Dieter Posch
Hessian Minister of Economics, Transport,
Urban and Regional Development

Motivation

Cars that change colour at the press of a button; glasses that never steam up, or house façades and pavements, which remove damaging particles from the surrounding air: about 70 % of all new products are based on novel materials. This means that materials development plays a key role in terms of the innovation capability of our society and economy. Enormous growth in innovate materials and in particular in nano-technologies is predicted over the next few years, from which all sectors will profit. According to the Federal Ministry for Education and Research (BMBF) the materials based sectors in Germany are already turning today over around a billion Euros and employ 5 million people. The Society of German Engineers (VDI) already estimated the market turnover in products from the nano-technology sector at 100 thousand million Euros in 2006. Whilst this is scheduled to increase to 500 thousand million Euros by 2010 according to one German estimate, market researchers from Lux Research are even assuming a market value by 2014 of 2.6 billion US Dollars and that is just from material innovations alone that are based on nano-sized structures. Even if this development does not unfold so dramatically as predicted due to the economic crisis, this changes nothing in terms of the fundamentally enormous potential and leverage effects of this key industry.

If public discourse has hitherto largely ignored the non-dissolvable links between products and material, this seems to be undergoing a noticeable change today due to the establishment of many materials libraries, trade fairs and electronic databases. Materials are currently in fashion and offer huge opportunities in the vehicle manufacturing sector, process engineering, construction industry, environmental protection and medical engineering, which need to be exploited in the coming years. Above all the use of innovative materials in design or architecture is an obvious choice.

Whereas in the past one had to develop materials with particular functions from scratch to address specific issues, today we have access to such a broad spectrum of raw materials and manufacturing processes that almost anything seems technically possible. This has far reaching ramifications for our traditional technology oriented, linear concept of innovation because what is often missing today in terms of the realisation of successful innovation processes is not the technological innovation in terms of a functional quality, but rather the successful conversion of a technological solution into a marketable product.

According to a study of the Bochum Institute for Applied Innovation Research, Germany has a striking weakness when it comes to realising ideas for new products because only 6 % of all officially inaugurated innovation projects in this country lead to a market success. The researchers see the cause as being a one dimensional engineering orientation rather than a comprehensive orientation on the market.

The ‘Innovation Capability of German SMEs’ carried out by the Fraunhofer Institute for Production Systems and Design Technology IPK in 2008 found that companies lack strategies for identifying opportunities for innovation within the business and to realise these in a targeted manner. Consultants from Booz Allen Hamilton went even further in the 2006 study ‘Global Innovation 1000’, concluding that having researched the innovation successes of the largest companies in the world, high R&D expenditures do not automatically increase a company’s innovation capacity and that the number of patents held is not an appropriate indicator of economic success. It has much more to do with the timely orientation of R&D activities on the market and the company’s ability to transfer a given technological quality to an application context earlier than the competition.

Creative professionals such as designers and architects take on a particular significance in this context for they are able to detect customer requirements that are not explicitly stated, take these into account during development and transform technical functions into emotional added value. Through the parallel development of technical excellence and marketable product applications the chances of success for a given innovation are increased!

Designers and architects are increasingly taking on a key role in terms of the success of an innovation process, especially as regards materials based developments, because it is often they who take the decision as to the choice of a suitable material and no longer just engineers. Also, companies now have recognised this subsection of the creative industries as their contact partners when it comes to developing meaningful product offerings for novel materials and, for instance, to bring the non visible added value of a nano-material to the attention of the user.

Hand in hand with this goes a change in our traditional concept of innovation, a culture, which understands innovations primarily as further developments of technological functionalities.

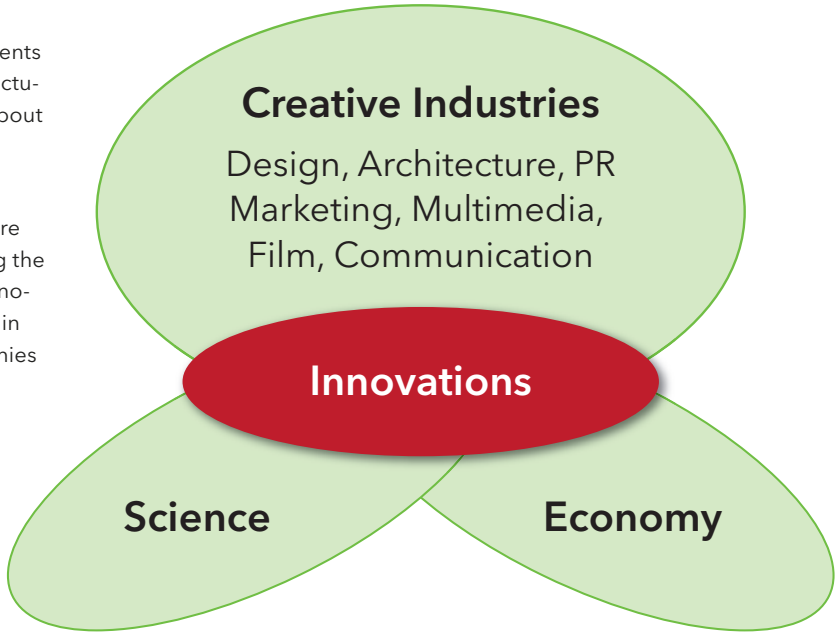
Because in future: "the role of the creative professional will develop from that of an application focused consumer to that of a conceptually arguing thought-leader for novel possibilities, who will, in discourse with manufacturers, encourage the development of new materials or manufacturing processes or develop them themselves.", according to Prof. Bernhard E. Bürdeck (The Offenbach College of Design)

With increasing frequency, designers and architects are themselves stepping forward as innovators of novel materials and manufacturing processes and move ideas from research into a successful application context.

This brochure showcases stories of success in bringing materials to the market, provides assistance for companies in their search for creative service providers and lists research opportunities for new raw materials.

Innovations
are solely the developments that markets and users actually achieve and bring about a sustainable change to everyday culture!

The creative industries are increasingly determining the success and failure of innovative technologies and in doing so, that of companies and products as well.



The factors of success for sustainable innovation culture (Source: Design Zentrum Bremen)

1 The Role of Innovative Materials and Nano-Materials in the Products of Tomorrow

Packaging made out of bio-plastics (Source: alesco green packaging GmbH)

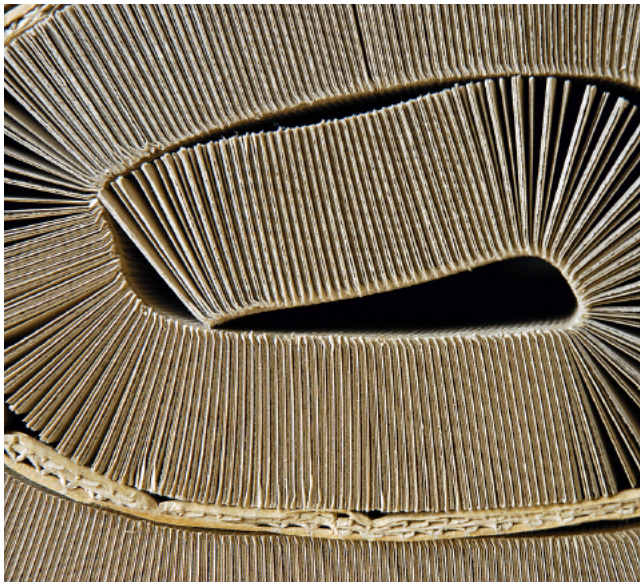
The study 'Materials as the Motor of Innovation' (Höcker 2008) puts the question into focus: new materials and technologies for their dissemination are highly important to the innovative capacity of companies and for the development of new product areas and applications. According to the Boston Consulting Group study 'Innovation Centre Germany – quo vadis?' Germany occupies a key position in materials technology, which forms the basis for our top-ranking position in machine engineering, the aviation and transport sector, as well as in medical and energy engineering. That the subject is also of high importance in Hessen is particularly demonstrated by the high number of Hessian companies participating in research projects in the field of raw materials (100 BMBF sponsored projects with Hessian participation since 2000). Above all, this is true of the nano-technology sector, in which Hessian companies have made a name for themselves over the past few years.

Nano-technology is the name of a specific field of raw materials, in which solutions are developed on the basis of particles and structures in nano-dimensions. A nanometer is one-thousand-millionth of a meter. It has to do with dimensions on about the scale of a thousandth of the width of a human hair. At this scale structures and particles of raw materials can furnish material surfaces with outstanding functional properties and bring about innovations in many different areas. Coating systems are currently in use that can be scratch proof, dirt repellent, electrically conducting, anti-bacterial or odour blocking whilst appearing transparent. Already over 1000 everyday products based on nanotechnologies are available on the market. What is noticeable is that German companies occupy a leading position in the future key technology areas since every second European nanotechnology company is located in Germany. A disproportionately large number of these companies, 16 %, come from Hessen. The finest nano-coatings for the improvement of surfaces have already found their way into successful applications in the areas of architecture and design; the potential for the construction sector and interior design as well as the qualities for everyday objects, are obvious.

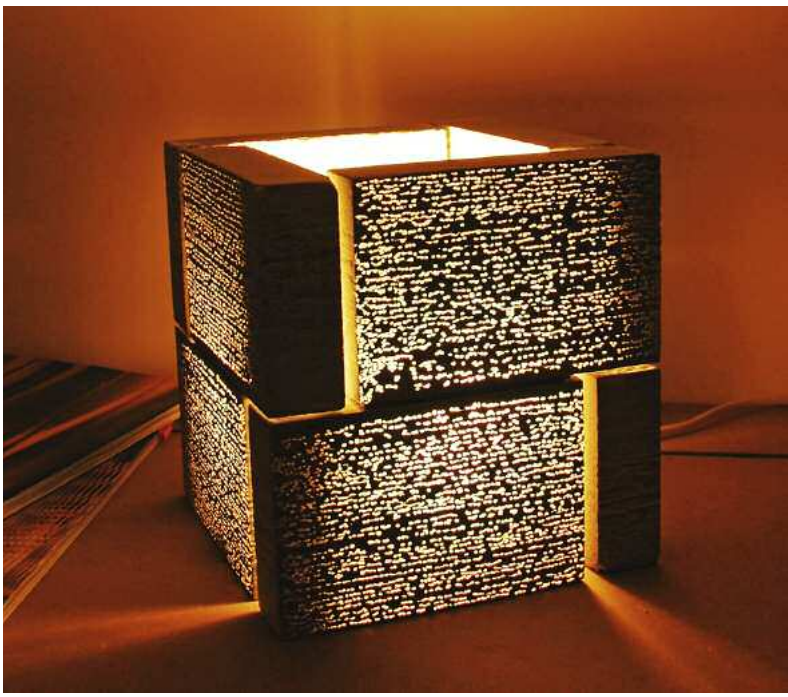
However, it is not only developments in nanotechnology that will be important for the products of tomorrow. Increasingly scarce resources are forcing us to use material solutions that guarantee a sustainable use of our raw materials and energy resources, and provide tailor-made functionalities for the given application. Plastics based on maize starch, acrylic glass of sugar or foam materials made of castor oil: over the past few years chemical companies have made enormous efforts, primarily in the field of bioplastics, to find alternative sources of raw materials and the possibilities seem huge. For example, the Frankfurt Trade Fair in Autumn 2008 successfully established a first congress with associated exhibition known as 'NUTEC'. However, several years will elapse before the new offers will become established in the market. The structures used by the petro-chemical industry as the basis for material manufacture are too well established.

Thus, the focus of attention for the reduction of resource utilisation is currently on lightweight building materials for logistics, the construction industry, medical engineering or vehicle manufacturing. Resin-soaked paper cell structures for aircraft seats, technical fabrics for architecture, cellular materials for engine components or foam structures with an unusual volume to weight ratio for the furniture industry: the product pallet is varied and demonstrates the enormous potential for material solutions in many different fields of application.

Cellular metal foam
(Source: hollomet GmbH)



Resin soaked paper cell structures
(Source: formvielt GmbH)



Translucent concrete
(Source: Áron Losonczi)

Façade elements with air cleaning properties – proSolve370e® (Source: elegant embellishments Ltd.)

Because the functional demands placed on materials these days can no longer be met by a single material, recourse is usually made to material combinations in order to create bespoke composite structures. Fibre reinforced plastics constitute a large part of this group of materials. One innovative initiative in this context is to work with natural hemp, sisal and flax fibres which have similar properties to conventional fibre materials. Other examples are coating systems such as flexible stone veneers with which a special interior space aesthetic with a light construction material can be achieved. Alternatively, there is translucent concrete whose properties are due to glass fibre, which can allow light and shadow to pass through up to 20 centimetre thick concrete and be seen on the far side.

The material appears to react to influences from its surroundings, which clearly demonstrates a further current trend: the trend towards active – or better – reactive materials. Plastics that change their geometry under the influence of electrostatic fields; shape memory alloys whose shape can be changed and subsequently revert to their starting shapes under the influence of heat or light; metal plates with luminescent properties, or wallpapers which change colour in reaction to manual contact. Materials can even have a positive effect on the climate and the ambient air. Developments of particular interest in this respect are façade elements with air cleaning properties, in which nano-titanium-dioxide particles are integrated, or temperature regulating phase transition materials, which when integrated into renders or plaster boards, can reduce the construction costs of air conditioning systems. In addition the significance of thin-film and dye-sensitized solar cells has increased enormously in the past few months in light of the flaring up of climate protection discussions. Over the coming years these will find increasing acceptance in our daily culture enabling the creation of electricity generating products.

Thermo-bimetal lamp (Source: serien lighting)

Thermosensitive furniture surface (Source: Jürgen Mayer H.)

1.1 Multi-Functional and Nano-Material

Nano-technology has experienced rapid growth in the last few years. Investment in the future market, currently almost 10 billion US dollars a year worldwide, has primarily been encouraged by the high expectations of the technology sector and the prognoses of many experts and trend researchers. Germany is in third place in terms of the amount of the R&D expenditure and the number of patent applications. Yet, whereas countries like China, India and Russia are strengthening their commitment in the various sub-sectors such as nano-materials or nano-coatings, in order to participate in the carving up of the future market, public discourse in the USA and Central Europe about the possible risks of nano-particles seems to be hampering the development of the market. However, the focus is actually only on a single aspect of nano-technology. Discussions revolve around the potential dangers to humans and the environment posed by nano-scale particles, tubes or fibres when they are not bound into a substance matrix but can instead spread through water and air. Due to their small dimensions and high reactivity some particles could enter the organism via the lungs where they could have a damaging effect on health. Of course everything shall be done to avert the dangers posed to the human organism by nano-particles. What is omitted from the discussions however is the fact that in instances where there is no direct contact with the nano-particles, for example because they are securely bound into a substance matrix, there is, in the final analysis, no exposure and therefore no risk (risk = level of danger x exposure).

To better be able to evaluate and minimize the dangers and to be able to succeed in the global market, industrialists and politicians have for some years been pushing for safer processing and handling of nano-technological products. Germany is taking a leading role in this context. Around ten million Euros worth of preventative and accompanying measures have flowed through the BMBF Project Fund – around 7 % of the total project funding volume for nano-technology. The most important aspects of the subject are summarized at: www.nano-sicherheit.de through which the HMWVL's initiative 'Nano Technology in Hessen' provides an information platform for the responsible handling of nanotechnologies. It is there to help entrepreneurs but also scientists, users and interested citizens to gain a quick and sound overview of current research activities and the discussions about safety in nanotechnology.

Scientific insights into the potential health ramifications of nano-particles were studied between March 2006 and July 2009 in the 'Nano-Care' project. The results can be found on the Internet at www.nanopartikel.info and are administrated by the 'DaNa' project.

The Nano Technology in Hessen initiative runs an information platform for research and discussion around the subject of nano safety not found anywhere else in Germany (www.nano-sicherheit.de)

Nano-Effects on Product Innovations

Chemical

- Reduced tendency to stain for windows, façades and roofing elements by nano-particle coating materials
- Anti-fingerprint for surfaces in bathroom and interior design
- Targeted, selective solubility of medicinal active ingredients and food additives
- More powerful batteries and rechargeable batteries by greater specific electrode surfaces

Mechanical

- Improved non-scratch properties of wall coverings, floor plate and finishes by ceramic nano-particles
- Improved rigidity of sports equipment through the addition of nano-particles (e.g. bicycle frames and surfboards)
- Increased air tightness of food packaging through nano-coatings

Optical

- Special effects for paints and finishes
- More transparent UV-protection in cosmetics, textiles and furniture
- Control of light line and heat conduction through window glass
- Anti-glare properties for solar cells

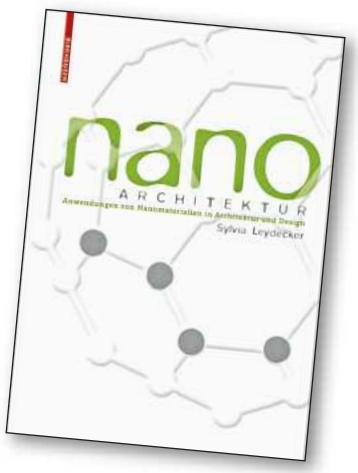
Biological

- Antibacterial properties for valves, refrigerators and hospital furniture through silver nano-particles
- Contaminant reducing concrete products, asphalt mixes, façades and paints through nano-particle integration
- Increased permeability of physiological barriers in medicines
- Increased biocompatibility through nano-structuring of bone replacement substances or wound closures

Nanotechnology's potential for marketable product innovations in many different sectors are enormous based on improvements in chemical, mechanical, optical and biological properties. Be it in construction, architecture, the optical sector, automobile manufacture or medical engineering, nano-technological developments are expected over the next 15 years that will lead to sustained economic growth.

Self-cleaning roof tiles and windowpanes, fireproof insulating material, dirt repellent wallpapers, scratch resistant finishes or anti-fingerprint coatings for the surfaces of valves and furniture: In particular for architects and designers applications are currently being launched on the market that can be traced back to about 150 companies located in Hessen (Germany's strongest region for the transfer of nano-technological developments to market).

Evonik Degussa GmbH offers a whole range of raw materials for the manufacture of nano-materials, which can fulfil many different functions. The most recent success story is the ceramic wall covering **ccflex stardust®** with water repelling, chemical and fire proof properties, the marketing rights of which were sold to the Marburger Tapetenfabrik (Marburg Wallpaper Factory) in summer 2009. One of the first buildings to be equipped with the nano-ceramic, which primarily offers an alternative to standard, commercially available tiles in wet areas, was Evonik Degussa research centre "Creavis" in Marl. Further offerings from Evonik Degussa are nano-titanium-dioxide as a basis for superhydrophilic, aroma preventing and contaminant reducing coating systems, anti-static coatings or nano-particles for the protection of electrical equipment against electromagnetic vibrations.



"Nano-Materials in Architecture, Interior Architecture and Design" by Sylvia Leydecker

ccflex Wallpaper
(Source: Sylvia Leydecker,
100 % interior)

The product offering of paint specialist **Caparol** (located in Ober-Ramstadt) includes photo catalytically active paints based on nano-quartz-particles (also known as silica sol or hydro-glass particles), whose fouling tendency (i.e., contaminant particle, fine dust and spore sticking) is noticeably reduced. Whatever manages to accumulate on the façade in spite of this is removed from the surface by wind and rain. This prevents adhesive agent swelling and maintains the protective function and colour brilliance. The advantages of a silicon resin paint are combined with those of a silicate paint thereby achieving, on the one hand, a highly water repellent effect, low chalking, universal applicability and easy processing, and on the other hand, a strong binding with the subsurface and mineral hardness with correspondingly lower fouling tendency.

Through the use of nano-scale silver particles, the water-dilutable, anti-bacterial clear varnish from **Lackfabrik Alfred Clouth** of Offenbach am Main prevents the spread of bacteria and moulds and stops their respiration and metabolism. This protects wooden benches, door handles and stairway banisters from bacteria. The product was awarded the Hessian Innovation Prize by The Hessian Ministry for the Economy in 2004.

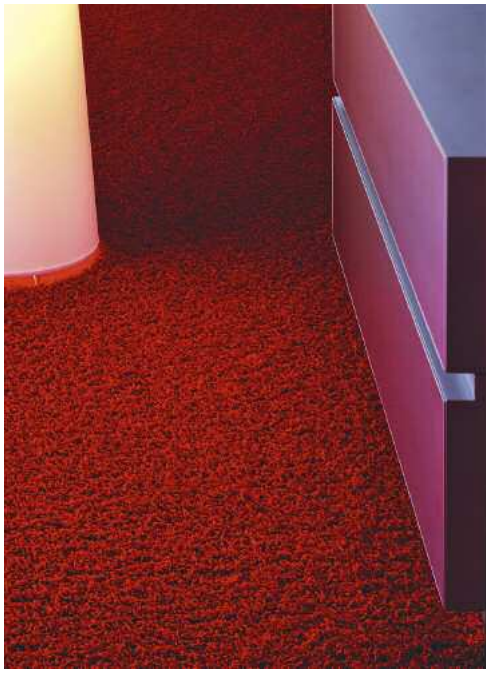
Anti-bacterial
clear varnish
(Source: Lackfabrik
Alfred Clouth)

Dirt and water repellent hygienic coating (Source: Möller Medical GmbH)

Möller Medical GmbH from Fulda offers bespoke nano-dimensional coating systems for medical products for the prevention of infections and for improved hygiene. These provide dirt and water repellent properties, low friction coefficients and higher scratch resistance. Wettable, conducting, isolating, decorative or 'soft-feel' layers can also be configured. Surfaces of steel, brass, copper, aluminium, glass and various plastics (e.g. PA, PMMA, PC, ABS) can be coated using the Sol-Gel process.

Using a combination of micro- and nano-structured ceramic surfaces in conjunction with the inclusion of functional materials like nano-particles and polymers in a material matrix with aluminium, **Seidel GmbH** of Marburg is currently betting on surface effects for cosmetic product packaging (cream jars, perfume stoppers). At its research centre for nanotechnology in Fronhausen, the company, in a research cooperative that includes the Universities of Marburg, Giessen and Hamburg, is working on the systematic development of new surface coatings for aluminium, to dramatically improve its haptical, optical and functional qualities. It has been possible for example, to achieve a self-cleansing effect through micro structuring of an Eloxal surface and a subsequent treatment with a water repellent reagent. In addition to this it should be possible to reduce the resources required for surface treatment techniques by using nano-particles.

Cream jars with nano-structured surfaces (Source: Seidel GmbH)



Air-cleaning carpet
(Source: Dura Tufting GmbH)

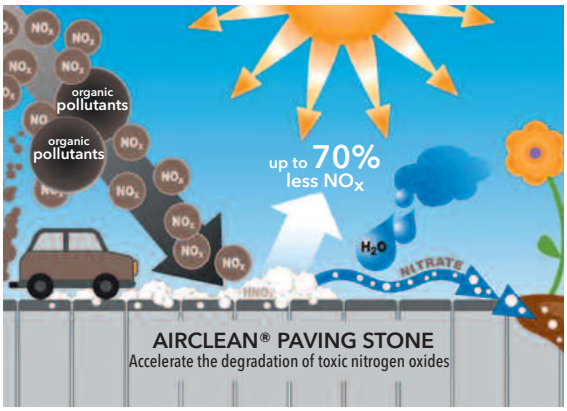
Air-cleaning concrete
(Source: F.C. Nüdling Betonelemente GmbH)

With its duraAir® **Dura Tufting GmbH** of Fulda is offering the first carpet anywhere in the world that, equipped with nano-particles, is capable of freeing interior spaces from odours and damaging formaldehydes. Household, animal or garbage and WC odour, as well as cigarette smoke and nicotine are all also degraded. In this way the carpet provides a healthier room climate.

The results achieved by the Fraunhofer IME between 2007 and 2009 for photo-catalytically acting sample surfaces primarily to demonstrate the potential for reducing nitrogen oxide concentrations in the air show that the contaminant reducing effect can be transferred to concrete surfaces and paving stones. Nitrogen dioxide (NO_2) attacks the mucous membranes even in very small concentrations. That is why an upper limit was set for NO_2 in the atmosphere. Nitrogen dioxide concentrations in the air also contribute towards smog formation. Photo-catalytically equipped concrete products can contribute to a nitrogen oxide reduction of up to 70 % (hourly value) in the presence of sunlight. **F.C. Nüdling Betonelemente GmbH + Co. KG** of Fulda exploits this potential with its contaminant reducing paving stones, which it markets under the name AirClean®. The effect is based on the photo-catalytically active titanium oxide which is added in a process specially developed for the production of paving stones.

Air-cleaning paving stones
(Source: F.C. Nüdling Betonelemente GmbH)

Experts consider an average yearly reduction of NO_2 contamination in central European urban environments of 20–30 % to be achievable using photo-catalytic paving stones. This was confirmed in the open-air tests. A representative long-term experiment at F.C. Nüdling Betonelemente's field testing facility was able to demonstrate a potential NO_2 reduction of > 25 % as a yearly value. On a heavily used federal highway in Erfurt bordered by pavement of AirClean® paving stones it proved possible, on a specified sampling day, to measure an NO_2 reduction of 20 %.



Air-cleaning effect of nano-titanium-oxide-particles
(Source: F.C. Nüdling Betonelemente GmbH)

Left: scratch proof poly carbonate plates (Source: Bayer Sheet Europe GmbH)

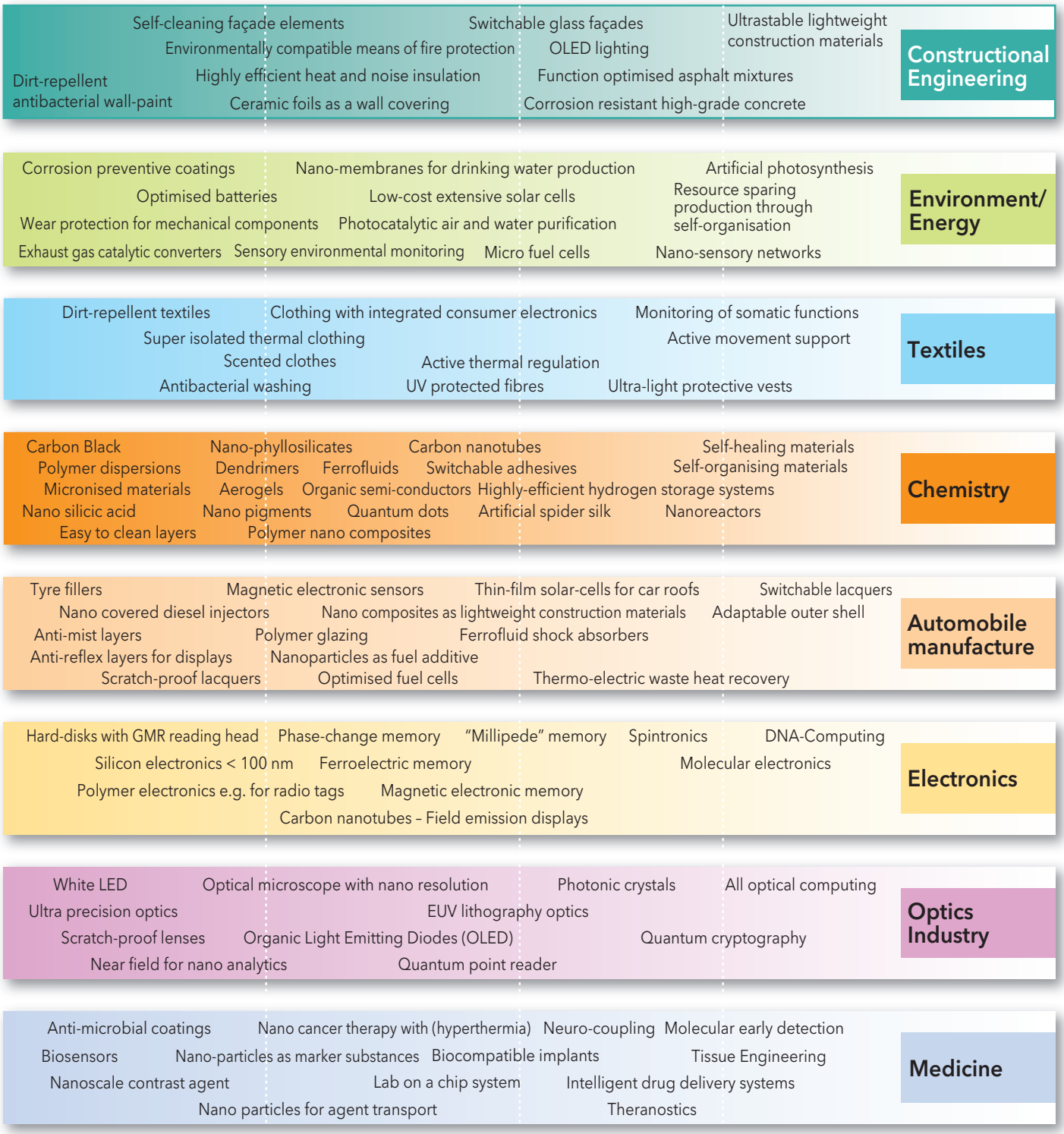
Right: soil improvement substance with water absorbing properties and an extraordinary swelling capacity (Source: Geohumus International GmbH)

As one of Germany's market leading producers of white cement, **Dyckerhoff** of Wiesbaden also offers construction materials with titanium-oxide based photo-catalytic effects. The nitrogen oxide molecules are converted to nitrate on the surface of concrete based surfaces. In this way the company's particular offering contributes to the pollution reduction.

The Makrolon® AR range from **Bayer Sheet Europe** (Darmstadt) comprises a selection of plastics with scratch and chemical proof surfaces based on nano-silicon-particles. The double sided coating increases shelf-life, improves the UV-stability and reduces long-term clouding and yellowing. The extremely durable polycarbonate plates have a glass-like hardness combined with impact resistance of polycarbonate.

Merck KGaA of Darmstadt has been particularly active during the past few years in the development of nano-technological products. For example, nano sized zinc particles have been used in wood treatment systems to protect furniture and parquet flooring from fading under the influence of solar radiation. Medicines have been developed that dissolve and act quicker in comparison with traditional products. Of the greatest interest to architects and designers are developments in the optical sector. Nano-porous anti-glare layers of SiO_2 prevent glass surface reflections thereby increasing the transparency of protective glazing and the legibility of displays. Because they increase efficiency of energy generation, anti-reflective layers for flat glass surfaces are used in solar panels. Schott manufactures brine-based interference layers for glass and plastics with angle dependent transmission angle for light radiation, for example to create optical effects for building façades. The colours change depending upon solar radiation, viewing point and background.

Application Options and Maturity Level of Nano-Technological Developments



(Source: Using Nano-Technologies in Architecture and Construction, Volume 7 of the Hessen-Nanotech Initiative Series)

1.2 Natural and Bio-Materials

Maize cob boards – lightweight palettes of corn cobs (Source: Kompetenz-Zentrum Holz GmbH)

Plastics reinforced with carrot fibres, wooden plates of corn cobs, paper made of apple juice production waste or algae-based foams: these are some impressive sounding examples of a group of materials that have undergone a rapid development over the past two or three years, namely biomaterials and substances made of natural raw materials. In December 2007 the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety calculated growth rates of 25 to 30 % for the bio-plastics sector alone. A production capacity increase to 3 million tonnes (currently 350,000 tonnes) is expected by 2020.

With the first NUTEC in November 2008, a convention in connection with an exhibition at the Frankfurt Trade Fair, the circle of companies with a high level of environmental awareness created a first mouthpiece and underlined the necessity to think in terms of raw material cycles. The focus was on futuristic materials and production methods that enable the exploitation of raw materials within closed cycles. For example the first compostable clothes could be seen, the parts of which, such as the buttons or threads, are based entirely on natural materials (e.g. bio-cotton) and bio-plastics (e.g. PHB or PLA). In addition, construction systems and solutions were introduced, that support the swapping and recycling of defective or worn components (e.g. the cloth covering of an office chair) or wooden structures for architecture, which need no glue or adhesives and can be connected simply with dowels. The architectural trend of greening façades and roofs was underlined through the introduction of moss matting products. These are able to rid the air of health damaging fine dusts, a capability, which promises the group a successful market launch.

"The Frankfurt International has become the meeting point for pioneers, who want to free themselves from raw material dependencies and to base their economic success on material and production changes in favour of environment friendliness." That is the summary of Prof. Dr. Michael Braungart (University of Lüneburg), who, under the banner of his 'cradle-to-cradle' initiative, has been battling for years against the wasteful use of raw materials in the industrialized nations.

Moss mat products (Source: Xeroflor)

There are also interesting biomaterial-based product offerings in Hessen. **Biowert Industrie GmbH** runs grass improvement facility in Brensbach (Forest of Odes), based on the 'green bio-refinery' principle. Without the addition of solvents, damp, fibre rich biomass is transformed into an injection mouldable granular composite consisting of up to 50-70 % cellulose fibres and 25-50 % polyethylene and/or polypropylene. The grains are pourable and are suitable for use in conjunction with any conventional injection moulding equipment to create cast forms such as flush-mounted sockets, stacking crates, drinking beakers etc. These are 20 % lighter in comparison with components made of 100 % polyethylene and/or polypropylene. The facility can process up to 5000 tonnes of grass silage per year. The required energy is produced in a biogas plant. In addition to the bio-plastic sold under the name AgriPlastBW, the company also sells the insulation material AgriCellBW, which is based on natural biomass.

Cellulose plastics based products (Source: Biowert Industrie GmbH)

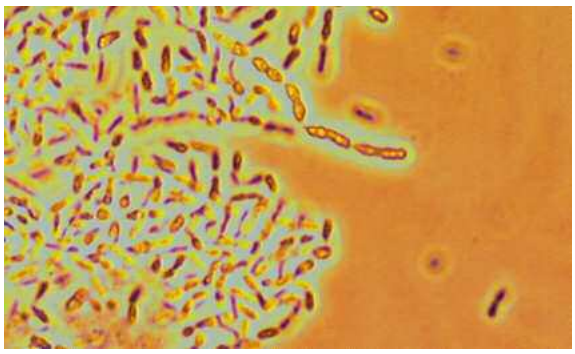
One of the first producers to include bio-plastics in its product catalogue, which, due to their outstanding mechanical qualities, compete well with traditional artificial, petrochemical-based plastics, is the Neu-Isenberg based **DuPont de Nemours (Germany) GmbH**. The concern has already launched several brands: thermoplastic plastic (Sorona® EP), thermoplastic polyester-elastomere (Hytrel® RS), plolyamide (Zytel® RS) and the packing plastics, Biomax® and Selar® VP.

Biomax® Strong, which was the first member of the product family to be introduced in 2007, is an impact resistance modifier for biodegradable Polylactate (PLA), which is manufactured from bio-based raw materials. This was followed by the market launch of the first plastic made of renewable raw materials sold under the name Biomax® PTT 1100 (poly tremethyl terephtalate). It is a polyester based on 35 % maize starch with a similar properties profile to those of polybutylene terephtalate (PBT) and polyethylene terephtalate (PET). The raw material was specifically optimized for use in injection moulding, is easy to dye, enables high gloss surfaces and is highly scratch resistant. In contrast to ABS or SAN no additional optimization using solvent containing substances is required.

Biological plastics based products (Source: DuPont de Nemours GmbH)

Selar® VP is a raw material from which one can manufacture breathable membranes. Areas of application are packaging for foodstuffs which needs to "breathe", e.g. fresh fish, fruit and vegetables. Through the incorporation of a vegetable fatty acid, Selar® VP consists of up to 30 % renewable raw materials. Fish and seafood can now be packed in sealed packaging, whereas it is currently the case that unsealed polyethylene packaging is used for this. In case the fruit and vegetables Selar® VP is an alternative to micro perforated membranes.

Moulded components, for container and case manufacture, made of plastic reinforced with natural fibres have for some time now been part of the **Jacob Winter GmbH** of Nauheim product range. In collaboration with leading research institutes, the company has optimized the relevant process engineering over the past decade. It has mastered the processing of such natural fibres as hemp, sisal, albaca, kenef and flax using injection moulding, extrusion or compression moulding. The total offering is marketed under the **Green LinE** brand. Apart from ecological reasons, the use of natural fibres makes sense primarily because of the reduced weight of the moulded parts as well as their good mechanical properties and similar production costs. Aside from synthetic plastics, 100 % oil free biopolymers are used as for the matrix material, from which biodegradable products are fashioned.



Bacteria for the production of precursor materials for PMMA manufacture
(Source: Helmholtz Centre for Environmental Research)

One innovative develop still currently in the research phase is the manufacture of polymethylacrylate (PMMA) from raw materials such as sugar, alcohol or fatty acids. PMMA is one of the classic polymer materials with properties similar to those of glass, already marketed under the name of 'Plexiglas' by Otto Röhm in 1933. It is made by the polymerization of methylmethacrylate (MMA). Scientists at the University of Duisburg-Essen and the Helmholtz Centre for Environmental Research (UFZ) have discovered an enzyme in a bacterial culture, which could be used to produce a precursor to MMA. Evonik took up these results within the framework of a research project aimed at the biotechnological production of MMA. MMA is the foundation monomer for acrylic glass, the production of which from sustainable raw materials will therefore be realized for the first time. In a few short years **Evonik Röhm GmbH** is plans to be operating a pilot facility for the production of several tonnes with a minimum impact on the environment. The discoverer of the process, Dr. Thore Rohwerder of the University of Duisburg-Essen was nominated in 2008 as one of three candidates for the Evonik Research Prize.

Products with natural fibres
(Source: Jakob Winter GmbH)

The polymers offered by **Evonik Degussa GmbH** under the trade name of Vestamid® Terra are largely based on vegetable fatty acids. Thus far the main source for the manufacture of polyamides is castor oil, the production of which can have no negative impact on the development of food prices. Vestmid® Terra DS is completely biologically based polyamide 1010 with a property profile somewhere between those of long chain high performing polyamides such as PA 12 and PA 1212 and the shorter chained standard polyamides PA 6 and PA 66. It is therefore primarily suitable for the production of glass fibre reinforced moulding compounds. Vestamid® Terra JS is a polyamide 610. It consists of about 60% renewable raw materials and has better technical properties than the standard polyamides PA 6 and PA 66. Evonik is currently carrying out research into other polyamides of renewable raw materials drawn from other vegetable oils.

"With Vestamid® Terra we have a biologically based alternative for high value polyamide components as used in sports, electronics or automobile manufacture".

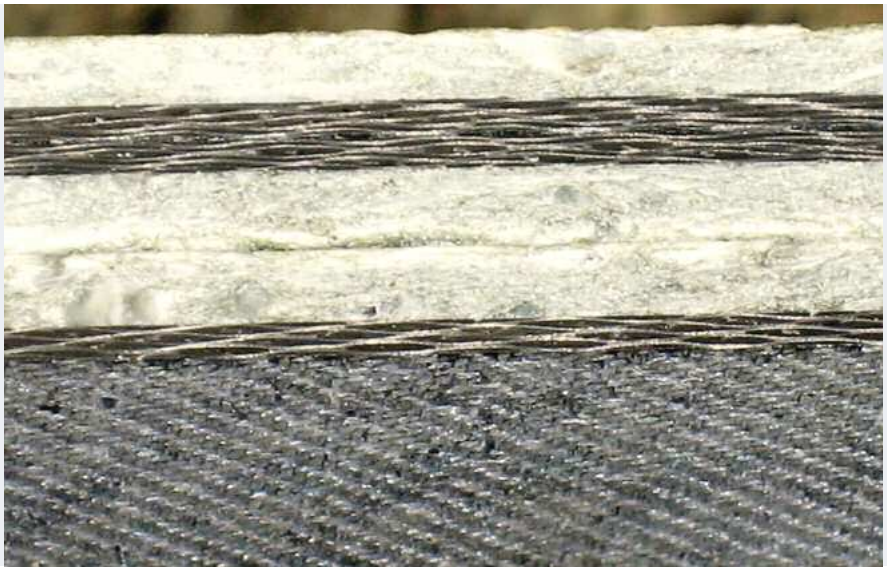
Dr. Joachim Leluschko (Director of the High Performance Polymers Division of Evonik)

Whilst for some businesses bio plastics represent the great market opportunities of the future other companies are attempting to reactivate the use of natural materials no longer produced in Germany for many years. Close to the university town of Giessen, farmers located in Central Hessen have begun planting bio-linen, i.e., native flax, under the auspices of the natural fashion label **hessnatur** in conjunction with the **Institute for Biological Dynamic Research (IBDF) e.V.**. The experiment, which began in 2005 was sponsored over a period of four years. Now over 30% of the linen required for the company's fashion collection is grown in Hessen. Since 2009 this amounts to 100 tonnes of flax straw over a cultivated area of c. 25 hectares.

From the beginning of 2005 to the end of 2008, scientists and engineers of the BMBF sponsored research project BIOTEX oriented themselves on natural structures in the development of fibre composite structures, with the goal of optimizing the fit of material properties to their intended stresses. Examples were trees, grasses or bones, which have evolved to be almost perfectly adapted to external stresses. Using nine methods of calculation based on observations of biological growth, the developers were able to optimize fibre-reinforcing geometries to achieve as even a structural loading as possible by homogenizing the stresses and the orientation of the fibres towards the main stress axes. The result were structures with optimized light construction potential for use in aircraft construction, automobile production, wind power farms, ship building and in general mechanical construction. Hessian companies involved were **KSL Keilmann Sondermaschinenbau GmbH** and **Dipl. Eng. H. Moldenhauer GmbH**.

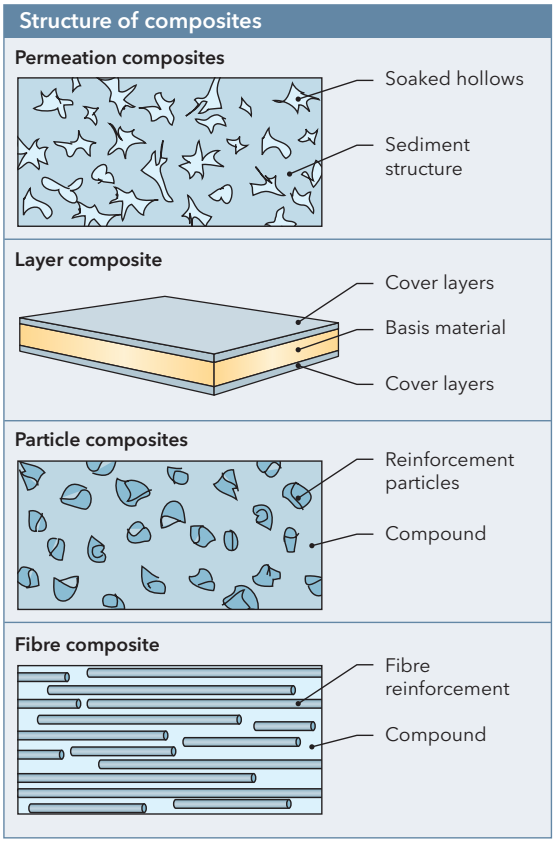
Bio-linen from Hessen (Source: Hess Natur Textilien GmbH)

1.3 Lightweight Construction Materials and Composites



Carbon fibre stone CFS
(Source: Techno CarbonTechnologies)

Stone veneers that are as flexible as paper and have the appearance of a masonry wall; products made of wood-plastic composites (WPC) manufactured using the injection moulding technique and have a wood surface due to the integration of wood particles, or carbon fibre stone, a carbon fibre covered rock materials that, because of its vibration free behaviour, is particularly well suited to the construction of rotor blades for wind power plants or sports equipment: the field of composite and lightweight construction materials is becoming noticeably bigger. Because the demands these days have increased to the point at which a single classical material cannot usually cover them. In addition, increasing product differentiation, new legal directives and mounting environmental constraints are leading increasingly to the requirement for materials with bespoke properties that can only be achieved through the combination of two or more materials. It is now possible to use textiles in architecture, to make concrete permeable by light and shadow and paper based aircraft seats. One also speaks in terms of composites, whose structure covers the disadvantageous properties of one material with the advantageous features of the other element of the composite. According to the spatial arrangement of the composite components one differentiates between permeation-, layer-, particle- or fibre-composites.



Structural principles of composites
(Source: Manual for technical product design)

Bridge reinforced with fibre-glass (Source: Hessian State Office for Highways and Transport)

The fact that fibre reinforced plastics are becoming increasingly important as an alternative to metallic materials in aircraft construction was shown by the Fulda-based development service provider **EDAG** at the 79th International Automobile Salon in Geneva in 2009. For the first time ever, the designers and engineers used a new type of basalt fibre as a lightweight, high tensile, chemical and heat resistant and above all 100 % recyclable material in automobile construction in their concept car 'Light-Car – Open Source' (see page 47).

Fibre reinforcements are not only being used as a highly loadable lightweight construction components in aircraft and automobile construction but also in architecture. In July 2008 for example, glass fibre reinforced plastic (GFK) was used for the construction of a road bridge in Friedberg (Hessen) for the first time ever in Europe. The bridge is 27m long and 5m wide. The basic design is made up of two steel girders upon which a road surface of glass fibre reinforced plastic was glued. The construction components were made by pultrusion, a process for the creation of continuous fibre reinforced plastic profiles with a glass fibre component of up to 60 %. The high durability of the new material and the quick assembly were the decisive factors in the choice of materials.

The road surface is a c. 4cm thick layer of polymer concrete, a mixture of epoxy resin and silicate spread. In order to achieve a long life span and low maintenance expenditure, bearings and lane crossings were omitted. The construction is the result of a multi-year collaboration between the **Hessian State Office for Highways and Transport (HLSV)** and the Institute of Building Structures and Structural Design (ITKE) lead by Prof. Dr. Eng. Jan Knippers at the University of Stuttgart.

HLSV President Wolfgang Scherz emphasises the fact that: "Fibre reinforced plastics will play a significant role in bridge construction. Whilst conventional reinforced concrete bridges involve lengthy construction phases and just as lengthy obstructions to traffic, a construction was found in the Friedberg bridge that was mostly pre-fabricated and able to be transported to the construction site and raised as a complete facility."

High performance fibre composite materials based on CFK
(Source: Schunk Kohlenstofftechnik GmbH)

High performance fibre composite materials based on carbon fibres (CFK) are, at low densities, extremely resilient, rigid and resistant to corrosion. Because it is possible to tailor the properties profiles to specific application areas, even metal components in machine construction can be replaced by CFK. Other typical areas of application for CFKs are in the fields of sport, medical engineering or robotics, in which high strength combined with low weight is required. **Schunk Kohlenstofftechnik GmbH** (Giessen) is one Hessen-based company that offers raw materials for the production of CFK-fibre composite construction components. The company has comprehensive know-how in terms of sizing, manufacturing and the application of fibre composite materials and can provide support with the targeted selection of reinforcement fibres and resin systems as well as the with reference to the most appropriate manufacturing engineering process.

Rotor blades of the Eurocopter, EC 135 Police (© Eurocopter Patrick Penna)

The Advantages of High Performance Fibre Composites

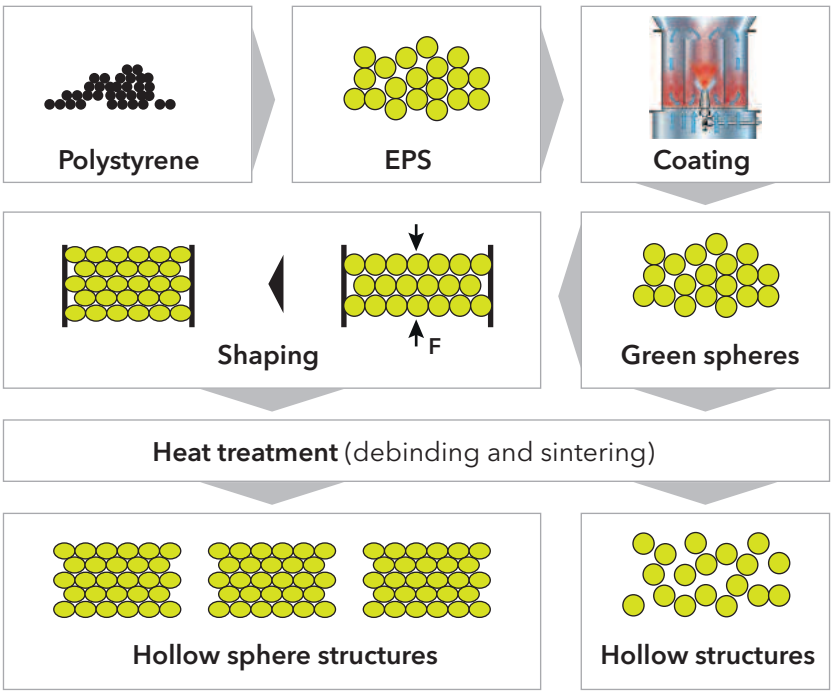
- High degree of design freedom
- Low weight
- High strength and rigidity
- Service temperature range of between -270°C to +2700°C depending on reinforcement material
- Very good damping properties
- Variable heat expansion
- Very good corrosion properties

Sandwich structures with high rigidity and pressure resistance and low density are an alternative to fibre reinforced composite materials for lightweight structures. They are made of two cover layers and a core material. Plastic or paper honeycomb-boards, cellular metals, lightweight timbers or polymer polyurethane foams can all be used as the core material. Whilst the cover layers absorb external stresses, the middle layer is responsible for diffusing sheer forces and holding the entire construction together. That is why Eurocopter uses the high performance sandwich core foam material ROHACELL® for the core layer in the rotor blade construction, which is made by **Evonik Röhm GmbH** (Darmstadt) using polymethacrylimide (PMI). ROHACELL® stands out through its high weight-specific mechanical properties and heat resistance and remains intact even under continuous dynamic loading. Because there is no material fatigue, the life span of rotor blades made of composite materials is higher by a factor of 4 or 5 compared with that of metal structures of aluminium titanium. This means that an operational life of 15,000 hours (40 years) can be achieved using sandwich structures. Apart from aircraft construction, ROHACELL® foam material cores are used in automobile manufacturing, wind power farms, medical engineering and boat building.

Hollow sphere structure as crash absorber with stabilising properties in the event of a crash (Source: hollomet GmbH)

One material that is well known to science but not yet used often in industrial contexts as a sandwich core material for the manufacturer of lightweight construction components for the automobile, machine tool or construction industries is metallic or ceramic hollow sphere structures as offered by **Glatt Gruppe** (Wiesbaden, Binzen, Dresden). They are made of high strength hollow spheres and therefore provide the possibility of a flexible alignment for filling free mould geometries. EPS spheres are produced using a fluidized bed process with a suspension of metal/ceramic powder, binding agent and water to coat them prior to being heated. The plastic evaporates leaving hollow spheres of a metallic or ceramic material, which can be pressed into a mould, sintered and/or glued together. As a matter of principle all sinterable materials can be manipulated so that it is possible to configure a broad properties profile. This can be matched to a given application by adjusting the thickness and porosity of the shell as well as the geometry of the mould. Because of the high porosity and the many surfaces radiating upon one another, the thermal conductance properties of hollow sphere structures are far lower than those of the full material. Very high temperatures reduce this to a value of 5 %. For this reason hollow sphere structures are well suited as heat shields in kiln engineering. Sound and vibration damping properties and the high internal surface area make them interesting as crash absorbers, catalyser elements, sound dampers or lightweight construction stiffening elements.

The potential of foam structures for lightweight construction have been known for years. Recently however efforts seem to have increased towards making these actually available for use in a broad-spectrum industrial context. To this end new manufacturing processes have been developed for metal and ceramic sponges in addition to which, novel foams of paper and wood have been introduced to the market. One of these foam materials is sold under the name Airmaxx® and was developed between BASF and Nolte Holzwerkstoff GmbH as an alternative to chipboard within the framework of the 'Lighter Timber Materials for International Furniture Production' project. The material is made of wood chips, a foaming polymer and a binding agent. Thus it weighs 30 % less than the chip board currently used today.



Manufacturing process of hollow structures (Source: hollomet GmbH)

Above: Airmaxx (Source: Nolte Holzwerkstoffe GmbH)

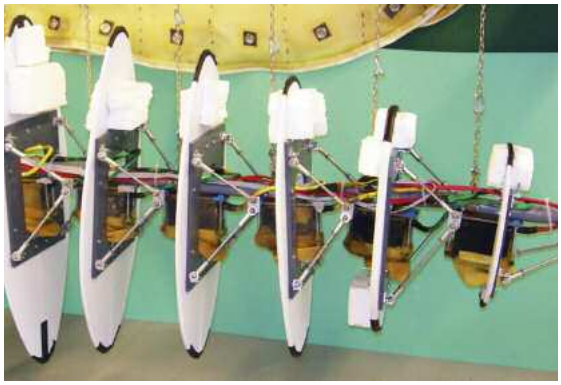
Low: Resopal plate with blown glass core (Source: Resopal GmbH)

Next to lightweight construction applications foam structures are also used in sound absorbing composite boards. **Resopal** of Groß-Umstadt for example sells a plate fabric under the name of resopal®-A2coustic with a blown glass core flanked by hole-boards. Noise gets lost in the fine pore-structure of the inflated recycled glass granules, which are press moulded together with an anorganic binding substance.

Another future market for lightweight construction materials are technical textiles. The 'Techtextil' instigated by the Frankfurt Trade Fair in June 2009, for the 13th time now, which ended with a record number of visitors, showed how important this materials group has become. Now that the traditional textile industry has almost completely disappeared from Europe due to competition from Asia, an increasing importance of textile fibres for technical areas has been discernable for a number of years. For example turnover in technical textiles has grown from 17 % to 45 % of the total textile industry over the past decade. German companies occupy one of the leading technical positions in this market space. Predictions are based on the assumption that the achievement potential of the West's textile industry will shift towards greater functionality.

Thus technical textiles today have special mechanical and weather resistant qualities that make them suitable for use in architecture and vehicle manufacture. With its 2009 concept study, 'GINA', BMW presented an initial experiment in the use of textiles in bodywork design. The shell consists of stabilising support meshes and a water repelling hybrid textile that is resistant to both high and low temperatures. The objective: are car that looks like it has been cast in a single mould, with functional elements that only become visible when they are needed. If the driver switches on the lights, the headlamps open like eyelids. If GINA needs to be cooled down the bonnet material moves to the side. The textile skin also optimises the cost structure as the bodywork is only made of four instead of ten parts, which can be stretched tightly around the aluminium superstructure in less than two hours.

GINA Textiles in vehicle construction (Source: BMW)



Left: Skeleton of fish robot "Smoky" (Source: TU Darmstadt Bernhard Köhler, Qualified Biologist Britta Abé, Qualified Engineer (FH)

Right: Lounge landscape in spacer fabric (Source: The Offenbach College of Design)

In 2009 researchers at the **Technical University of Darmstadt** (Fluid Systems Engineering Faculty) exhibited a fish robot at the Hannover Trade Fair, with a flexible outer skin of latex: the bionic fish robot, 'Smoky'. It is used to study the fluid mechanics of a body wriggling in a fish-like manner as well as the forward propulsion force it generates and its effective range. The objective is to develop a drive system for water vehicles with environment protecting characteristics in terms of waterside structures and lake and sea bottoms or riverbeds, plant growth and fish stocks. The scientists derived the shape of the robot from the gilthead sea bream. The fish robot has a 1.5m long flexible backbone with eight actuators. A computer guides the wriggly body movements through the water.

The goal of the EU-sponsored joint research project 'Contex-T' (8/2006-8/2010) in which the Frankfurt Trade Fair organisation is involved, is to qualify textiles as high-tech materials for the construction industry and to develop the value chain of textile architecture for future applications. Since August 2006, 30 partners from 10 countries have been attempting to exhaust the innovative potential of technical textiles in architecture and to obtain insights for other areas of technical textile application (e.g. protective clothing, packaging, fibre reinforced construction components). Shorter construction times, a long life span and low costs are the factors that will lead to an increased use of textiles in architecture. Thus, among other things, attempts are being undertaken to develop radically new concepts for multi-functional technical textiles using nanotechnologically structured materials.

"Contemporary architecture and modern design are increasingly bound in to dynamic processes. Textiles are ideally suited materials in particular for temporary surfaces and flowing forms", says the Berlin architect, Jürgen Mayer H.

Bathing ship in Berlin with textile cover in winter (Source: Bathing ship Berlin)

1.4 Reactive and Smart Materials

Music is downloaded via the internet; a plane ticket is issued in email form. With the new electronic media, the digital flows of finance, the ubiquitous availability of information, it appears that our society has moved closer to the digitalisation of our product world so long prophesised by trend researchers – a product world that emerges without any haptic objectification and without materialisation. At the same time we expect that the products we use in our everyday lives will satisfy our desires and needs in an individualised and autonomous manner. Clothing should warm or cool down the wearer depending on the ambient temperature, or release fragrances as required or alter its shape in response to our emotions. Wallpaper changes colour when we touch it, the concrete floor projects a floral pattern when wet and dents in our car's bodywork disappear by themselves, because the material has developed a distinct shape-orientated memory.

Materials belonging to the next generation not only retain traditional mechanical properties, they also have a virtual "smart" aspect because they are intelligent. They possess indivisible additional functions that only become apparent when actually utilised by the user. It thus appears that the long revised understanding of materiality together with the virtual dematerialisation of our product world are being revolutionised by a new material culture. Within the context of this development, the "creative industries", i.e. designers and architects, is assuming a significant role in the development process. For who else can give a purposeful application to an (invisible) function and bring this to the perspective of the user. Electro-active polymers for forming car seats or for the flattened musculature of airships, laminated glazing with thermo-tropic properties, which can reversibly change their transparency and reflective characteristics depending on the incidence of light or self-healing materials, which autonomously rectify cracks in a material.

Left:
Floral concrete
(Source: Frederik Molenschot)

Rechts:
Thermochrome Tapete
(Quelle: Zane Berzina)

Electro-active polymer acting as surface layer muscle
(Source: EMPA aeroix)

"Electroactive polymers can adapt their intelligent design to the human body. Their use in car seats yields great potentials which will revolutionise our understanding of mobility."
Dipl.-Ing. Daniel Jarr, TU Hamburg-Harburg

Whereas the focus of researchers five years ago primarily lay on material processing, we appear to be currently moving closer to the vision of 'customised materials' through development activities in relation to material with precisely determinable characteristics that can react to the environment. First and foremost, radically diverging individual demands and new environmental regulations sometimes make it necessary to have materials that can reconcile contradictory properties. The conception of multifunctional materials with reactive characteristics has become an important focal area within just a very short time, with the following distinctions being apparent:

Shape-memory materials

Shape-memory alloys or plastics have the ability to recollect their initial geometry and store shape-related information within their molecular structure. At low temperatures shape-memory alloys can be plastically deformed. Once heated above the transformation temperature of the structure, they return to their original form. They can for example by used in medical technology to produce surgical cables. Interior design is already able to employ textiles with interwoven threads made from shape-memory alloy with darkening and screening functions. With shape-memory plastics the recollection of the original shape is stimulated through the application of heat. Model applications in this context include visco-elastic polyurethane foams for mattresses or carpeted surfaces.

Left:
Carpet made from memory foam
(Source: kymo GmbH)

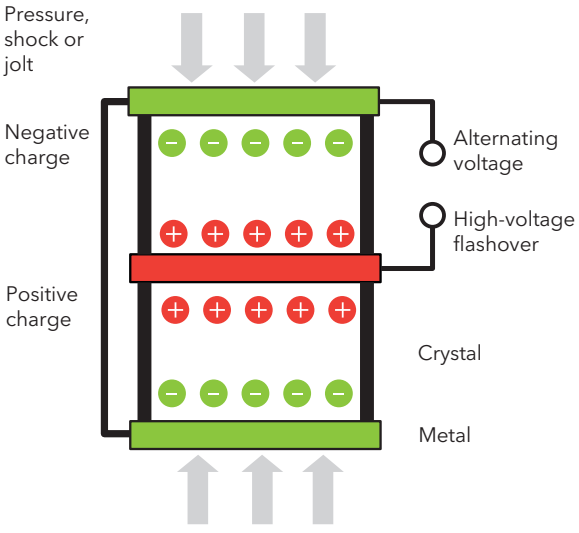
Right:
Shape memory yarn in textile and fashion design
(Source: Max Schäth, UDK Berlin)

Piezoelectric materials

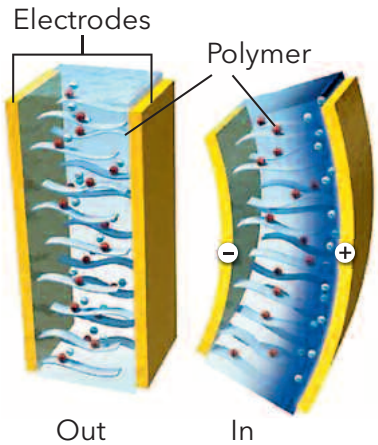
The importance of piezoelectric materials for various applications has increased in recent years. It describes the creation of an electrical field through the deformation of certain material surfaces. Although discovered back in 1880 it is only through the promulgation of new legislation and environmental regulations that the demand for materials with piezo electrical qualities has increased. Related applications include vibration damping and airbag controls and there are other fundamentally important areas such as medical diagnostics and material testing. Piezo electrical polymer films are used as large-area sensors or as flat profile loudspeakers. They are used in construction, mounted under floors to detect the movement of people.

Electro-active polymers

Electro-active plastics are still a very new class of working material. This group encompasses polymers or composites of polymer materials, the volume of which changes upon application of a voltage, i.e. they expand or contract. Scientists from across the world for example are working on the vision of an artificial muscle or car seats with respond to the body shape while others are seeking to change the shape and properties of an aircraft during flight through the use of "morphing materials". Different objectives are being pursued in the form of soft dielectric elastomers (DE) or ionic polymer metal composites (IPMC).



Structure of a piezo element



Structure of an IPMC

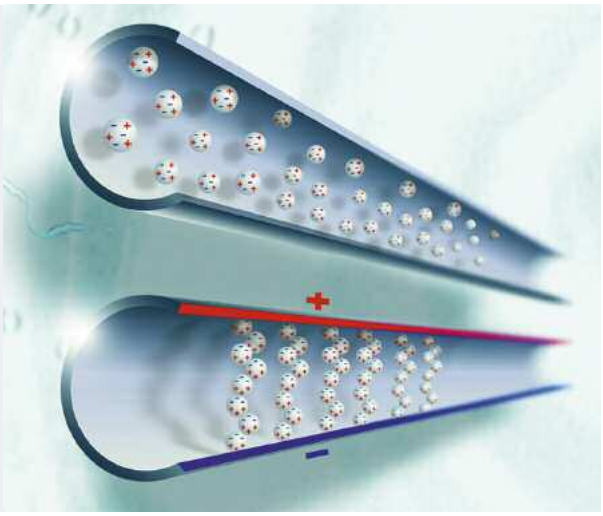
Thermochrome glass facade
(Source: Fraunhofer IAP)

Photo, thermo and electrochrome materials

These materials react to light, heat or electrical voltage, changing their colour and transparency. They can be found in numerous applications such as fashion, e-paper or the design of magazines and wallpaper. Electrochrome mirrors will be used as self-dimming rear-view mirrors in the car industry. Thermochrome laminated glass changes the degree to which it admits sunlight upon the incidence of light. This capacity enables glass façades to automatically adjust themselves to the climatic conditions. Whereas sunlight is deflected during summer, in winter it is admitted to the interior through the crystal-clear transparency of the glass.

Self-healing materials

The development of self-healing materials is one of the current interesting research fields, because these materials enable bicycle wheel tubes, boot hulls and offshore wind generators to have a longer lifetime. A self-healing bio-concrete is currently being developed at the Delft University of Technology, which will repair cracks after hardening. Dampness penetrating gaps will trigger micro-organisms to produce calcium oxide. The yeast extract and peptone required for this process are added to the concrete at the outset. Another example is that of the fluid-filled nanospheres developed by Fraunhofer IPA for integration into the galvanised coating of metal chassis elements. If the surface is damaged by a fissure, these spheres burst open releasing the liquid carrying various chemicals to protect the material from oxidation and rust. These nanospheres can also be used to carry lubricants to increase the short-term life of ball-bearings, or they may even contain two-component adhesive that seal the cracks in boat hulls without any external involvement.



Functionality of electro-rheological fluids
(Source: Fludicon GmbH)

Electro and magneto-rheological liquids

These liquids react to the introduction of an electrical or magnetic field through the direct and universally adjustable setting of viscosity between liquid and solid. Polarisable micro particles within the non-conductible carrier fluid become aligned under the influence of electrical or magnetic fields and form chains; the viscosity of the fluid is thereby increased. This collapses once the field is removed; fluidity is again restored. Application areas for these intelligent fluids include vibration dampers (absorbers) in clutches, brakes, engine mounts and controllable valves. Magneto-rheologic fluids can also be used in the construction of earthquake-proof buildings and bridges.

Fludicon GmbH based in Darmstadt specialises in the development and marketing of industrial products and systems the function of which is based on electro-rheologic fluids (ERF). Sample products include dampers, clutches and actuators. Car shock absorbers can benefit from the comfort and safety provided by ERF. This is because the absorption effect can be adjusted to the relevant conditions within a fraction of a second. The eRRide® chassis with Fludicon shock absorbers can be optimally adjusted in alignment with speed and the road surface conditions. This results in reduced fuel consumption due to the decrease in body movement as well as longer tyre lifetimes because of the evenness of the distribution of contact with the carriageway. Fitness equipment can also benefit in this context. The conventional weights stack is replaced in this instance by an electro-rheologic damper which enables the training program to be individually tailored to the needs of the particular sportsperson. Fludicon GmbH is the commercial supplier of an electro-rheological fluid RheOil®, unique anywhere in the world. Numerous intellectual property rights secure the feasibility of further development in co-operation with industrial and scientific partners and the subsequent transfer into marketable products. In 2009 Fludicon GmbH was the recipient of the European Automotive Advanced Suspension Technologies Excellence in Research Award for its efforts in developing shock absorbing systems.

Electro-rheologic fitness device
(Source: Fludicon GmbH)

1.5 Optical and Energy Efficient Materials

Practical mobile application of solar films.
(Source: Sunload GmbH)

The solar bags produced by Berlin-based **Sunload GmbH** are in no way a gimmick, but instead represent a trend that can be currently detected in numerous applications: power generating, optical as well as energy-efficient materials, which aid us in using our energy resources carefully. Stitched-in thin-film solar cells found in bags, rucksacks and suitcases generate energy for mobile applications, afterglow materials increase safety in underpasses and lifts in the event of power blackouts. Light-conducting architectural façades with a high level of heat insulation, OLED for the manufacture of extremely flat and energy-efficient displays or phase changing materials, which are integrated into construction materials in order to significantly reduce the cost of interior climate control: all these are examples of the trend towards the development of materials which concentrated on one primary concern – the desire to use energy more carefully.

Afterglow metal sheets application
(Source: Novelis Deutschland GmbH)

Thin film solar cells

Now that conventional solar cells with a silicium wafer base are used in a wide range of applications, thin-film technology represents the next development step in relation to solar modules. What we are talking about here are flexible solar cells which are 100 times thinner than the conventional wafer-based ones. While the initial efforts at producing thin film solar cells in the 1990s were based on vapour deposition techniques, various printing techniques are now used in production to achieve layers less than two millimetres thick. The physical properties and the effectiveness of the new generation of thin film solar cells are differentiated according to the materials used for the semi-conductors and substrates as well as the selected printing technique and the thickness of the layers. Suitable semi-conductor materials include not only silicium gallium arsenide (GaAs) but cadmium telluride (CdTe) and micro-crystallised silicium. A whole range of manufacturers currently promise good results through the use mainly of copper indium (gallium)-sulphuric-selenium compounds (CIGS solar cells).

According to the EU Commission there are some 200 companies in Europe currently active in the development and production of thin film solar cells. One such example is that of the scientists and engineers working with **Evonik-Projekthaus Functional Films & Surfaces** in Hanau-Wolfgang to produce polymer film coatings using nano and micro-scale coating systems with the objective of reducing the weight and costs of solar cells and to make thin film technology marketable.

	1st wave	2nd wave	3rd wave
	Silicium/wafer-based cells	**Thin film solar cells (vacuum technology)**	**Printed thin film solar cells**
Process:	Silicium wafer processing	Vacuum methods (e.g. sputtering)	Roll-to-roll printing techniques
Process control:	Fragile wafers	Narrow process window	Integrated repro-ducibility (bottom-up nanotechnology)
Process yield:	Robust	Vulnerable	Robust
Prop. Material consumption:	30 %	30–60 %	Over 97 %

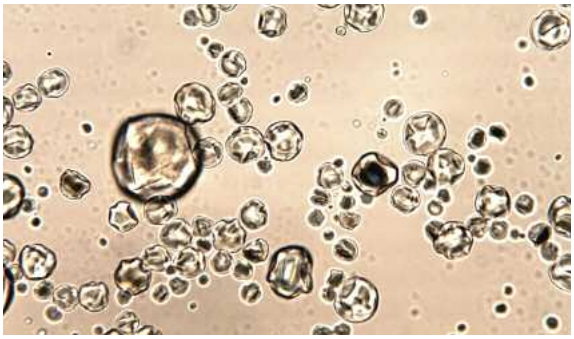
Manufacturing process for thin film solar cells

Solar Decathlon 2009

The Solar Decathlon Prize is awarded by the US Ministry for Energy and is regarded as the unofficial world championships of company working in the solar industry. Under the guidance of Prof. Manfred Hegger, in 2009 students from **TU Darmstadt** 2009 again won the prize following their previous success in 2007. Both institutions produce more energy than they require due to the clever design and ultra-modern technology. The tremendous success underlines Germany's position as a leader in energy-efficient construction. The energy gained is used by a heating pump for heating and cooling. One new development is the cooling ceiling, which was equipped with phase change materials (PCMs).

Submission by TU Darmstadt to Solar Decathlon 2009

Phase change materials



Microscope image of Micronal® (Source: BASF)

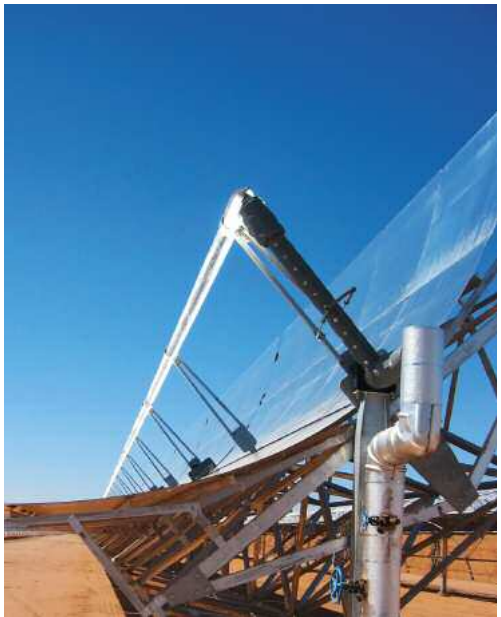
One of the most interesting examples of materials that are transformed by energy are the so-called phase change materials (PCM). These have already been in use for some time as hand and pocket warmers. In 2009 researchers from Fraunhofer ISE and developers at BASF added new possible applications to the range developing PCM products for the construction industry. The basis here are microscopically small synthetic spheres marketed under the brand name Micronal®, consisting of a core made of wax which forms a carrier medium. When the temperature increases heat is absorbed once the wax has melted, and this will be released back into the environment when the temperature decreases again. PCM can be integrated in a non-obvious fashion into diverse construction materials, such as wall plaster or construction slabs – it can then positively used to influence the climate of the environs. The cost of air-conditioning systems is greatly reduced, enabling the supplementary costs of the construction material to be recouped within just five years. PCM products for the construction industry were nominated for the Deutscher Zukunftspreis in 2009.

Desertec Projekt

Desertec Industrial Initiative

October 2009 saw the commencement of a unique industrial initiative with the aim of achieving a reliable, sustainable and climate-friendly supply of energy from the Middle East and North Africa (MENA). Twelve companies – with **Deutsche Bank** and **Schott Solar AG** numbered among them – have come together to form the Desertec Industrial Initiative (DII) GmbH. The long-term objective is to use solar and wind power plants based in the deserts of North Africa to generate a significant part of the power needs for the MENA Region and 15 % of the European power requirement. Following the establishment of the requisite political, economic and technical parameters, the first power plants are planned for construction as early as 2015. The total investment to 2050 is estimated to be in the region of 400 billion Euro.

Solar thermal power plants have already been deployed for more than twenty years in Spain and the USA. The core element of each plant is the receiver, which is located in the focal line of a groove-shaped parabolic mirror. The solar radiation is collected heating the formal oil flowing in the receiver up to temperatures of between 350-400 °C. This is then pumped to the generating unit creating steam, which ultimately drives the turbines of the power plant. Schott Solar AG has developed a special solution for these requirements. The Schott receiver consists of a specially coated absorption pipe made from metal, which is embedded in a vacuum-tight glass tube. Just a few hundred nanometres thick the coating of the absorber is designed to accommodate particularly wide-ranging temperature fluctuations, thereby ensuring that a given solar-thermal plant can be commercially operated for at least twenty years. In response to the differing expansion coefficients of glass and metal, Schott has developed a special type of glass which possesses the same thermal expansion properties as the metal. A special construction design was developed to bind the two materials. A bellow compensates for the differing expansion lengths of the glass hull and absorber pipe so that the two materials can be connected together in a tension-free manner.



Solar thermal power plant
(Source: Schott)

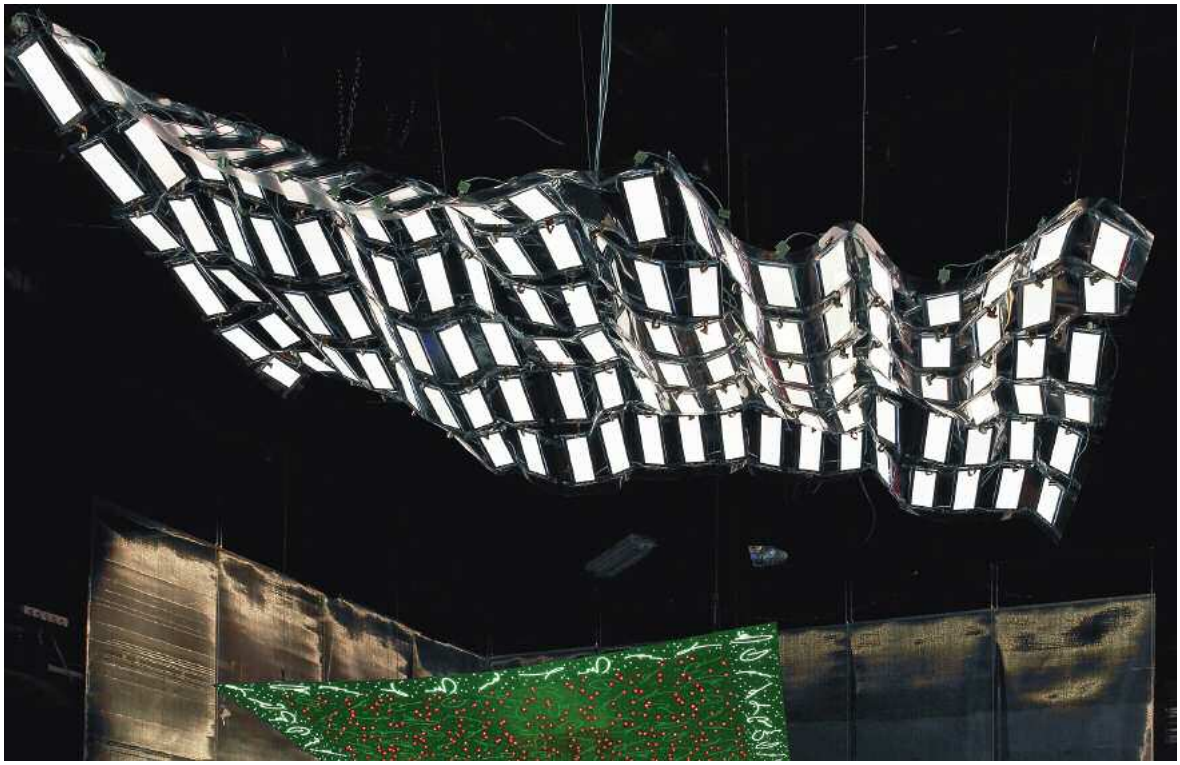
Nanogel insulation in transparent panels (Source: Bayer Sheet Europe GmbH)

Light-conducting building façades

Light-conducting façades are currently one of the most significant development areas in architecture and the construction industry. With their transparent, heat-insulation and noise-dampening properties, it is Aerogele products that have proven especially successful for these kinds of applications, due to their ability to remain extremely airtight with large enclosed volumes of air. **Cabot Nanogel GmbH** based in the Industriepark Frankfurt-Höchst manufactures Nanogel®, a highly porous translucent silica Aerogel with water-repellent, mould-resistant qualities. This is now used by the specialist glass-maker Okalux in the inter-pane cavity of its Okagel® insulating glass for energy-efficient applications in museums, sports centres and event arenas. It exhibits remarkable U-valves irrespective of the angle of mounting, unlike conventional air or gas-filled insulating glass. With a nanogel intermediate layer of 60 mm, the U-valve is actually less than 0.3 W/m^{2}K, thereby satisfying the requirements of a low-energy building. Integrated into thin wall constructions, Nanogel® provides a high level of thermal insulation combined with outstanding background brightness.

Bayer Sheet Europe (Darmstadt) markets polycarbonate transparent sheets filled with Nanogel® that boast extreme thermal insulation, a high level of light permeability and optimal light diffusion in the form of ceiling glazing. With a Ug-value of 1.0 W/m^{2}K, when installed overhead they have the same insulation characteristics as triple glazing. The utilisation characteristics are underpinned with an extra thick exterior layer, optimised UV protection and translucent panels. The product is marketed under the Makrolon® Ambient label.

Nanogel insulation in glass (Source: Okalux GmbH)

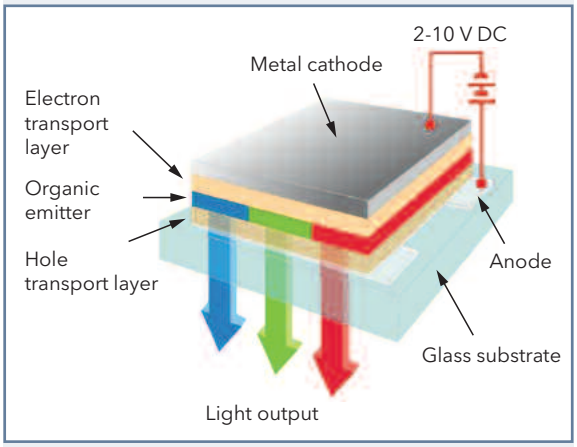


OLED lamp
(Source: Ingo Maurer)

OLED

The next generation of light diodes, known as OLEDs (**o**rganic **l**ight **e**mitting **d**iodes), for the manufacture of extremely thin displays and flat-screens, can also be attributed to the nanotechnology sector. This is because the construction is comprised of several thin functional layers, some of which are just 100 nanometres thick. The result is a flexible luminous film with a radiation angle of 170°. Possible uses as electronic paper or luminescent wallpaper have already been envisaged. The tremendous investments made in research and development during the last ten years has resulted in considerable advances in performance and stability, due not least to the efforts of companies such as the Darmstadt-based **Merck KGaA** with its OLED activities. One study undertaken by an American market research institution estimates the total market volume to be around 15.5 billion US dollars. The primary returns gained from OLEDs today are in the area of producing small displays in mobile devices such as MP3 players and mobile phones; the revenue generated here is already in the region of 1.3 billion US dollars. It is estimated that by 2014 this will rise to 7.1 billion US dollars in the mobile sector and approximately 6 billion US dollars in the TV monitor sector. It is forecasted that 2.8 million OLED televisions will be sold in 2013.

It was due to this large potential that Merck joined with well-known partners in the worlds of industry and science to launch the "New materials for OLEDs"-Project (NEMO). The object of this project financed by the Federal Ministry for Education and Research (BMBF) is the development of innovative soluble materials for applications in large-area components for OLEDs, such as may be found in televisions, electronic road signs and lighting systems.



Structure of an OLED
(Source: F. Erler; N. Seidler)

2 The Gap between Material Innovations and the Market – How can it be closed?

"The integration of innovative materials in mass produced applications is an extremely difficult business, which is only feasible if large players get involved. Otherwise experience shows that they will remain isolated in top-priced high-end niche applications."

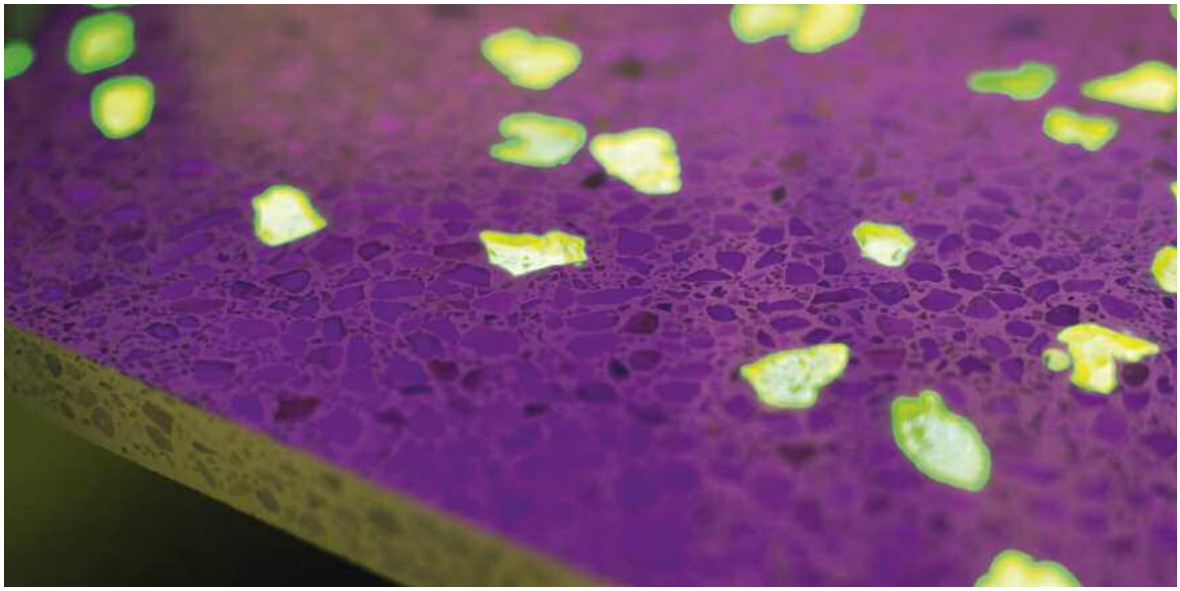
Jose Delhaes, Design Planet, Guest Professor, The Offenbach College of Design

Although the number of material innovations and technologies being processed is increasing, it always takes a long time until a new material becomes used in a mass product. This of course is due to the lengthy development work required to make a material-specific function viable for a specific application. But if we look at the process by which marketable solutions for the quality profile of certain materials are identified in this country, some deficits become apparent which impede the transfer of technical material innovations into the marketplace.

One problem is clear in relation to the education of material scientists, which still lacks adequate interdisciplinary focus. The emphasis here is on the teaching of technological skills, which are doubtlessly required for the development of material-specific functionalities. But the identification of novel applications in new areas and working together with other disciplines demands that engineers have other abilities, which are usually not explored adequately during training and degree courses.

Thus we have the situation where material and application developments take place sequentially in isolation from one another. Connections to future application scenarios (so important for material development) are usually not identified or formulated in time, and are only taken into consideration when the material is revised. It is precisely these connections which can give a company an advantage over its competitors and its survival in the marketplace. So we see in the study "Global Innovation 1000", performed by the consultants of Booz Allen Hamilton in 2006, the conclusion that an early strategic focus on

Model application for Bayer polycarbonate material
(Source: Rinspeed)



Model application for afterglow rock particles (Source: Ambient Glow Technology)

R&D activities in the market and towards customer benefit will increase the success probability of new developments and, parallel to the functional material technology, the link to practical uses should also be developed in the form of model applications.

This is fundamentally dependent on one thing – the integration of people from the creative industry, i.e. designers and architects into the development process at a very early stage, who, due to their training, can potentially make crucial connections for the future application contexts of material innovations. People working in both the creative and technical disciplines should be trained in inter-disciplinary development, moreover, and be able to bring the requisite communication skills to the table. This could prevent problems in working partnerships from arising and facilitate inter-disciplinary working in open innovation processes over and beyond the boundaries of the enterprise.

Bayer Material-Science pursues a functional model with its **Creative Center**. Since 2004 future applications have been derived there from new user requirements, which give transparency to the development requirement for new materials and technologies across various disciplines. The Robotics, Logistics, the Construction Industry scouting fields and the optical and light areas future scenarios are developed with the participation of designers, architects, trend researchers and technologists to serve as the bases for the derivation of model markets and for the visualisation of new production concepts for existing material solutions or future material developments.

LED-illuminated Bayer tower in Leverkusen (Source: Bayer MaterialScience)

Model project – BMS Innovation Centre in Diegem, Belgium (Source: Bayer MaterialScience)

The **EcoCommercial Building (ECB) Program** is an example of how such an analysis can lead to the development of new innovative business models. This program was established by the chemical group as a response to the increasing energy-saving requirements in the construction sector and in particular to the economic development in emerging economies such as India and China and the associated imminent improvement in life standards that this will bring. Through an integral planning process extending from idea generation and conception to the implementation of product and system solutions ending with certification, the aim is the optimum adaptation of building constructions to the locally prevailing climate conditions in order to enable energy-efficient and economic construction with a neutral impact on the climate. The potential is indeed enormous given that one-third of global greenhouse emissions is caused by buildings. Furthermore, some 40 % of the final energy consumption throughout the world is due to the construction and operation of buildings. In relation to industrial buildings in particular, there is currently a trend towards standard solutions that demand a high amount of energy.

Bayer MaterialScience is therefore combining with partners in the construction sector to realise future-orientated model projects for various climate zones. A cross-sector knowledge platform is being established to provide architects and designers, the construction materials industry and construction companies with access to the knowledge gained in relation to building and running right up to the analysis of the respective operation situation. The use of renewable energies such as solar energy for the generation of power and geo and solar thermals for heating form part of the focus as does the development of suitable heat insulation for building shells in order to satisfy the requirements for zero emissions buildings. Insulation materials with a polyurethane hard foam base, water-based raw materials for painting systems, photovoltaic modules with thermoplastic polyurethanes, fibre-reinforced construction elements with a fibre glass concentration of up to 80 %, insulation for refrigerators and freezers or applications in lightweight vehicle construction are just some of the examples where existing material solutions are already been used. One of the partners in this network is **Bayer Sheet Europe** based in Darmstadt. This Bayer subsidiary markets polymer sheet material in diverse versions for use in façade cladding, roofing and glazing.

"The crucial step for energy-efficient, economic and well designed construction is a holistic approach incorporating the intelligent linking of the various disciplines: an integral planning process is based on a network of experts."

Dr. Thomas Braig, Head of The EcoCommercial Building Program in the EMEA region Europe, Middle East, Africa

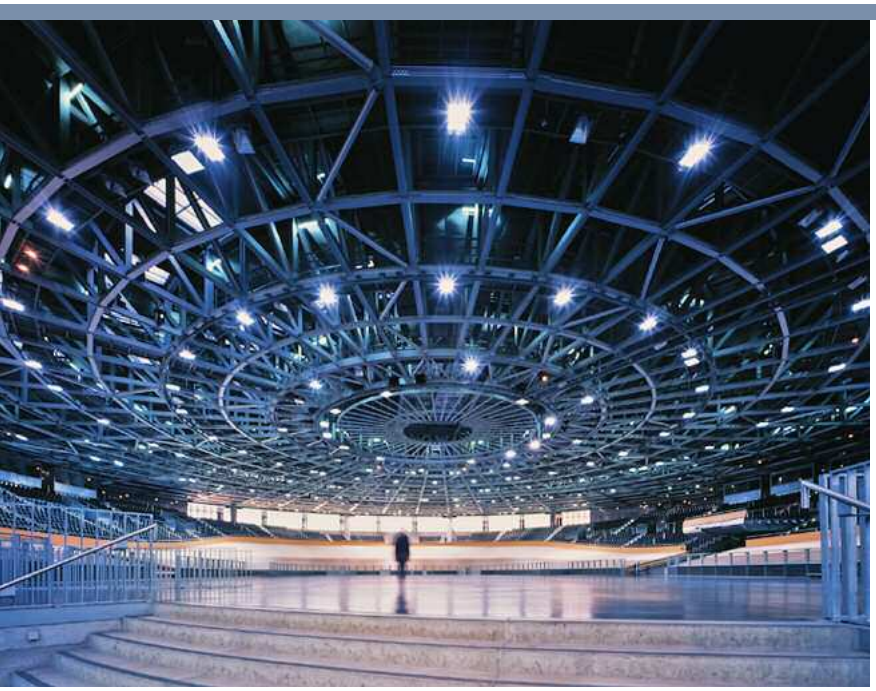
Evonik Industries with its subsidiaries, **Evonik Degussa GmbH** (Frankfurt) and **Evonik Röhm GmbH** (Darmstadt), is also pursuing a similar objective with its strategic research and development unit, Creavis, which involves a focus on identifying new markets for new developments. In "science-to-business centres" all the disciplines involved in the value creation chain are including in examining high risk future issues, with this process ranging right across from the basic research to the product development to the pilot production. The aim is the accelerated development of new businesses right up to the production of finished systems for end users and the transfer of fundamental results into the market. The individual areas actively work in an integrated, open and dynamic corporate culture. Furthermore, potential target customers are involved in the development process, in order to achieve a better understanding of the requirements in future markets and of new products and in order to significantly reduce the timeframe from invention to market viability when compared to conventional methods.

Medium risk research issues that overarch business areas are worked out in "project houses". Researchers from the business areas involved in the project house come together for a period of three years. One such example is the **Systemintegration project house** that was launched on 1st January 2009 in Hanau-Wolfgang. The objective here is to develop the respective product with the requisite processing technique and to align the two together in such a way that the customer can integrate the system into its current production process simply and perfectly. This comprehensive approach is intended to speed up the development process, hone additional skills along the entire value creation chain and facilitate the market launch of new products. The issues are numerous and for example include "push-button bonding" for automotive and industrial applications or the production of nano fibres for filtration applications. Alongside the technical aspects, new business and marketing models are also being developed and implemented. In order to achieve an optimum result, the group is deploying all the necessary disciplines – from architects to natural scientists to power plant engineers. The industrial player is providing about 15 % of the annual budget of 300 million Euro for research and development in relation to overarching research projects.

The interaction between market, applications and technology development is therefore giving rise to impulses and information both in Bayer MaterialScience's Creative Center as well as Evonik's Creavis to close the gaps between material innovation and the market and to develop products with a low level of innovation risk. Functional aspects in this context require the modelled development of new markets, whereas user expectations of future scenarios influence the technological innovation process. Material innovations are aligned towards market and customer requirements at any early stage with the inclusion of people from diverse disciplines. Both internal and external resources are involved.

3 Creative Professionals as Partners. Targeted Deployment of Designers and Architects.

What are the Strengths of the Creative Professionals in the Process?



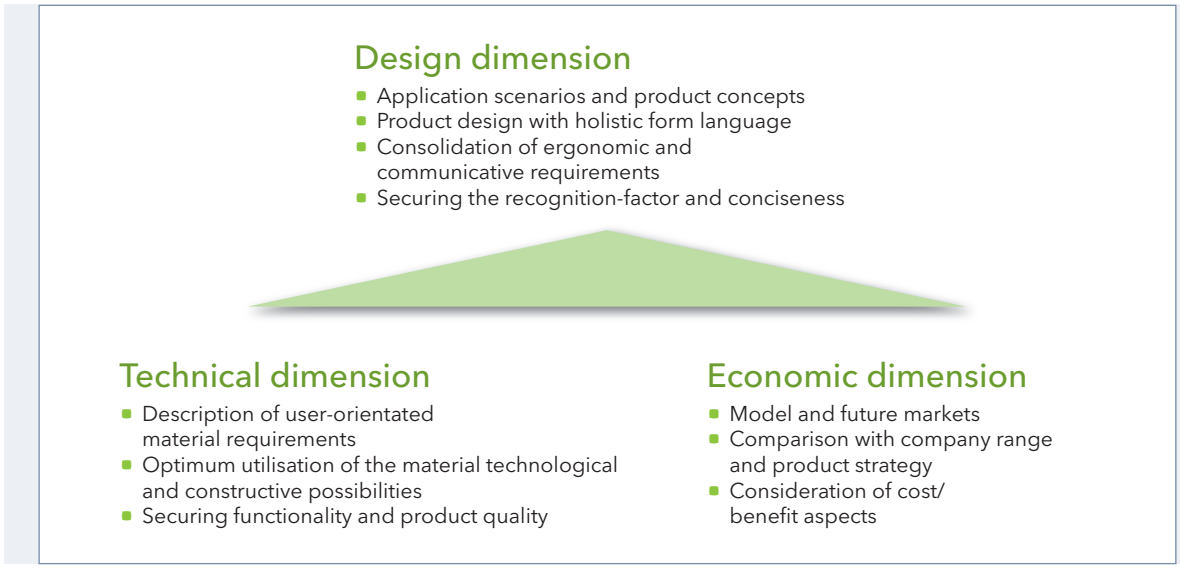
Velodrome, Berlin (Source: Velomax Berlin; Photo Werner Huthmacher; Architect: Dominique Perrault)

Providing the potential is focused upon, the new material developments for designer and architects are highlights within the marketplace and at the same time there is an analysis of the difficulties that German companies in particular have in relation to transforming new technologies into marketable products, there can be no plausible justification for the question about the reasons for the all too seldom integration of creative professionals into the innovation process at any early stage.

The possible explanations are numerous. One initial hurdle to the working partnership between technologists and creative professionals arises where the majority of decision-makers in the industrial context primarily view the services of designers and architects as the opportunity for aesthetic qualities to be enhanced and which is a phase that takes place after the technical development process has been completed. But current studies clearly underline the value of designers for successful product development and of architects for the transfer of innovative materials from alien sectors into the construction industry. For example, Dominique Perrault in the 1990s was one of the first architects to use wire mesh thereby creating a wholly new market. Furthermore, in the industrial context designers, in particular, act as significant sources of inspiration within the product development process, in that apart from generating product ideas they ever more frequently also deliver methods for the solution of technical construction problems. And in recent times architects have become established in developing materials and processing techniques themselves. Examples in this context include translucent concrete developed by the Hungarian architect, Áron Losonczi, in partnership with Schott in 2004 or the free internal high-pressure forming technique (German abbreviation – FIDU) by the Polish architect Oscar Zieta at the ETH Zürich.

Left:
Translucent concrete (Source:Áron Losonczi)

Right:
Freely blown metal forms (Source: Oscar Zieta)



Services provided by creative professionals in material-intensive innovation processes

It is precisely in connection with material-intensive developments that designers and architects ensure the communication of the innovative substance and the quality of a product and who establish the recognisability and delineation of the portfolio in the market. One very vivid example (see too the Success Stories, page 56) is the work of the interior designer Sylvia Leydecker for Evonik Degussa GmbH during the development of **ccflex stardust®**, with which she made the properties of a wall covering finished with a ceramic nano coating (water-repellent, UV-resistant, fire-resistant) visible to the user from outside.

"We pursued three core objectives during this development from 2003 to 2007: ccflex had to be able to cope with applications in heavily used wet areas. It also had to be easily workable for the tradesman and finally, the end customer had to receive an emotional impulse."

Dr. Frank Weinelt, Evonik

It is in this context that designers and architects are clearly to be regarded as essential partners in materials-based innovation processes and should therefore be linked as strategic components with the central areas of the business such as research and development, production and marketing. For in the current market situation many companies, in competition with providers in emerging economies, are finding innovative success by pursuing an inter-disciplinary rather than a single-dimensional approach which could result in long-term increases in sales. The most recent examples confirm that the opening up of innovation process and the integration of external resources can increase the success probability of new developments. These factors are all too frequently ignored by manufacturers in the context of long-term innovation programs.

"The potential of design is recognised and exploited first and foremost within the area of inter-disciplinary research. Design is the link between disciplines as diverse as technology research and sociology. Design establishes the link between the hi-tech and the everyday. The aim here is to establish a better and direct link between the society and our everyday lives."

Prof. Gesche Joost, Chairman of the Deutsche Gesellschaft für Designtheorie und -forschung e. V. and Head of Design Research Labs at Deutsche Telekom Laboratories in Berlin

Myto Chair
(Source: Konstantin Grcic)

The question as to the strengths of creative professional in materials-based innovation processes can be much more cogently explained based on the development history of the Myto chair, designed for **BASF AG** by the designer Konstantin Grcic (manufactured by Plank in Italy). The objective was to visualise the functionality of a nanoparticle additive for the technical plastic PBT for improving fluidity when used in the injection moulding process and to make the new qualities of this material apparent to customers. Firstly the designer proceeded on the basis of the erroneous assumption that the material could be hard and soft at the same time. The confusion may have been clarified by the BASF technologists but Grcic used the tension in these contradictions as the method by which to approach the product development. The remit was to create a cantilever chair, the backrest of which – "stretched like a pillow" – would curve in response to the body. This then was the approach focused upon by the customer and the technical function and physical efficiency were used as the parameters for the innovation process.

Because of their day-to-day work and their training, people in the creative industries have the ability to be better able to visualise products from the perspective of the future customer. Due to their intensive activities in the product markets, they notice social developments at any earlier stage than personnel from the technical disciplines and so act as "seismographs" within the development process. They work using ethnographic methods in order to identify hidden user requirements and to place these in context with the technical possibilities. In this sense the process is directed towards a singular event – the search for the "unique" in the "multitude of possibilities". A product is given a special character, a sense and a symbolic-communicative effect specific to a particular target group – i.e. a unique selling proposition within the market which ensures that the material-technical innovation has a successful and financially profitable transfer into a marketable product.

Due to the very diverse area of activity, designers and architects are very flexible in tackling conceptual work. They are readily able to establish links between different areas of knowledge and can dismantle them just as quickly. This ability firstly and foremost makes them useful for the fundamental research as they can act as intermediaries between developers and users, when years after the knowledge was discovered it is necessary to communicate the benefit of the research focus by means of a clear image and to prepare model product concepts. One example is the fire-fighting robot which was developed by designers in Magdeburg as a potential application for a vehicle conceived by Fraunhofer IFF. The concept is to have autonomous robots patrolling forested areas in order to prevent fires and other situations hazardous to people. The scientists were enthusiastic, because following the publication of this clear image their developments were being discussed all over the world.

A step further was taken in the "The worst case – high-rise fire" project during the winter semester 2007/08 at the Offenbach College of Design. In conjunction with the building safety department of the Commerzbank Tower, Fraunhofer IAIS (St. Augustin), the fire-prevention experts from HHP Süd, the fire insurance company FM Global as well as the fire services from Offenbach and Frankfurt, this project developed products and resources to ensure survival in the event of a high-rise fire.

Fire-fighting robot OLE (Source: Hochschule Magdeburg-Stendal, Design: Henner Hinze, Jana Peterschmidt)

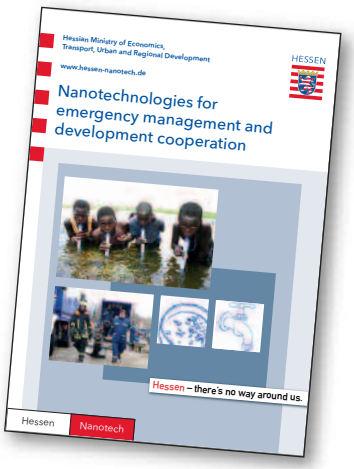
Respiratory mask with integrated data projection (Source: The Offenbach College of Design, Design: Mykhaylo Falkovych)

The numerous partners ensured a realistic estimation of a catastrophic scenario and provided an overview of the current capabilities of fire-fighting methods. By means of an iterative process the students delineated the problem areas, developed conceptual solutions and derived concrete product concepts. These ranged from a fire analysis robot that ascends steps to a respiratory mask with integrated data projection, façade elements that serve as escape routes from the building and a mobile fire-fighting unit.

"I deliberately chose not to speak to individual industrial partners as I wanted to open up the student project as much as possible. From what I have heard from fire-prevention experts afterwards, the results display a very realistic vision of fire-fighting in high-rises in the future."

José Delhaes, Design Planet, Guest Professor, The Offenbach College of Design

The approach taken by designers can be characterised as an iteration process with small steps. It is precisely this ability that makes them important for the current innovation climate, which features short development cycles and radical changes within the markets. Notably the wish of many innovation researchers to have the development objective continuously aligned to the current development situation can be more easily realised by involving creative professionals in the innovation process. Furthermore, the ability to work with imprecise processes and to apply indistinct specifications, i.e. factors of influence, which is a phenomenon experienced in every successful innovation process, appears to be much more apparent in designers and architects than in other professions.



For more details see brochure "Nanotechnologies for emergency management and development cooperation", Volume 17, issued by Aktionslinie Hessen-Nanotech

Fire analysis robot (Source: The Offenbach College of Design, Design: Raphael Krug, Andre Federico Look)

4 The Process of Collaboration between Technical and Market Oriented Disciplines within the Creative Industries

Rigid processes and overly exact specifications in the initial development phases hinder the later success of the product and the timely alignment of an innovation project to the market. Moreover, the "tendency towards rigidity and oligarchisation inherent in all societies" (Gustav Bergmann) is a counterweight against interdisciplinary development plans. For the organisation of multidisciplinary processes for innovative products based on innovative materials and material technologies to be successful, it is therefore necessary to have the arrangements instituted within an open environment free of rigid paradigms. In this connection current innovation researchers like to talk about innovation islands or units, the functionality of which (especially in smaller companies) is fostered through allowing self-organisation to prevail. The management only holds the function of meta control, sets out the framework and accepts the permanent realignment of the process and the objectives to the development status. In large organisations small units usually have to be separated by allocating a separate space in order to enable the innovation objective to be achieved. One example is the concept of project houses operated by Evonik Industries, where up to 15 employees work for periods of three years focussing solely on how customers can utilise future technologies.

IInnovation process based on a co-operation between technical and market-orientated disciplines with the creative industries should always be aligned towards a people-centred understanding of innovation. The term "human centric innovation" is one of the buzz words used by the current international innovation research movement. It indicates a philosophy that combines knowledge and methods from the design and ethnography fields with methods found in the technology development and economics fields. The objective is to identify the hidden needs of users, to co-ordinate these with the parameters of technical feasibility and financial profitability and to direct research activities determinedly towards the market requirements. Here in Germany the discussion about the future of innovative activities is lagging behind the international knowledge process. In Finland for example during the course of a radical educational reform the Helsinki School of Economics, the University of Art and Design Helsinki and the Helsinki University of Technology were amalgamated and in January 2010 the Aalto University was opened boasting an educational slant towards multidisciplinary partnerships and user-centric innovation processes. But there is also one such example in Germany too: the Hasso Plattner Institute in Potsdam. Since the winter semester 2007 / 08 it has been offering an additional qualification in "design thinking". What is revolutionary about this approach is that four to five students in each working group and their professors and lecturers all come from different disciplines. The concept was one of the locations chosen in 2008 under the "Germany – Land of Ideas" initiative.

A heat exchanger is a functional model application for metallic foam (Source: hollomet GmbH)

All the approaches are based on the objective of breaking up the arrangement of sequential and separately implemented technology and application developments, in order to exploit mutual interactions and synergies for the success of the product. As long as material developments require a significantly longer lead-time than the resulting products, all materials-based innovation processes will also be performed in advance of the functional material development. The potential of creative disciplines in the early material development phases has until now been underestimated however, something which has led to a unilateral division of work on the part of the technical engineering disciplines. But if we are to pursue the ideal of the multidisciplinary innovation process, other disciplines should from the very outset have received information about the development approaches in the material laboratories. It is possible at an early stage to formulate the methods for future product concepts and future markets, which could positively influence the technological material development.

In the majority of cases material manufacturers wait until the latter stages of the material development before preparing application scenarios to enable industrial customers to see the particular functional qualities. Designers and architects could be important partners for this development. They are able to contribute a user-orientated perspective to the development process. This frequently leads to the situation where product concepts with a direct customer benefit are developed, which can also be more easily communicated as a result. For example the Myto chair was developed in order to demonstrate the functionality of a nano additive developed by BASF for the product process (see page 42). Because this was successfully implemented in the form of a cantilever chair, it led to the possibility of presentations at numerous design fairs and to a spread of knowledge among designers and interior designers about BASF's nano-technology skill set.

Members of market-orientated disciplines are assuming an increasingly important role not least in relation to the development of future markets and new product concepts. They create images for the possible widespread use of the new material or technology and convey a future vision by means of a functional product. The development at an early stage of model product concept accelerates the transfer of a material innovation in the marketplace and is an important instrument for the market development. One example from 2007 is the Merck-initiated development by the designers Hannes Wettstein und Ingo Maurer of lighting systems based on OLED technology. As a result the first OLED lamps were launched on the market in 2008.

OLED lamp (Source: Hannes Wettstein)

Light Car
(Source: EDAG)

Proof that a combination of existing technologies and materials can generate products for a new market was provided by Bayer MaterialScience in the form of the EcoCommercialBuilding Initiative. The principal objective here is to inform all parties involved in the building of a zero-emissions building of the possibility of using existing solutions and to redevelop the market on that basis (see page 38).

The necessity of developing a future market for innovative materials and technology solutions through multidisciplinary development teams was also recognised by the decision-makers at EDAG. In January 2009 at the 79th car show in Geneva, the development services provider from Fulda unveiled a vehicle research project, "Light Car – Open Source", based on a close working partnership between designers and engineers, featuring the same three approaches for future markets within the framework of a resource and energy-efficient motor and chassis concept.

"The electric engine provides designers and developers with tremendous potential to realise truly innovative vehicle concepts and to position a unique type of electric car on behalf of the end customers."

Jörg Ohlsen, Spokesman for the Board of the EDAG Group

For the chassis EDAG used basalt fibre as lightweight, stable and, most importantly, a 100 % recyclable material – the first time it was deployed in automotive construction. The propulsion is provided by intelligent, electrical drive units in the wheels, which are not only highly effective in transporting the power of the lithium ion battery onto the road but they also allow more scope for the design of the vehicle package. With its innovative light concept, the "Light Car – Open Source" will also be one of the first cars to use (O)LED technology as an individually modifiable design and communications element.

Light Car – vehicle construction
(Source: EDAG)

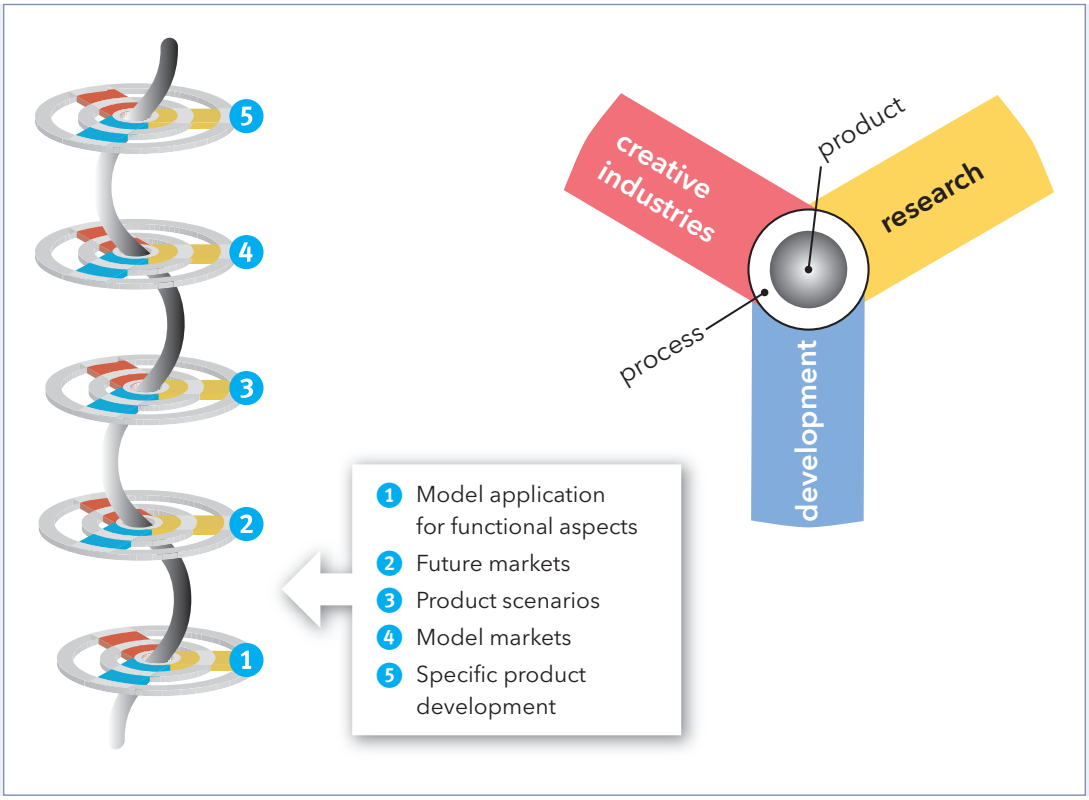
"We have transferred the current standards of multi-media and lighting technology to the car and want in future to offer the end consumer the scope to configure their vehicle precisely how they would like to – after all the entire surface of the vehicle functions like the screen of a multi-media device and can be used intelligently and individually."

Johannes Barckmann, Head of EDAG Design Studios, talking about the idea behind the Light Car.

Due to its choice of innovative materials, the entire vehicle concept was awarded the Design Plus Prize at the Material Vision event in June 2009. EDAG also clearly demonstrates the excellence of the results that can be achieved through parallel technology and application development in multidisciplinary processes and how an open innovation approach together with partner companies can unlock wholly new potential in relation to development. Alongside its vehicle project, the EDAG Group has also prepared a proposal for an innovative product concept, which accommodates the specific requirements existing in relation to the production of an electric car.

Factors for fostering cooperation between technical disciplines and the creative industries:

- Respect for the work of other disciplines
- Participation in the materials-based innovation process by all disciplines involved in the value creation chain
- Organisation of development teams allowing for free self-organisation
- Avoidance of rigid and linear process philosophies
- Tolerance of fuzziness
- Continuous alignment of innovation objectives to the current development results
- Regular communication of information to all the disciplines involved in the development through the medium of visualising the development status



Partially parallelised process steps in relation to multidisciplinary materials-based development processes

5 How do I find the right Partner?

Selection Criteria for Representatives of the Creative Industries

Plenty of time should be allowed for researching and selecting people from the creative industries. There are no clear criteria which could simplify the selection process. The decision is rather based on an impression comprised of numerous pieces of information. A fundamental distinction can be made between two research approaches: firstly there is online research to enable the company to get an overview of what is available or to make a preliminary selection. On the other hand there is the qualified search undertaken during workshops and seminars, during which institutions such as German Design Council or Hessen Design (see page 50) will readily provide assistance.

© Nicolas Loran, istockphoto.com

Online research

Many companies evaluate the qualities of a creative service provider primarily on the basis of reference projects and professional experience. The majority of designers and architects therefore carefully use their websites to extensively document the projects they have undertaken and the successes they have enjoyed in development. Other information about the areas of activity in which particular creative professionals are involved can be found from online platforms, publishing houses and institutions. Architects are also showcased via the various architect chambers.

Alongside the core activities, selected references, education, training and equipment, the size of the particular studio can be determined according to the number of employees working there. This information is usually enough to enable a decision to be quickly taken as to whether a particular creative professional is suitable for a certain project. If unconventional development methods are anticipated, it is helpful to work with a newer studio, from which extensive references cannot of course be expected. Following the initial meeting and a discussion of the job specification, final clarity can be secured by requesting the submission of a written elucidation of the project.

Designer search

- www.designer-profile.de
- www.industriedesign.de
- www.agd.de
  (Alliance of German Designers)
- www.vdid.de
  (Association of German Industrial Designers)
- www.vdmd.de
  (Association of German Fashion
  and Textile Designers)

Architect search

- www.architonic.de
- www.architektenweb.de
- www.architektenscout.eu
- www.bda-bund.de
  (Association of German Architects)
- www.bda-hessen.de
  (Association of German Architects in Hessen)
- www.bak.de
  (Federal Chamber of Architects)
- www.baunetz.de
- www.german-architects.com

Qualified search

One concrete approach to finding a designer or architect comes in the form of a workshop or seminar on particular issues. Institutions such as German Design Council and Hessen Design are experts in this context. Accessing a qualified network can enable the respective specifications and parameters can be taken into consideration at the very outset.

In order to transform a design into a valuable brand ambassador, many requirements have to be identified and satisfied. With its many years of experience, German Design Council for instance is able to assist companies to promulgate their brands through design. It is only on the basis of thorough analyses that tailored brand and design strategies can be developed and the requisite specialists pinpointed within the creative industries. Apart from relaying the bases for strategic implementation with the design partners, where requested the service can also encompass supervision of the design process.

"It's all about the chemistry! Irrespective of which method is chosen – the working partnership with a designer or architects studio ultimately depends on the chemistry between the customer and the creative services provider. The innovation process in its early stages is crucially dependent on a free and open atmosphere, promoted by the unrestrained interaction of the various parties together."

Dr. Sascha Peters, haute Innovation

Hessen Design

Hessen Design e.V., based in Darmstadt, is an expert point of contact for all issues relating to designs. The range of services extends state-wide and encompasses companies, designers and students as well as a wide section of the public. Comprehensive consultancy services, lecture series, workshops, symposia and exhibitions all form part of the portfolio of Hessen Design.

Hessen Design is funded by companies and design studios in Hessen, the Hessian universities, the chamber of trade and industry in Hessen, the consortium of Hessian chambers of crafts and trade associations, the Hessian Ministry of Economics, Transport, Urban and Regional Development, the Hessian Ministry for Science and Art and the City of Darmstadt.

www.hessendesign.de

German Design Council

The German Design Council was founded in 1953 upon a resolution taken by the Deutsche Bundestag, in order to meet the growing demand from industry for information about the issue of design. The institution is now numbered among the world's leading centres of excellence for communication and transfer of knowledge in relation to design. Through its competitions, exhibitions, conferences, consultancy services, research and publications, it opens up new horizons for players in industry and the design disciplines. The sponsors of the German Design Council are now made up of 160 of the most influential German companies.

www.german-design-council.de

© Rat für Formgebung, photo: Lutz Sternstein, Frankfurt am Main

6 Success Stories: From Raw Material to Product

6.1 Glass Fibres make Concrete Translucent

Translucent concrete (Source: Áron Losonczi)

Called "LiTraCon" (Light-Transmitting Concrete) by Losonczi, this construction material was named Innovation of the Year by TIME magazine in 2005 and it triggered a trend within the cement industry resulting in a number of imitation products. And so we are indebted to the innovation capacity of an architect for the formation of numerous enterprises and whose product, according to the architects, will soon be on the shelves of every builders store. For alongside the construction industry, others to have discovered the material include advertisers, furniture designers and media designers.

At the outset there was the experiment, playing with different materials and the question of how this grey heavy-looking rock material could be made to allow the passage of light and shadows. As part of a postgraduate course at the Kungliga Konsthögskolans Arkitekturskola (Royal University College of Fine Arts) in Stockholm, the Hungarian architect, Áron Losonczi, tackled the issue of glass in architecture, learned about optical fibres and made contact with SCHOTT, one of the world's leading manufacturers of optical glass fibres. Based in the Rhine-Main region, the company provided him with glass fibres, thousands of which he cast in concrete.

The result of this unusual combination of materials was the invention of a new construction material with light-permeable and carrying properties. The fibre glass proportion of 4–5 % enables the transport of about 70 % of the light incidental on one side of a concrete block, with thicknesses of up to two metres, straight through the inside to the other side, where is appears luminescent on the surface. And conversely shadows will appear on the other side of the stone surface as distinct outlines. In this way a concrete wall is transformed into a mixture of a projection wall and a light experience. It is able to convey the silhouettes of trees, houses and passers-by onto the interior wall of the building in question.

"If trying to describe how a mighty wall suddenly loses its heaviness, then 'luminescence' is probably not even the right word, because the aesthetic of the material is much more complex", says the Hungarian architect, Áron Losonczi.

"We are constantly searching for new applications for optical glass fibres, but this application surprised even us. This new building material could immensely add to the design possibilities available to architects. But it may also be very interesting for light planners."

Patricia Alter, Product Manager Lighting & Visual Merchandising at SCHOTT Architecture & Design

www.litracon.hu; www.schott.com

For more details see the brochure "Einsatz von Nanotechnologien in Architektur und Bauwesen", Volume 7, issued by Aktionslinie Hessen-Nanotech.

6.2 Access New Markets with Design

Carus Esencia Room Fragrance System
(Source: Seidel GmbH)

Carus Candela
(Source: Seidel GmbH)

Seidel GmbH & Co. KG is a global leader in aluminium packaging products for the cosmetic and pharmaceutical industries (customers include Hugo Boss, Procter & Gamble, Avon, L'Oreal). High-grade design components such as perfume caps, crème jars, or lipstick devices constitute the core business of this Marburg-based company, which possesses wide-ranging expertise in processing aluminium design articles and top-quality finishes. The additional manufacture of plastic components and the extensive decoration variations and the fully automatic assembly enable the implementation of complex projects and the realisation of high-grade products. By concentrating on aluminium as a material, the company is pursuing a strategy towards the optimised use of resources and the avoidance of hazardous wastes. Aluminium can be recycled with very little energy being expended. Seidel has therefore focused its research on this particular material. In the company's new research centre, projects are systematically carried out in partnership with the universities of Marburg, Giessen and Hamburg for the development of surface finishing techniques for the optimisation of aluminium products. The primarily objective of these projects is the realisation of micro- and nano-structured ceramics to create material composites with aluminium in order to achieve functional, optical and tactile properties. By lending surfaces a nano-structure it may be possible to achieve new optical and tactile effects. The functional objectives are to improve the control between containers themselves and the surrounding container surface. The company maintains various partnerships for the development of new product concepts. It now offers contract research in relation to ceramics.

The development of technological expertise with application possibilities in various product areas serves the strategic aim of the management to expand the role of Seidel GmbH & Co. KG as a conventional supplier to the cosmetic, pharmaceutical and stationary industries through new product ranges and new marketing structures. In order to achieve this objective, since 2005 the expansion of an internal design department has been advanced to facilitate the transfer of technical potential into marketable products. The results are quite apparent. Seidel has marketed a series of design articles since 2009 under the CARUS brand. With these "Made in Germany" design articles, the company has created a distinct new field of action in which new developments and growth may be boosted.

"We have taken this step quite deliberately in order to make ourselves less exposed to market fluctuations and to significantly expand the ways by which we can influence our growth. In this context, we regard the enhancement of our technological expertise as being just as important as the development of concrete applications our R & D activities. We want to bring our design expertise to bear on these results in order to develop attractive products."

Dr. Andreas Ritzenhoff, Managing Director of Seidel GmbH & Co. KG and materials and nanotechnology representative for the State of Hessen

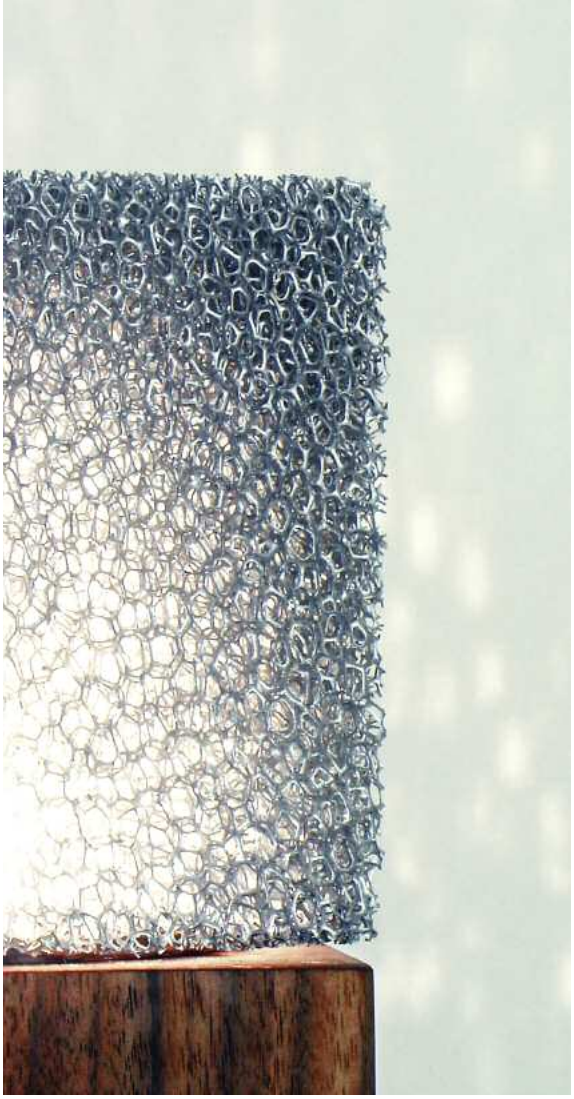
www.seidel.de

6.3 Communicating Material Innovations

EDAG trade fair stand
(Source: formvielfalt GmbH)

Honeycomb boards, such as those used in aircraft construction, three-dimensional technical webbing, LED lights on glass sheets or membrane film – Formvielfalt GmbH from Gross Umstadt has made a name for itself in recent years through the use of innovative materials and design elements for trade fair applications. The reasons are numerous. For one thing the high consumption of materials at trade fairs makes it logical to use materials with light-weight construction properties, and the product developers and material producers exploit this opportunity to communicate their innovative strengths to visitors through the utilisation of innovative materials in the construction of a trade fair stand and to gauge reactions to new developments. The most recent example is the trade fair stand for Fulda-based EDAG at the IAA in Frankfurt, where the exhibitions include the "Light Car" concept car (Hessen-Nanotech NEWS 5 / 2009).

Metallic foam is one material that the trade fair services provider has already used many times thereby demonstrating the ways in which it can be applied in the context of interior design and architecture. Even though the principle for the manufacture of metallic foams has been around for some 30 years now and designers and architects are all very appreciative of its light-permeable properties and formal aesthetic qualities, it nevertheless has failed to make the leap into successful applications outside of the industrial contexts. While closed-pore foam structures have been used in the last decade as a light-weight construction material in the automotive sector, e.g. for stiffening cabriolets, for truck cabs, in tram cars or in the aerospace industry and the good absorption characteristics have been useful in collision protection applications, the open-pore qualities have yet to find their way into mass-produced applications. This is mainly due to the complex production processes and the high cost, because the benefits of its characteristics profile is very evident. Apart from the high stiffness / low mass ratio, which make metallic foams a light-weight construction material also suitable for the building industry, they possess excellent noise-absorption qualities. The potential for interior applications are therefore just as obvious as the uses in wall cladding construction.



Lampshade made from metallic foam
(Source: Zoon Design)

Architects will be particularly delighted that the Glatt Group (which also has a site in Wiesbaden) is now able to supply a new metallic foam from its sinter production chain-based plant with structures ranging from the large to the small-pored and all at a wholly affordable cost. The plant was put into operation in October 2009 and promises a breakthrough in the materials sector. Designers will be particularly enthused by the freely selectable form geometry, enabled by the production method. For the basis of the sinter process chain is a plastic foam, the shape of which can be altered and which is initially coated with a metallic powder binder suspension. The polymer material is then removed at 300°C and the metal is sintered. What is left is a metallic foam structure of variable thickness with many finer structures than would not be possible using conventional methods. Because the powder can be processed from almost any metallic material, the application scenarios are boundless.

www.formvielfalt.de
www.edag.de
www.hollomet.com

Open-pored metallic foam
(Source: hollomet GmbH)

6.4 Art and Science Light up Concrete

A new material developed at the chair of artist Prof. Heike Klussmann at the University of Kassel is the reflex concrete known as "BlingCrete". It combines the positive properties of concrete (fire-safety, stability, construction method) with the property of retro-reflection. Retro-reflective surfaces reflect incidental rays of light (sunlight, artificial light) precisely in the direction of the light source. This optical phenomenon is usually created by embedding micro-glass beads in a carrying medium.

The qualities of BlingCrete open up a wide variety of design possibilities both in architecture and in traffic safety-relevant contexts. The benefits compared to lacquers and paints include its abrasion resistance, the inherent quality of the surface and (based on the concrete matrix used) the possible approval for use as a construction product. The new material is planned to be used for the technical safety marking of edges and dangerous locations (e.g. the edges of steps, kerbs, train platforms) as well as the design of control systems integrated into structures and novel wide-area construction elements (façades, floors, ceilings). Because of its particular haptic properties, BlingCrete can also be utilised for tactile guidance systems for the blind.

The dematerialised aesthetic originates from a continuous integrated dialogue between material and light. BlingCrete therefore represents a category of new material with its own special logic of cause-and-effect. Financed by the Zentrale Innovationsprogramm Mittelstand (ZIM), BlingCrete was created in partnership with the medium-sized company, Hering Bau International, high-performance concrete development specialised engineers from G.tecz and the chair for functionalised thin layers of Prof. Dr. Arno Ehresmann, an experimental physician at the University of Kassel, whose nano-technical process for the magnetisation of aggregates was for the first time used to control the crystallization and hardening process and for positioning the micro-glass beads in the material matrix.

"We observed how the demands on modern materials are ever increasing. I think that, given the continuing technologisation, some potential for ideas can be generated from the both the methodological and material exchange of experiences between researchers, – such as those found in experimental physics and nano-technological research – architecturally-related design and artistic research."

Prof. Heike Klussmann, University of Kassel

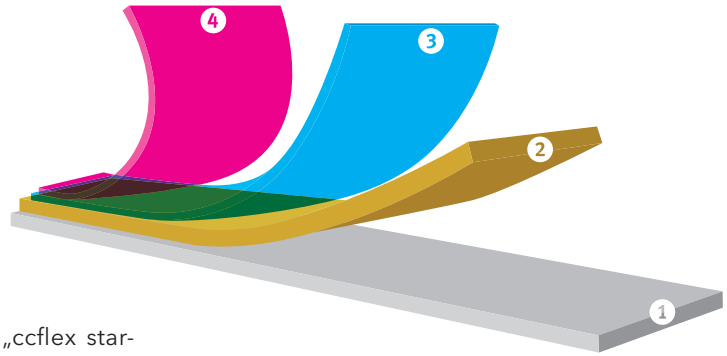
"Material research has now arrived at the molecular level. Attention is shifting from the properties of materials to their performance. Designers should tackle the issue of the technologisation of materials. It enables them to increasingly determine the behaviour of materials rather than merely take it into consideration."

Thorsten Klooster, Architect

www.asl.uni-kassel.de; www.klussmann.org

Reflex concrete (Source: University of Kassel)

6.5 Ceramic Wall Covering enters Internal Architecture



Structure of ccflex: Four layers of "marble on a roll": The basis (1) consists of a polymer non-woven, which possesses the requisite flexibility. Unto this is directly applied the ceramic material (2) consisting of a metallic oxide mix which can also be coloured even at this stage. Alternatively a wide variety of motifs can be embossed (3). Finally the transparent topcoat layer (4) is applied, which is also ceramised. (Source: Evonik Industries)

„ccflex stardust" is the first ceramic wall covering that can be applied like wallpaper. With a water-repellent and simultaneously vapour-permeable, impact-resistant, UV-resistant and fire-resistant surface, it exhibits the range of characteristics lying between those of a ceramic tile and conventional wallpaper. But packed into rolls it is easy to handle. The high water-repellent property means that ccflex first and foremost is suitable for wet area applications (e.g. to provide a hygienic finish to baths and showers cubicles), because it can be applied quickly and easily to walls and does not form joints. The outstanding qualities are due to the nano-structured particles, which the developers from Evonik Degussa GmbH integrated into the surface. Water, oil and chemical substances are not absorbed but instead form droplets and run off the surface. The licence to market the ceramic wall covering was acquired by the Marburg-based wall covering maker Evonik Degussa GmbH in the summer of 2009.

"The development of the ccflex wall covering was a spin-off of a separator material found in the modern lithium-ion battery. During a strategic brainstorming session the idea for 'tiles on a roll' was born, with the idea being to simply affixed these to a wall like wallpaper and ensuring that the characteristics required of a tile, e.g. in a shower, were also met."

Dr. Frank Weinelt, Evonik Degussa GmbH

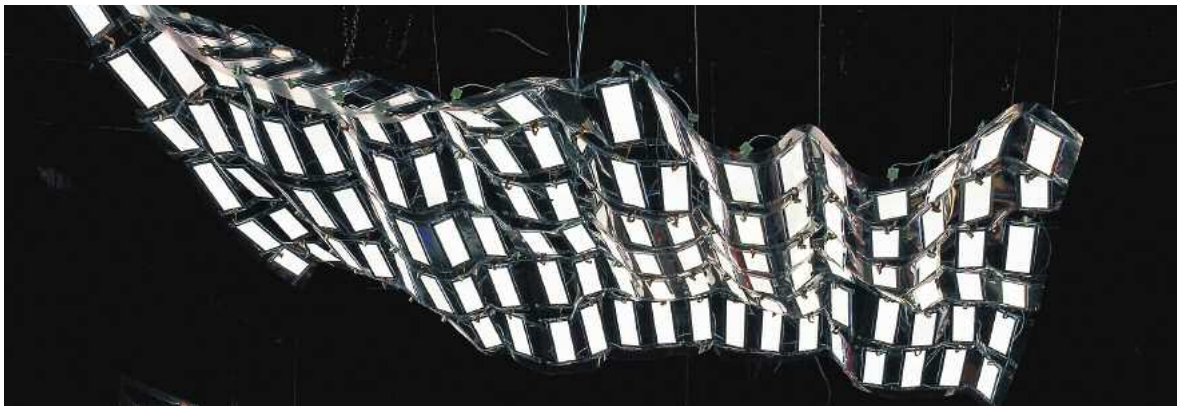
The persons involved in the development project trace the success of the innovation to what was almost a perfect working partnership between marketing, research and interior design. The designer Sylvia Leydecker (100% interior) discovered the material at an industry trade fair and noted that an optimised communication and a new product design could be used to make the outstanding qualities and innovative strength of the product much more visible. Working on behalf of the Evonik Degussa Group she then joined forces with a small team of marketing specialists and technicians to draft a product collection, which received numerous prizes and awards during 2009 (e.g. Design Plus Award, Ruhr 2030 Award). The flood of publications and press articles this unleashed was a decisive factor in enabling the marketing rights to be assigned to the Marburg-based wallpaper maker, J.B. Schäfer GmbH & Co. KG in Kirchhain.

www.marburg.com

"Unlike researchers and developers, creative professionals are working constantly with the desires and requirements of customers. They therefore possess a wide-ranging knowledge of the market and have a nose for sensing which products might even be useful in the near future. So, when integrated into a development team, it is they who can lend suitable forms to a new technological achievement and transmute a functional benefit into an emotional one."

Sylvia Leydecker, 100% interior

6.6 Designers Smooth OLEDs Route to Market



OLED lamp
(Source: Ingo Maurer)

Merck is the world's leading manufacturer of OLED materials. Organic light diodes are regarded as one of the future markets due to their potential in the manufacture of ultra thin displays and light emitters. The main sales with OLEDs are currently being earned in the area of small displays in mobile devices such as MP3 player and mobile phones. Due to their extremely thin construction and the possibility of producing flexible qualities, it is to be expected that there will be future innovations in the lighting market, in particular. In OLED displays and OLED lighting there are currently two types of OLED materials being used: the "small molecules" and polymers which are present in solution form and which can be printed on. Polymer systems suggest themselves over the medium term due to the simple coating of large areas or flexible substrates using the roll-to-roll method. To date the vapour deposition process, with which small molecule-OLEDs are produced, has proven the more efficient production method. In this instance the goal of generating a brightness of 100 lumen per watt was also achieved (R&D result), which is something still to be attained with the solution-based systems.

Since 2007 Merck has therefore been working closely with renowned designers Hannes Wettstein and Ingo Maurer in order to visualise the potential of OLED technology in designer lights. Wettstein developed a mobile light made from white plastic, which like a modern nightlight can be removed from its base and moved around the room. Its luminous sheet with integrated OLED exudes an atmospheric, shimmering light. Another thing of interest are the OLED gold bars. In this case the 120 x 40 millimetre OLED-glass mini-panels are enclosed by a ceramic surround covered with a Plexiglas skin. The thickness is due to the battery compartment which stimulates the OLED into emitting light. Only by rotating the bar can the ultra thin design of the light be seen under the cover.

For more details see the brochure "Nanotechnologie in Kunststoff", Volume 15, issued by Aktionslinie Hessen-Nanotech.

The design of Ingo Maurer describes a light as a type of luminescent sky, which is created by integrating a number of OLED light panels into a flexible plastic film. The results were presented in 2007 during a special show at the Design Annual of the Messe Frankfurt. Maurer in the meantime has launched the first OLED lamps on the market.

"Our activities in the OLED lighting sector were strategically directed towards creating an exemplary demonstration of the fascinating possibilities of OLED materials by means of a high-quality designed light."

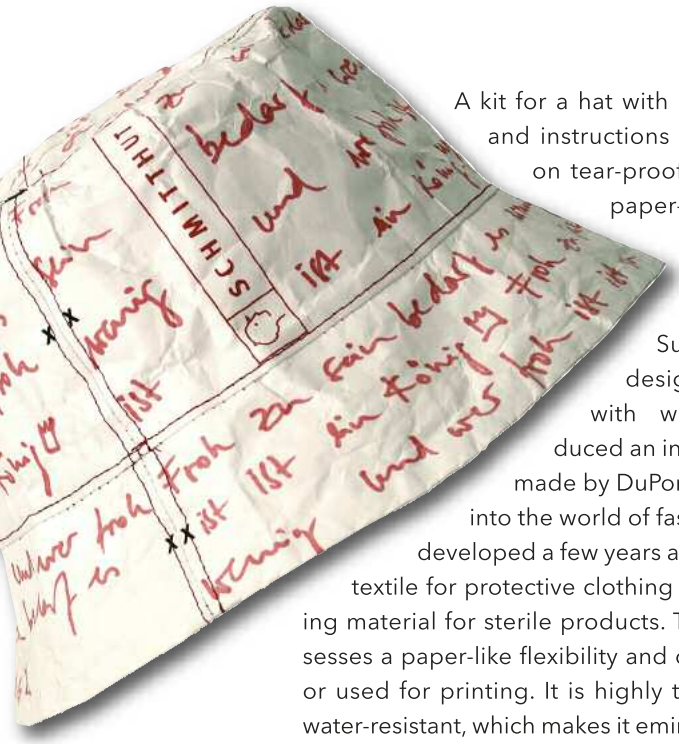
Alexander Biebel
Liquid Crystals Division, Merck

"The creativity possibilities are boundless – we are excited to see what new technological developments will bring over time."

Ingo Maurer, Industrial designer

www.merck.de

6.7 Tear-proof Paper for the Fashion Industry



Hat kit made from tear-proof paper (Source: Schmitthut)

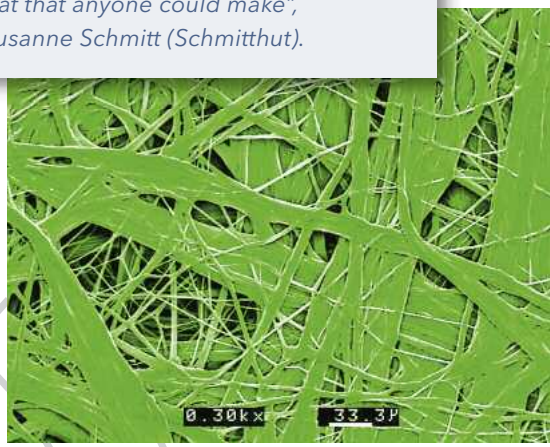
A kit for a hat with a cut-out pattern and instructions – all that printed on tear-proof, water-repellent paper-like PE spun-material – these are the special aspects of the Susanne Schmitt's design (Schmitthut), with which she introduced an innovative material made by DuPont (Neu-Isenburg) into the world of fashion. Tyvek® was developed a few years ago as a functional textile for protective clothing and as a packaging material for sterile products. The material possesses a paper-like flexibility and can be written on or used for printing. It is highly tear-resistant and water-resistant, which makes it eminently suitable for rain-proof maps for cycling or watersports. During the manufacturing process polyethylene fibres are interwoven and pressed when heated. Unlike paper the material only loses just a very few fibres. It is extremely robust, which underlines its suitability for sterile environments. Thanks to its vapour-permeable structure, it can also be used in under-roof covers and underlays in order to protect buildings from climatic conditions.

The fashion designer Susanne Schmitt from Schmitthut in Darmstadt found inspiration for her hat kit in qualities comparable to those of Japan paper. The individual parts are printed on DIN A0 Tyvek material and can be cut out using a sharp knife before being stitched together. The hat is practically indestructible and can be cleaned in any washing machine. It therefore constitutes a model example for an allocation of tear-proof synthetic non-woven in the fashion market.

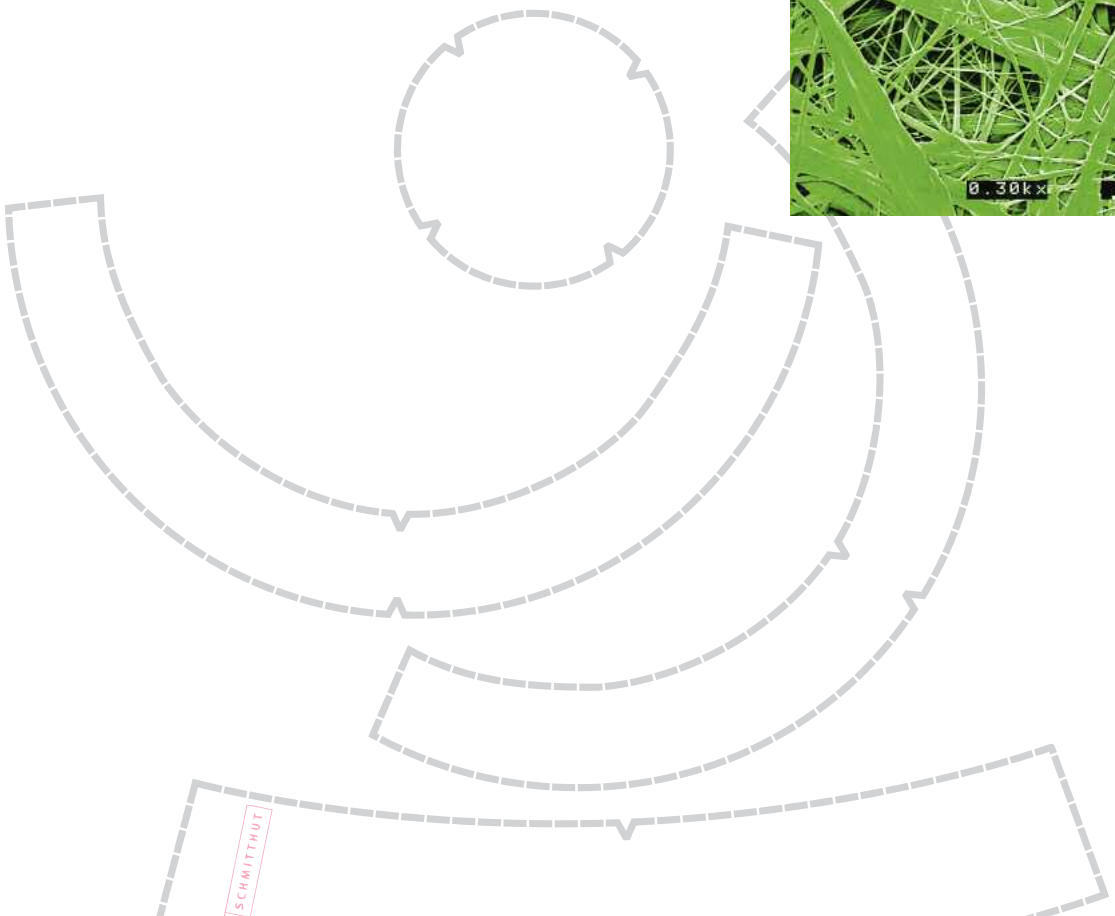
The kit received the Design Plus Prize in 2007 and was nominated for the German Design Prize in 2009. There was no direct contact with the manufacturer Du Pont however, as the fashion designer discovered the material at Modulor GmbH, a wholesaler of materials for design and architecture in Berlin.

www.schmitthut.de

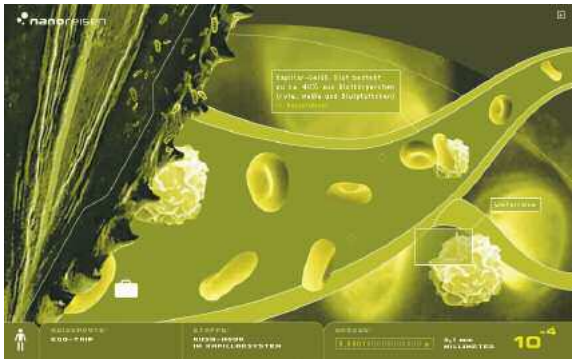
"An envelope made from synthetic fabric gave me the idea of using the same material to design a hat that anyone could make", explains Susanne Schmitt (Schmitthut).

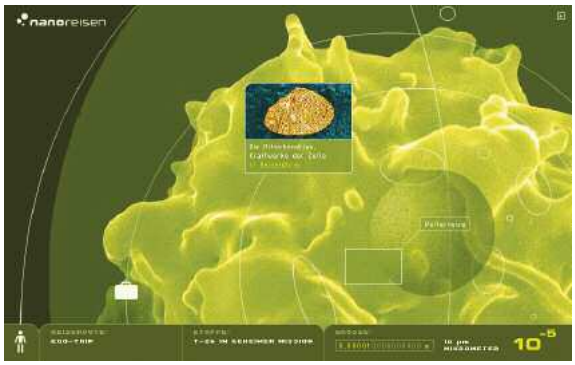


Right: Microscopic non-woven structure of Tyvek



6.8 Grasp the Invisible on a Nano-Journey





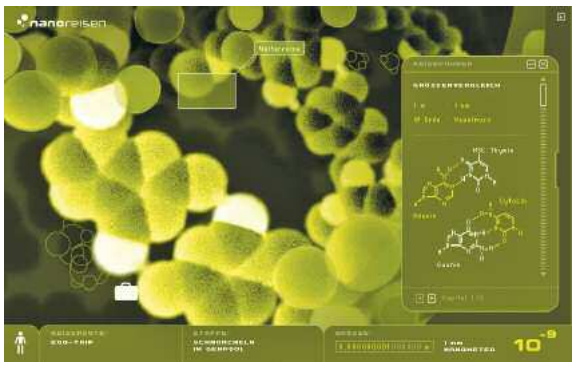
"Rush hour in the capillary system", "Snorkelling in the gene pool" and "Proton ballet in the power plant" are just some of the 33 stages awaiting visitors on a journey through invisible tiny worlds. The nanotourist can choose from three different methods – on the arm of a person, in the processor of a computer or in the LED of a futuristic car headlight – to gradually shrink ever smaller and make their into the smallest dimension of our known universe. And just like any proper journey, a suitcase is also near to hand containing useful utensils for on-the-go, including a virtual travel guide as well as a route planner with which visitors can jump within and between the routes.

The idea and concept for nano travel first occurred in 2002 as part of a dissertation prepared at the Technical University in Wiesbaden (since 2009 the RheinMain University of Applied Sciences). Scientists from the VDI Technologiezentrum GmbH in Dusseldorf then realised the potential of the project and commission the design office Lekkerwerken of Wiesbaden to completely realise the interactive journey.

The aim was to generate interest among younger target groups for scientific matters via an active and emotional mode of communication, without giving the impression of actually instructing them about something. Nano journeys combine knowledge with entertainment in a high-quality package. It is by means of an explorative and interactive journey through the various sized dimensions that a wide target audience can learn about complex interrelationships in relation to the structure of the universe. Users are actively included with the aid of animations, audio and interactive features.

The project clearly highlights the potential for designers to communication scientific and technical relationships in a manner that is comprehensible to those new to the topic. The project was realised under a commission issued by VDI Technologiezentrum GmbH with funds from the Federal Ministry for Education and Research (BMBF).

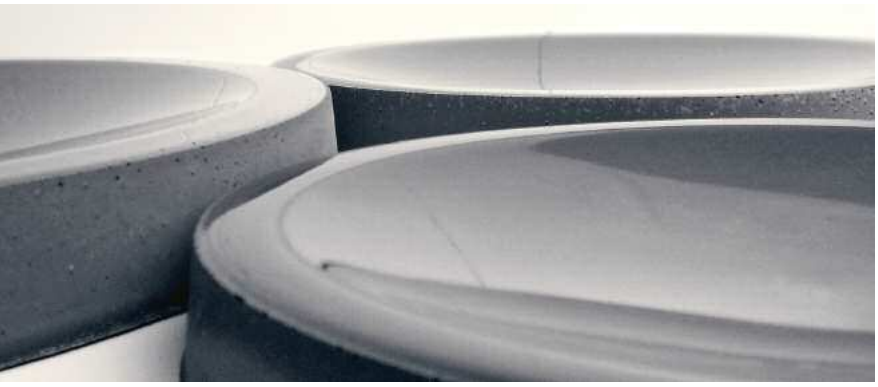
The journey can be embarked upon by visiting www.nanoreisen.de and is available in four languages.



Excerpt from the nano journey (Source: Lekkerwerken)

6.9 Living Environments with Ultra-Hard Concrete

When talking about manufacturing tools and constructing buildings, then stone and concrete are some of the oldest materials that even exist. It is all the more astounding that, particularly in recent years, classic construction materials have inspired designers to create unusual new potential products. Drawing upon the wealth of knowledge possessed by the concrete specialists from G.tecz of Kassel, Dr. Thomas Teichmann and Dr. Gregor Zimmermann – the project was successful in bringing ultra-hard concrete into our living and dining rooms.



Left: Tableware made from concrete (Source: Alexa Lixfeld)

Right: Concrete wall cladding (Source: Doreen Westphal)

Whereas concrete applications to date have resulted in large objects, the form language of which was radically impaired by a minimum thickness in the side, wholly new results are now being achieved today. The designer Alexa Lixfeld from Hamburg was one of the first to dismantle the former barrier through combining high-performance concrete with a special surface coating to transform the material into an elegant component for kitchen and bathroom. She achieved surfaces with permanently shiny, hydrophobic, abrasion and acid-resistant qualities that would simultaneously be suitable for using with food.

International designers also sought the expertise of the G.tecz specialists, in order to utilise concrete in elegant product designs for porcelain and furniture. For example, Doreen Westphal, a renowned designer from Amsterdam, developed thin-sided cups and vases and presented her ceramic-like collection during the Milan Design Week 2009. The use of concrete shortens the production process in comparison to ceramic kiln processes. Energy consumption and costs are significantly reduced. For the first time ever the products of Doreen Westphal are being manufactured in series and are available to an international market.

Caroline Swift also used concrete in designing picture frames and cutlery, and Greta Hauer from Kassel underlined the potential through numerous designs for bowls and plates. In the summer of 2010 at deadal.de, a large design shop in Kassel, furniture designed by Gregor Zimmermann was showcased that presented concrete as a material in a wholly different light. Heavy-set, ponderous concrete furniture was now a thing of the past.

The Monolithic Concrete Design Competition has enabled students of architecture at the University of Kassel to develop visionary application ideas for the new cement-based hi-tech material "Quantz" from G.tecz – from initial draft to the prototype-ready stage. The results of the Concrete Advanced Project were presented in February 2010 at an exhibition in Kassel.

The direct working partnerships with designers and architects are a focal area for G.tecz alongside its own material development and research activities. Direct exchanges of ideas and thoughts with designers such as UNStudio, NOX, Splitterwerk, LOMA and others have resulted in visionary projects for architecture and design, which could not have been implemented by more conventional means.

www.gtecz.com

6.10 Resource Protection and Material Cultural Dialogue

In a time during which the German construction industry is importing bricks from the Netherlands and Poland, cement from Spain, steel and marble from India, aluminium from Brazil, wood from Canada and tropical rain-forest regions, the utilisation of local building materials appears atypical and out of tune with current trends. However, with increasing transport costs and the ever-increasing importance of sustainably using our energy and material resources, more and more experts within the construction industry are demanding a return to the use of locally produced building materials. Thus Roy Antik (Development Manager Sustainability in the Swedish construction group, Skanska) declared in October 2009 that Skanska was planning to reduce its consumption of energy and resources by 50 % in coming years. Local recycling and the use of locally available materials were important elements of this strategy, it was said.

While the construction of a house simply by excavating the foundation site was a somewhat romantic ideal until very recently, the approach is gaining ever more in support. And this is not just a matter of preserving resources. For it is a fact that using globally available materials and price-efficient human resources as a matter-of-course has also led to a long-term change in the quality of our architectural environment and our culture of craftsmanship.

It is due to this that the Rang architects studio in Frankfurt, in constructing the Tower of Bhaktapur in Nepal, was not just following the objective of acquiring the building material wholly from the foundation site, but was also looking to combine Hessian building culture with the centuries old craftsmanship skills of the Newars. Thus, brick moulds were exported from Frankfurt to Nepal, but the building material was locally produced. Even the bamboo for the scaffolding was cut from a grove in Bhaktapur. The building described by the architects as a "brickwork sculpture" could stand as an inspiration for the revival of brick production fired from local clay. There are many parallels to the architectural histories of Hamburg or Amsterdam. Given the context of the current developments, the idea of imitation appears to be practically demanded.

Tower of Bhaktapur
Above: details
Left: Front view
(Source: Rang studio)

"The flow of the free selection of material for a specific place, its design and coloration, needs to be set against the displacement of materials caused by the global market economy. Interchangeable places with no place in time are being created, places that the French anthropologist, Marc Auge, also termed 'non-places'", says Prof. Wolfgang Rang.

www.atelier-rang.de

7 Material Research: Who can provide me with Information about new Materials and Inspiration?

Material exhibition at Materia (Source: Materia)

Material Vision: Materials for product development, design and architecture

Materials are bearers of innovation. Their intelligent deployment among other things is decisive for the durability, comfort, design and therefore the commercial success of products. Use and design possibilities of materials offer tremendous development potential today. The technical development in this context is only ever part of an innovation, with its well-timed practical application being of equal importance. It is precisely at these interfaces that Material Vision, the international industry's trade fair and conference, tackles material-related issues connected with product development, design and architecture. Material Vision is attended by representatives from manufacturers of modern materials and research institutions, who are seeking to establish direct contact with designers, product developers and architects. There is where creative heads can find a platform in order to get to know about new materials and to discuss the possibilities for using them. The common objective is to transfer knowledge from research and development into practical applications in a more speedy, better directed and improved manner. Material Vision is the vehicle by which Messe Frankfurt and its co-operation partner, the German Design Council, are fostering the interdisciplinary exchange of ideas between industry, researchers and creative thinkers – for the benefit of all. Material Vision is run parallel to Techtextil, the international industry trade fair for technical textiles and non-wovens.

More information from:
www.material-vision.messefrankfurt.com

Range of colours in the Colour & Material Lab of designaffairs (Source: Berlac)

Material libraries, exhibitions and databases

Architonic — Switzerland

Architonic has established itself as an international seal of quality for selected, high-grade design products, materials, architecture projects and information supply. The online platform is managed from Zurich and is numbered among the top three most popular websites for architects.

Architonic AG
Müllerstrasse 71
8004 Zurich, Switzerland
www.architonic.com

designaffairs — Germany

Design Affairs is a design agency, which has been running the "colour&material lab" since 2001. With a permanent exhibition, various partner companies are afforded the opportunity to present the latest developments in relation to coloration, surface finishes and production processes.

designaffairs GmbH
Rosenheimer Strasse 145b
81671 München, Germany
www.designaffairs.com

Innovathèque — France

Innovathèque is a team of material experts who constantly examine the market for innovative materials. They have to date entered some 2000 materials into a database and a permanent exhibition.

Innovathèque
10, avenue de St-Mandé
75012 Paris, France
www.innovatheque.fr

Materia — The Netherlands

Materia is a know-how platform for material innovations and applications in relation to architecture and design. Alongside a permanent exhibition, a database is also provided free of charge. New developments and around 1500 material samples are presents in the setting of an inspiration centre.

Materia
Binnenhof 62D
1412 LC Naarden, Netherlands
www.materia.nl

Material ConneXion — Germany / USA

As the link between material manufacturers and users, Material ConneXion offers consultancy services in relation to material and product development. The consulting aspect is supplemented by an extensive materials library, which is expanded each month with the addition of new materials selected by an independent panel of experts. The company's HQ is in New York.

Material ConneXion Cologne
Lichtstrasse 43g
50825 Köln, Germany
www.materialconnexion.de

Materialarchiv — Switzerland

Collections aimed at the design-orientated professions. The objective is to interlink the individual collections by means of a common online database. The initiators are: Gewerbemuseum Winterthur, Hochschule Luzern, Sitterwerk St. Gallen, Zürcher Hochschule der Künste

www.materialarchiv.ch

Materialbiblioteket — Sweden

Materialbiblioteket was established following two years of research and development work at the Swedish University for Art, Crafts and Design in Stockholm. It provides expert information, a database and communication forums in connection with complex materials and material applications. Materialbiblioteket is based with its permanent material exhibition at the Stockholm Design Centre, a growing centre close to the centre of Stockholm and the trade fair site.

Materialbiblioteket
Tellusgången 4
126 37 Hägersten (Stockholm), Sweden
www.materialbiblioteket.se

Materialsgate — Germany

The technology agency, Materialsgate, has been up and running since 2000 and it offers a service for the online researching of the technical characteristics of materials by using so-called material cards. The company has main offices in Dieburg and Munich and regards itself as a facilitator standing between the research, technology and application fields.

Materialsgate
Grenzstrasse 22a
64807 Dieburg, Germany
www.materialsgate.com

matériO — France, Belgium, Spain

matériO is an independent information centre for materials and innovative products with branch offices and permanent exhibitions in Paris, Antwerp and Barcelona.

matériO Paris
74, rue du Faubourg Saint-Antoine
75012 Paris, France
www.materio.com

Modulor — Germany

More than 20 years ago Modulor was established as a small specialist enterprise for architectural model construction material. Today it is the no. 1 in Europe, supplying everything that creative heads required for the construction of models, prototypes and for providing samples. Materials can be selected and accessed via and online shop or a catalogue with detailed descriptions also being supplied. All materials can also be searched and purchased in the outlet based in Berlin-Kreuzberg. For 2011 an extensive materials library is also being planned for the future "Planet Modulor" to be sited in Kreuzberg's Moritzplatz.

Modulor GmbH
Gneisenaustrasse 43-45
10961 Berlin, Germany
www.modulor.de

Ravara — Sweden

Ravara is a platform for materials and innovative technologies that are aimed towards designers and architects. The company operates an online database and markets small series of material samples.

Ravara
Götaforsliden 17
Kvarnbyn
431 34 Mölndal (Göteborg), Sweden
www.ravara.se

Raumprobe — Germany

Raumprobe runs a materials database and maintains a permanent exhibition in Stuttgart boasting more than 10,000 material samples.

raumprobe OHG
Hohnerstrasse 23
70469 Stuttgart, Germany
www.raumprobe.de

Stylepark — Germany

Stylepark provides information about contemporary designs via an extensive online service, a product database and the quarterly published Stylepark Magazine. The service (which also encompasses the possibility of researching materials) is aimed at architects, developers, interior designers and other designers as well as end customers with an interest in design matters.

Stylepark AG
Brönnerstrasse 22
60313 Frankfurt am Main, Germany
www.stylepark.com

Material exhibition at Innovathèque in Paris (Source: Innovatheque)

Appendix A – Specialist Literature

- **Achilles, Andreas**: "Glasklar – Produkte und Technologien zum Einsatz von Glas in der Architektur", Deutsche Verlagsanstalt, 2003.
- **Ambrozy, H. G.; Giertlová, Z.**: "Holzwerkstoffe – Technologie, Konstruktion, Anwendung", Springer-Verlag, 2005.
- **Ashby, Michael F.; Johnson, Kara**: "Materials and Design: The Art and Science of Material Selection in Product Design", Butterworth-Heinemann, 2002.
- **Bäuerle, Hannes; Stumpp, Joachim**: "Raumproben2 – Aktuelle Materialien für Design und Architektur", Callwey Verlag, 2009.
- **Beylerian, George M.; Dent, Andrew; Quinn, Bradley**: "Ultra Materials: How Materials Innovation is Changing the World", Prestel Verlag, 2007.
- **Beylerian, George M.; Dent, Andrew; Moryadas, Anita**: "Material ConneXion: The Global Resource of New and Innovative Materials for Architects, Artists and Designers", Prestel Verlag, 2005.
- **Braungart, Michael; McDonough, William**: "The Next Industrial Revolution: The Cradle to Cradle Community", European Publishing House, 2008.
- **Hirsinger, Quentin**: "Materiology – The Creative Industry`s Guide to Materials and Technologies", Birkhäuser Verlag, 2009.
- **Klooster, Thorsten**: "Smart Surfaces – and their Application in Architecture and Design", Birkhäuser Verlag, 2009.
- **Lefteri, Chris**: "Making It. London", Laurence King Publishing, 2007.
- **Lefteri, Chris**: "Materials for Inspirational Design", Roto Vision, 2006.
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- **Leydecker, Sylvia**: "Nano Materials – Applications of Nano Materials in Architecture and Design", Birkhäuser Verlag, 2008.
- **Peters, Sascha**: "Material Revolution – Sustainable Multi-Purpose Materials for Design and Architecture", Birkhäuser Verlag, 2010.
- **Peters, Sascha; Kalweit, A.**: "Handbuch für technisches Produktdesign – Material und Fertigung", Springer Verlag, 2nd edition, 2011.
- **Ritter, Axel**: "Smart Materials in Architecture and Design", Birkhäuser Verlag, 2006.
- **Sauer, C.**: "Made of ... New Materials Sourcebook for Architecture and Design". Die Gestalten Verlag, 2010.
- **Schmidt, Petra; Stattmann, Nicola**: "Unfolded: Paper in Design, Art, Architecture and Industry", Birkhäuser Verlag, 2009.
- **Thompson, Rob**: "Manufacturing Processes for Design Professionals", Thames & Hudson, 2007.
- **Zijlstra, Els**: "Materia – Material Index 2009", Architectenweb bv, 2009.

"Material Revolution – Sustainable Multi-Purpose Materials for Design and Architecture," by Sascha Peters, Birkhäuser Verlag, 2010

Be it vases made of algae fibre, wall paper made of tree bark, coffins made of almond shells or bike frames made of bamboo, the world of materials is about to experience a decisive change. At the latest after it became clear that fossil fuel resources shall dwindle in the coming decades and many raw materials shall only be available in limited amounts, intensive work has been undertaken to find alternatives. The material achievements of the twentieth century, which are mainly owed to crude oil, will lose in their importance in the near future. The awareness of the environmentally sound treatment of materials and thinking in material cycles have reached consumers meaning that investment in sustainable products is now profitable. The use of environmentally sound materials with multifunctional properties and the implementation of sustainable production procedures are already expected by society.

The book gives a brief overview of sustainability aspects for designers and architects concerning the important issues. At the same time it not only covers natural and biodegradable materials, but also materials with multifunctional properties (e.g. thermochromic glasses or surfaces that purify the air) as well as the potential to reduce the amount of energy used (e.g. lightweight construction and phase changing materials).

In the sustainability discussion designers and architects bear a particular responsibility because they are often the ones, who select the materials used in many development projects. As such they have a decisive influence on the sustainability of our product range. The book is written in a confident manner as regards style and content that supports the designers´ and architects' way of thinking and working. It also makes important references to material qualities and uses of material techniques as well as what is offered by the manufactures.

"Strategisches Industriegüterdesign" (Strategic design of industrial commodities), by Guenter E. Moeller, Christof Herrmann, Ronald Gleich and Peter Russo, Springer Verlag, 2009

It is shown that the design factor is currently of great importance for companies in the industrial commodities sector by the results of the research project "Markenbildung durch Industrial-Design: Konzepte für kleinere und mittlere Investitionsgüterhersteller" (brand identity through industrial design: concepts for small and medium sized capital good manufacturers). From 2007 to 2009 this project was sponsored by the Stiftung Industrieforschung and was carried out by the research group "Industrial – Design and Innovation Management" at the European Business School's Strascheg Institute for Innovation and Entrepreneurship.

However, many industrial enterprises still neglect product design. Nevertheless, in recent years companies, such as Bosch, Festo, Gildermeister, Heidelberg, MAN and many others, have proven that design is of great importance precisely in the sector of industrial commodities. This does not only apply to the development of new product solutions, but also to the general development of the company because design positively influences the perception of quality, the willingness to pay a set price, the success of innovation, the brand strength, thus also the turnover and profit of industrial enterprises.

The book assesses these exact challenges and reveals ways for a new and strategic-orientated understanding of design in industrial enterprises. Starting with a comprehensive overview of the current state of research and practice, the authors present numerous cases studies, in which industrial enterprises use strategic design to increase their own power of innovation and growth. For this purpose important methods, instruments and procedures are presented so that a practitioner of industrial commodity design could consistently implement them in his own company.

One of the case studies is the company Angell Demmel that was established in 1998 as a joint venture between Angell Manufacturing and the Demmel Group with the goal of producing high-quality trims made of metal for the inside of vehicles. Thanks to innovative design, material and production solutions, the Angell Demmel GmbH quickly became the market leader for metal application in the auto industry.

"Angell-Demmel can be regarded as an excellent example for a strategic innovation and design management because it is precisely the association of the technological know-how and design competence that has evoked the company´s enormous growth since its establishment in 1998," according to Prof. Roland Gleich, Academic Head of the research project "Markenbildung durch Industrial Design im Industriellen Mittelstand" (Brand identity through industrial design in small and medium-sized industrial enterprises) and Managing Director of the Strascheg Insistute for Innovation and Entrepreneurship at the European Business School, Oestrich-Winkel.

Appendix B – Courses of Study for Design, Architecture and Material Sciences in Hessen

Design

- Darmstadt University of Applied Sciences
- University of fine arts Kassel
- The Offenbach College of Design
- Academy Rhine-Main
- Academy of visual arts Frankfurt

Architecture

- University of Kassel
- Darmstadt University of Applied Sciences
- Technical University of Darmstadt
- Frankfurt University of Applied Sciences

Materials Courses at Hessian Colleges

- University of Kassel
- Technical University of Darmstadt
- Justus-Liebig-University Giessen
- Philipps-University Marburg
- Giessen University of Applied Sciences
- Frankfurt University of Applied Sciences

Appendix C – Contact Details of the Material Manufacturers and Creative Service Providers Referenced

Alfred Clouth Lackfabrik GmbH & Co. KG

Otto-Scheugenpflug-Strasse 2
63073 Offenbach am Main, Germany

Alexander Eisenacher
Phone +49 (0)69 89007-0
alexander.eisenacher@clou.de

www.clou.de

Architonic AG

Müllerstrasse 71
8004 Zürich, Switzerland

Nils Becker
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www.architonic.com

Atelier Rang

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60385 Frankfurt am Main, Germany

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Corporate Development – New Business
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www.bayermaterialscience.com

Bayer Sheet Europe GmbH

Otto-Hesse-Strasse 19 / T9
64293 Darmstadt, Germany

Dr. Norbert Pingel
Phone +49 (0)6151 130-3102
norbert.pingel@bayersheeteurope.com

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landessekretariat@bda-hessen.de

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Biowert Industrie GmbH

Ochsenwiesenweg 4
64395 Brensbach / Odwald

Dr. Michael Gass
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m.gass@biowert.de

www.biowert.de

Cabot Nanogel GmbH

Industriepark Höchst, Gebäude D 660
65926 Frankfurt am Main, Germany

Georg Gertner
Phone +49 (0)69 305-29331
georg_gertner@cabot-corp.com

www.cabot-corp.com

Caparol Farben Lacke Bautenschutz GmbH

Rossdörfer Strasse 50
64372 Ober-Ramstadt, Germany

Dr. Stefan Kairies
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www.caparol.de

Design Planet

Hausener Strasse 2
63165 Mühlheim am Main, Germany

José Delhaes
Phone +49 (0)6108 7967-0
info@designplanet.de

www.designplanet.de

Deutsche Bank

Mainzer Landstrasse 10–12
60325 Frankfurt am Main, Germany

Dr. Thomas Rüschen
Global Head of Asset Finance & Leasing

www.deutsche-bank.de

Deutsche Telekom AG, Laboratories

Design Research Lab
Ernst-Reuter-Platz 7
10587 Berlin, Germany

Prof. Dr. Gesche
Phone +49 (0)30 8353-58357
gesche.joost@telekom.de

www.designresearchnetwork.org

Dominique Perrault Architecture

6, rue Bouvier
75011 Paris, France

Phone +33(1)44060000
dpa@d-p-a.fr

www.d-p-a.fr

DuPont de Nemours (Deutschland) GmbH

Hugenottenallee 173–175
63263 Neu-Isenburg, Germany

Thomas Werner
Phone +49 (0)6102 18-2767
thomas.werner@dupont.com

www.dupont.com

Dura Tufting GmbH

Frankfurter Strasse 62
36043 Fulda, Germany

Stefan Hohmann
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EPEA Internationale Umweltforschung GmbH

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International University Schloss Reichartshausen
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36037 Fulda, Germany

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www.nuedling.de

FIT Fraunhofer Institut für angewandte Informationstechnik

Schloss Birlinghoven
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markus.klann@fit.fraunhofer.de

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G.tecz – German technologies and engineering conceptz

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Lutz Dietzold
Phone +49 (0)6151 159-1911
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Hess Natur-Textilien GmbH

Marie-Curie-Strasse 7
35510 Butzbach, Germany

Rolf Heimann
rolf.heimann@hess-natur.de

www.hess-natur.de

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Schlossstrasse 31
63065 Offenbach am Main, Germany

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Institut für Industrial Design am Fachbereich IWID
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Funding Opportunities and Contact Networks in Hessen

Pilot Projects in Hessen

The Pilot Project Division of Hessen Agentur provides support and advice to small and medium enterprises (SMEs) that wish to partner with other companies from the private sphere to realise technology oriented projects requiring high levels of research and development in collaboration with colleges and research institutes.

Hessian pilot projects provide a framework within which between 30 and 49 percent of eligible expenditure arising from research and development projects undertaken by consortia are sponsored. This contribution must be co-financed by individual contributions from all members of the consortium submitting the application. Within the Hessian pilot project framework there are currently three courses of action available:

1 The State-Offensive for the Development of Scientific and Economic Excellence with funding route 3: LOEWE-SME- group projects.

   This funding programme is financed by the state and falls within the remit of the Hessian Ministry for Science and Art (HMWK). Funding is provided for projects carried out by Hessian SMEs in collaboration with colleges and public research institutes.

2 SME-Model- and Pilot projects for technology oriented research and development SME collaboration projects (with the possible involvement of public research institutes) primarily in North and Central Hessen and the Forest of Odes region. Funding from the European Regional Development Fund (EFRE) are available for this, which are co-financed by the State of Hessen. In this context Hessen Agentur acts as project sponsor for the Hessian Ministry of Economics, Transport, Urban and Regional Development (HMWVL).

3 Model-like research and development projects focussed on the automotive sector. Funding from the European Regional Development Fund (EFRE) are available for this, which are co-financed by the State of Hessen. This programme is conceived as an augmentation of programme 2 with a specific sector focus. The project sponsor is Hessen Agentur on behalf of the Hessian Ministry of Economics, Transport, Urban and Regional Development (HMWVL).

The first step towards funding is the submission of a short, meaningful project outline to Hessen Agentur prior to the start of the funding programme. A form for this is available for download at: www.innovationsfoerderung-hessen.de

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LOEWE – Landes-Offensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz

(State-Offensive for the Development of Scientific and Economic Excellence)

Hessen-Nanotech – the Nano Initiative

The Hessian Ministry of Economics, Transport, Urban and Regional Development launched the Nano Technology in Hessen initiative "Aktionslinie Hessen-Nanotech" in the year 2005. This initiative brings together and coordinates all economic and technology-based activities involving nano and materials-based technologies throughout the State of Hessen. The objective of the initiative is to promote Hessian competence in nano technology and related fields such as surface technology, micro-system technology and optical technologies, both nationally and internationally. The intention is to improve international competitiveness and innovative capability of Hessian science and economy through technology and location marketing and the promotion of networking. In particular the Nano Technology in Hessen initiative supports networking between technology providers and users. Specific focal points are those areas of application strongly developed in Hessen – the automotive, chemical, pharmaceutical, biotechnological sectors as well as medicine, construction, environment and energy engineering together with information and communications technologies.

Hessen-Nanotech is working with NanoNetzwerk-Hessen on the interfaces to the nano sciences. The state-owned Hessen Agentur GmbH (HA) is the project sponsor of the initiative.

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NanoNetzwerkHessen

The NanoNetzwerkHessen (NNH) was founded in March 2004 with the support of the Hessian State government with input from the State's five universities and five universities of applied sciences, with a view to launching a tightly focused innovatively oriented collaborative effort in the nano science sector on the basis of a cooperative agreement. The NHH aims to pool the existing competences at Hessian higher education institutions, initiate collaborative efforts and to expand and enlarge Hessen's role as a nano technology centre. The University of Kassel coordinates the NNH. Researchers from the physics, chemical, biological, pharmaceutical, medical and material sciences as well as the various engineering and humanities faculties are working on nano technology within Hessen's higher education institutions. It is exactly this penetration by the classical disciplines that is significantly increasing the innovative potential of this science and creates excellent starting conditions for collaboration within the State of Hessen. A broad spectrum of technologies currently are currently represented within Hessen's institutes of higher education extending from nano-scale and nano-structured raw materials as well as nano system engineering, through nano-medicine, nano material chemistry, nano biotechnology right up to nano analysis. A combination of scientists, developers and users could therefore already carry out research and development in these areas during the pre-competitive phase thereby bringing the main players, resources and activities into contact. Not only does this provide networked parties access to complementary resources, it also creates a stronger link between the science and the economic application than was previously the case, which contributes to a more rapid implementation of nana-technological knowledge in products, production processes and services.

www.nanonetzwerkhessen.de

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The volumes of the publication series Hessen-Nanotech on the following page provide comprehensive information about the potential for innovation and fields of application for developments from the fields of nano- and materials technology.

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