TECHTEX & AUTOMOTIVE

Fibre-based materials for mobility tomorrow
Textile research institutes specialising in mobility applications

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FTB – Fachbereich Textil- und Bekleidungstechnik at Hochschule Niederrhein – (Mönchengladbach) | Director: Prof. Dr.-Ing. Maike Rabe; http://www.hs-niederrhein.de/fb07/ ||
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Cover pictures: Superstrong, super-lightweight carbon fibre reinforced plastics (CFRP) | Sports car with CF reinforced body and exhaust manifold built by students at RWTH Aachen | In future, light-conducting fibres will be used in the passenger compartment | The BMW i3, the first production electric car with a body made entirely from CFRP | CFRP bumper bracket
To an ever increasing degree, a dominant feature of the society of the future will be mobility. Since the invention of the automobile, Germany has emerged as one of the most powerful players on the international growth markets of transporting people and products efficiently and with economical use of resources. The contribution of the German textile industry to visions of the mobile future is considerable. Since 2006, 16 research institutes throughout the Federal Republic and cooperating under the auspices of the Forschungskuratorium Textil (FKT) have pooled their scientific capabilities regarding technical textiles in the innovation network entitled “Mobility” and have developed close relationships with the sectors that consume these commodities beyond the boundaries of their own industry. The results of this cooperation may be seen for example in the strengthening of traditional materials with glass or carbon fibres to reduce weight in motor cars – a particularly essential consideration for electrically powered vehicles. Positive consequences for the environment, such as reduced emissions due to a lower drive energy requirement, are a desirable side-effect.

Textile materials that are manufactured using innovative technology and processes make people safer and preserve the environment more effectively in production and as they move from place to place in their daily lives. On the strength of investments by the textile industry in research and development, German manufacturers now lead the global market in technical textiles. Today, 25 percent of their total turnover derives from new products, not a few of which are associated with mobility. This ensures the continued existence and growth of these companies, safeguarding jobs in the future. Industry analysts of a well-known major bank recently recommended that cooperation between the textile industry and industrial consumers in the automotive field should begin even earlier and become even closer. According to their recommendation, this is the only way to ensure that superior textile materials are incorporated and utilised early in the design of new parts and components.

Of course, in order to realize this objective, the automobile, aircraft and ship builders must learn about the astounding capabilities of technical textiles as a new material technology. This brochure therefore represents our contribution towards this end.

Klaus Huneke and Peter Schwartze
In this industry perhaps more than any other, the importance of components and even entire bodies made from technical textiles is growing: even today, cars would not even roll off the production line without fabrics, non-wovens and fibres. One only has to consider the tyre cord, or the seat covers, door paneling, seatbelts and airbags, to say nothing of the pressure hoses and timing belts. But the models of tomorrow and those yet to come would not make it off of the drawing board or the simulation screen, because, for example, super lightweight bodies would have to remain a hopeless ideal without carbon fibres. As it is, carbon fibre composites are considered to be the most promising lightweight construction material of the present and the future.

FIRST AIRCRAFT, THEN CARS

In keeping with their concerns about fuel consumption and CO₂ emissions, aircraft designers led the way in replacing relatively heavy aluminium components with carbon fibre reinforced plastic (CFRP). It has now become standard practice to manufacture large parts of the non-load-bearing aircraft skin and other design elements, such as the upper wing shells, in this way. In the new Airbus A350 for example, which is almost ready for series production, about 50 percent of the construction consists of textile composite materials. Boeing is using an even greater percentage of CFRP composites in its new long-haul 787 aircraft. Now the car and bike industry is tending toward lightweight construction on a textile base in the highest quality segments: carbon fenders with an eye-catching high-tech style, engine spoilers or helmets, and for bikers super-lightweight wheels, forks and full carbon fibre frames. Now the automobile industry is catching up fast in its use of the miracle material, even though at prices over 20 euro per kilo (CFRP components often cost four times as much) it is still expensive. BMW has announced that it will introduce the world’s first mass production vehicle with a passenger compartment of this kind onto the market in 2013: the Mega City Vehicle with zero emission electric powertrain in urban and sports car variants i3 and i8. Car makers VW and Mercedes are planning similar models. The Wolfsburg company is working on a body made entirely from carbon fibre and weighing just under 800 kg for its “XL1” model, while Mercedes intends to expand its E Class series with the “Mercedes E-Superlight”, a four-door sedan with a curb weight of just 1300 kg.

On the road with high-tech fibres

Textiles are essential for progress: New materials and the resulting innovations are made possible by high-tech fibres. This is true not only for textile-reinforced building or implantology with fibre-based materials such as stents, hernia meshes or artificial blood vessels but also for the automobile industry, where lightweight construction based on textiles represents a vast area for critical research affecting all aspects of e-mobility.

In this context, textile research and the textiles industry have forged close and long-standing links with the car manufacturing industry on a national level. Today, about 50 small and medium-size enterprises in the automotive supply sector already earn well over four billion euro per year and provide work for 10,000 employees.

LEAPS IN MOBILITY

Pictures from left: After seat covers and the airbag, the most well-known textile product in the car, mandatory in all new cars produced since 1974 and responsible for saving countless lives in traffic accidents – the seatbelt | LEDs can be positioned precisely in the weaving process – providing new design possibilities for the vehicle interior

What will be the distinctive design feature of the cars of tomorrow? Fibre elements in the body, perhaps, that enable active or passive lighting? The “Blackbird” concept model by Hungarian designer Péter Várdai ventures a look into the future.
Bmw and VW have now purchased shareholdings in
the company – a strategic decision on the part of
both corporations to secure the future of their light-
weight construction material needs.
Experts are in agreement: vehicle series of up to
80,000 passenger cars per year with carbon fibre
construction will be possible in a few years, both
with regard to automation technology requirements
and in terms of cost. For the economy model de-
scribed above, with fuel consumption of 0.9 litres
per 100 km, VW has succeeded in lowering the cost
of the carbon fibre body considerably. Whereas the
first design cost 35,000 euro in 2002, VW manage-
ment claims that this price has now fallen to about
5,000 euro. However, the time is not yet right for
large-scale production runs of 500,000 and more
CFRP vehicle. According to Prof. Dr.-Ing. Klaus Drech-
sler, Head of the Department of Carbon Composites
at the TU München, it will be another 10 to 15 years
before that stage is reached. Because there are still
many problems that have to be solved: production
efficiency, reproducible qualities in series production,
carbon fibre replacement and recycling to name but
a few.

SMART TEXTILES

However, automotive progress is also determined
by other textile innovations in fibres, fleeces and fab-
rics. Every car is already being fitted with about 30
kg of textile materials – and this quantity is rising
fast. Moreover, everyone involved in car manufac-
turing is rapidly coming to the realisation that textile
materials and the technologies implemented to pro-
duce them are among the essential key technolo-
gies for mobility in the future. Fibre-based materials
are becoming steadily “smarter”, they can supple-
ment and replace wood, plastic, metal or glass. For
example, when integrated in HighTex fabrics, the
textile microsystem technology – also called Smart
Textiles – is able to carry out a wide range of new
functions: most importantly lighting, signal man-
agement and air conditioning. In future there will be
cars that reveal completely new aspects of their de-
sign only after the engine is switched on: the non-
woven fabric in the head-liner or the side panelling
will emit a soft, diffuse light; where we now have
switches, this function will be performed by illumi-
nating textile surfaces via a touchscreen. Among
other tasks, the Lightweight Construction Working
Group of the Forschungskuratorium Textil is cur-
rently making an inventory of new functions and the
associated unanswered questions relating to the use
of textiles in cars. From this inventory the group is
developing study topics and stimulation projects in
support of small and medium-size enterprises.
The use of high-performance fibres, composites etc.
in the automotive field has now been adopted as a
primary field of research in 13 of the 16 German tex-
tile research institutes cooperating under the um-
brella organisation of the Forschungskuratorium. In
all, five cluster topics that are significant of the au-
tomobile of the future are being studied:
• Material (behavioural simulation, new materials
and functionalisation, smart materials),
• Lightweight construction (construction, design,
processing technology, joining processes, testing,
quality management),
• Equipment, comfort,
• Safety (prediction of failure behaviour, structure
monitoring),
• Sustainability (renewable raw materials, product
lifecycle analysis, recycling).

The Forschungskuratorium Textil has logged about
150 current, precompetitive research projects in
the last four years, most of which have been spon-
sored by the German Federal Ministries of Eco-
nomics and Technology or Education and Research,
and by the EU. FKT managing director Dr. Klaus
Jansen states that about 40 million euro in subsi-
dies has been allocated for the period from 2011 to
2013 to projects in the mainstream topic of elec-
tromobility alone. The forward-looking research
and development activities, are undertaken on a
broad front, in projects ranging from pedestrian
protection means in the textile engine bonnet in
the event of an impact, passive and active lighting
effects (head-liner illumination, lock depressions,
facings), textile switches to smart seats equipped
with sensors. These sensors will be designed to
measure for example the driver’s pulse rate, tem-
perature and degree of fatigue or indicate seat oc-
cupancy.
The following is a sample list of the automotive-
related activities that are being carried out at just
one research facility: The Institut für Textil- und Ver-
fahrenstechnik ITV Denkendorf, for example, is not
only working for the motor vehicle industry in its
remarkable light laboratory. Textile researchers are
also emulating nature: From a bionic perspective
(bionics = a combination of biology and technics),
researchers are attempting to transfer operating
principles from the plant and animal realms to tex-

Pictures from left: A glimpse of the possibly not too distant future – textile switches integrated in the upholstery | The ITM Dresden coordinated the lightweight construction cluster and constantly proposes new solutions itself – a reduced weight component made from glass fibre reinforced plastic with metal stabiliser.

Used by all German automobile developers: the Light Laboratory at the ITV Denkendorf. Brightly coloured textile il-
uminating yarns developed in-house here are also scheduled to be fitted in bus interiors in the near future.
AN INDUSTRY EXAMPLE
SGL KÜMPERS

As globalisation and the political changes in Eastern Europe prompted the demise of a large portion of the traditional textile industry in Germany, Mr Kümpers, who trained as a mechanical engineer in Aachen, was initially only aware of a vague feeling of unease: "Working with cotton will not see you as far as retirement!" After a little less than ten years as one of the bosses of the family-owned firm with 100 associates, he first resolved to relocate the company F.A. Kümpers to the Czech Republic and Slovakia. His judgment with hindsight: "We would not have been able to survive just in Germany". Today, 400 employees work at the three sites.

Mr Kümpers also serves as a scientific consultant to a number of technical universities as well as the Forschungskuratorium Textil, and as such he is very well informed about the trends in his industry. During the relocation period, he heard about a High-Performance Textiles (HPT) – fibre composite materials made from 2D- and 3D-braids or multiaxial, multi-ply weaves – and realised that this field offered immense possibilities for the future. Drawing on decades of experience with weaving technology and high-volume production in his own company, Mr Kümpers saw a growth market develop and mature around wind energy, which even today uses rotor blades up to 60 metres long and made from glass-fibre reinforced plastic (GRP).

What began in the mid-1990s with a single engineer, who was responsible for all new products and technologies related to fibres made from carbon, glass and aramid fibres, would even attract BMW ten years later. The breakthrough came in the late 1990s when the company began providing serial supplies to leading wind turbine manufacturers, and in lightweight construction with a bumper bracket made from braided carbon fibres, which the team processing technologies from F. A. Kümpers with the long-standing expertise in manufacturing and materials that the SGL Group has acquired in carbon fibres and carbon-fibre based prepregs (pre-impregnated fibres), weaves and composites. Major customers of the constantly growing company at the site in Lathen (incidentally on the premises of a failed traditional textiles company) are manufacturers of wind energy facilities. Multilayer glass fibre webs, up to three centimetres thick on the breaking parts, account for half of the weight of the rotors. These composite structures must be able to sustain untold wind pressure for more than 20 years, and at the same time survive 200 million rotations without damage. An enormous challenge for the lightweight material and for the downstream manufacturing and testing processes.

Nowadays, High Performance Textiles made from high performance fibres have also become indispensable in many other industries: besides wind energy, all fields of transportation engineering, including ship- and boatbuilding, even aerospace, are benefiting from these reduced weight structural components, with which better mechanical properties are achievable with higher quality and at lower cost. Using innovative textile technologies – primarily the weaving of carbon fibres to create "preforms" (textile precursors for components which are then made rigid by infusion of polymer resins) – SGL Kümpers now manufactures customised new products and processes.

One example is BMW: In a joint project with the Munich-based car manufacturer, a new bumper bracket for the BMW M6 based on carbon fibres was developed and made ready for mass production in this way. The weight of the CFRP component is less than half that of the component made with conventional materials. Kümpers, who is aiming to double yearly sales by 2015, is also enticing customers with the promise of relatively inexpensive preform fabrication. The reason: SGL Kümpers owns the very latest equipment – some of it has even been developed and implemented in-house – and, in the words of the 52-year-old company boss, they are "world champion optimisers" of novel processes in the cause of advancing the industrialisation of reinforcement fibres such as carbon and glass fibres.

www.sglkuempers.de

Changing direction after 110 years

led by Mr Kümpers developed from an idea to mass production in just fifteen months. In 2007, Mr Kümpers founded SGL KÜMPERS GmbH & Co. KG, a joint venture with the SGL Group, the foremost carbon fibre manufacturer in Europe. The new company now employs a workforce of 65 and combines the technology leadership in 3D braiding and 2D multi-ply weaves and the most up-to-date weaving still goes on there – but these days they work with carbon fibres instead of cotton. At SGL Kümpers in Lathen/Emsland.

Pictures from left: Carbon fibre braid (preform) and CFRP bumper bracket for the automobile industry | Glass fibre warpknitted multiaxial layers are even used in wind turbine rotor blades | The ultimate in lightweight construction – warpknitted multiaxial layers made from carbon fibres

Franz-Jürgen Kümpers
Composite materials go into series production

A technological race has begun all over the world. The object: to produce the lightest motor vehicle. After increasing the efficiency of the powertrain (batteries, engines, hybrids, power units), lightweight construction is the single most important route to achieving sustainable mobility.

It lowers the weight of the vehicle that has to be accelerated, reduces harmful emissions (a reduction of 100 kg weight saves 8.5 g/km CO₂, Source: VW) and consumes less energy. A lighter body also translates to longer travel ranges for the electric cars.

SIGHTS SET ON MASS MARKET OF THE FUTURE

“This alliance, funded by grants from basic (DFG – Deutsche Forschungsgemeinschaft) and applied (IGF – Industrielle Gemeinschaftsforschung, a funding scheme of Federal Ministry of Economics and Technology) research sponsoring agencies thus represents the first attempt anywhere in the world to develop automated handling and processing technologies with end-to-end process chains in this materials segment”, explains project coordinator Prof. Dr.-Ing. Chokri Cherif. “The economic benefit of automation solutions with reproducible qualities is enormous: the manual labour that is necessary in order to manufacture parts from composite plastics still accounts for 70 percent of the cost.” Furthermore, given its relationship with electromobility, lightweight construction will be a mass market of the future, declares the Director of ITM. This is why we are working to develop a system lightweight

For decades, the weight of cars went in only one direction: upwards. In 1974, a VW Golf tipped the scales at 750 kg, but by 2008 a Golf VI weighed in at 1,217 kg. The reason for this unfortunate trend was the constant emphasis on more sophisticated safety equipment, greater comfort and more powerful engines. As the era of lightweight construction begins, the industry is performing an about-face.

But price considerations mean that superlight fibre composites are reserved for aircraft or extremely expensive luxury sports cars: just as before, they still have to be prefabricated by long hours of manual work (medium volume series will not be possible for a few more years yet).

The German textile research institutes have been working as one to correct this technological anachronism since 2010. A lightweight construction research cluster has been set up under the direction of the Institut für Textilmaschinen und Textile Hochleistungswerkstofftechnik at TU Dresden. In eleven research subprojects, partners from the scientific and industrial communities aim to develop materials and technologies for mass production of textile-reinforced plastic components.

Images from left: Carbon fibres, the miracle material – having revolutionised aviation, extremely light and exceptionally strong CFRP material is now doing the same to the automotive sector | A new development – A machine for laying and bonding carbon fibres
construction in a multi-material design, for future applications not only in carbuilding, but in machinebuilding as well. Besides metal materials (aluminium, magnesium, high-strength steels), which have become increasingly eligible as components of lightweight construction through systematic advances in the last few years, it is expected that the use of continuous fibre reinforced composite plastics will also increase. Accordingly, a total of eleven thematically linked basic and application research oriented research programmes have been grouped together in the “Lightweight construction and textiles” cluster, with the participation of scientists from ten German research facilities in the fields of textile engineering, textile machinebuilding, lightweight construction, plastics technology, bonding technology and polymer materials research. On the basis of such a concentration of skills and expertise in composite science, it is not surprising that astonishing pioneering achievements have already been made along the entire production chain.

LABORATORY SCALE PRODUCTION LINE

The production chain begins with the optimisation of drapable weaves, fixed as monolayer or multilayer structures from high-performance fibre materials, which must be laid out without creasing in single plies or in a stack pending further processing to obtain the shape of the final component. This also includes the precise, computer-generated cutting patterns for producing the semi-finished goods, the textile preforms. Processing and handling the completely “limp” textiles while avoiding distortion as far as possible pose a particularly difficult challenge for the engineers in fibre composite technology. In a ZIM project between the ITM and topcut bullmer GmbH a prototype of a complete production line was created, consisting of a laying machine, coordinate-controlled spraying technology for adhesives, and an automatic size-cutting apparatus. At the end of this process chain, in conjunction with an injection moulding system for example, it is possible to create a textile reinforced product sample that has been injection moulded with short cycle times, and which features all of the properties essential for car manufacturing, such as high bonding/torsional stiffness, and defined crash behaviour.

tu-dresden.de/mw/itm

MOTHER NATURE AS (LIGHT-WEIGHT) BUILDER

While the R&D activities at the Dresden Lightweight Construction cluster are concentrated primarily on the technological aspects of automated mass production, the researchers at the Institut für Textil- und Verfahrenstechnik Denkendorf (ITV) are drawing their inspiration from the (lightweight) master builder nature and are implementing what they learn with mass production processes developed especially and specifically for this purpose. The winter horsetail is an example of lightweight construction from the plant world. It consists of an arrangement of cavities strengthened with cellular ribs. Despite the minimal use of material, this natural fibre composite exhibits astounding mechanical stability. Besides extremely good specific strength and rigidity values, horsetails have excellent vibration damping properties and “well-manered” breaking behaviour, in which failure of the structure is signalled in several stages. “Fibre composite materials are a classic example of the way science emulates natural principles”, says Prof. Dr.-Ing. Heinrich Planck, former Head of the Institute. “With the aid of a braiding method developed by us, we have succeeded in copying this special cross-sectional structure and created what we call ‘technical plant stalks’ that have the mechanical properties we want.” With this innovative technology, these hitherto unique fibre composite profiles can be manufactured inexpensively on a large scale.

www.itv-denkendorf.de

MIRACLE MATERIALS THAT HEAL THEMSELVES

Nature’s building technique is based on features that lend themselves extraordinarily well to application for advances in fibre composite technology: sustainability, material and energy efficiency, multifunctionality, even the ability to heal themselves. New “composites” offer this property as well. Just as the human body heals itself over time after an injury, certain materials are able to regenerate themselves after suffering damage, and so restore their former material properties. “Today, special polymer technologies have made it possible to achieve up to 30 continuous repair cycles”, declares Prof. Dr. rer. nat. Michael Buchmeiser, Director of the Institut für Textilchemie und Chemie- fasern (ITCF), which is also based in Denkendorf. These cycles either took place spontaneously or were induced using UV light or heat. On the other hand, other types of self-healing composites contain what are known as one-time repair elements. These are tiny capsules that burst open and release a “healing” chemical in the event of damage. They are also compatible with epoxy resins, which means that they can be used in carbon-fibre reinforced composites – a dented wheel arch might then repair itself to some degree after a crash. Researchers expect an innovation boost for self-healing paints and tyres as well. Preliminary market tests are already being conducted for these paints, Polyrotaxan, for example, a self-healing coating used by automobile manufacturer Nissan. With the shape memory, some self-repairing polymers exhibit a further remarkable ability: they “remember” their original shape. Materials of this kind are ideal for unsurpassed driving comfort in seats, for example, because they adapt perfectly to the individual contours of the body. Smart Material Design offers a promising way to minimise repair costs for the lightweight car of the future, and to prolong the durability of its materials. Moreover, “intelligent” self-healing materials make entirely new safety features possible: they can help to maintain or restore the functional capabilities of tyres, wind-screens or important CFRP composite components.

www.itcf-denkendorf.de
Scientists and engineers certainly have a few decades of work ahead before it is announced that the next but one generation of cars will run entirely on a solar power unit. But the day when cars are at least partly solar-powered no longer seems so far away. A number of encouraging clues have also come from textile research.

**SOLAR POWER FOR MOTORHOMES**

Caravan and motorhome owners usually have to hope that their camping sites will have a good infrastructure and an ample supply of electric sockets. Because without electricity, their refrigerators, lights, shower or television won’t work. Still the intention is they will be independent of those power refuelling stations. InoReTex, an innovation network located in Saxony whose main purpose is to find textile-based renewable solutions has gone as far as to obtain legal protection for a new direction.

The alliance of businesses and scientific organisations from seven federal states plans to fit the roofs of Caravan & Co. with powerful, hard-wearing photovoltaic systems to enable the vehicles to function as their own source of electric energy. To do this, the caravan must first be put in a parked position. Then, a system consisting of several PV modules is unfolded over the roof. The solar surface is thus expanded from 1.8 to 5.4 square metres, which is capable of delivering up to 1.2 kWh of electricity per day.

According to an evaluation by InoReTex network manager Steffi Volland, this quantity of energy is entirely sufficient to achieve the three key objectives of the new development: the autarchic electricity supply should guarantee that the vehicle’s starter battery always has enough power. Secondly, with extra batteries serving as temporary storage, a diffuse light should already be sufficient for charging to guarantee the operation of all “on-board” electrical applications for an extended period. Thirdly and lastly, it should also be possible to “fill up” rechargeable electric bicycles and other modes of transportation at the planned charging station, so that the radius of mobility can be extended further with no additional burden on the environment.

When the home on wheels is not in use, its mini-power plant can be taken off the roof and can continue being used, on top of the carport or garage for example. “Our main problem was balancing a large surface area with the lowest possible weight, while still ensuring good load resistance”, explains Lutz Ludwig, head of the metal working firm in Cleebronn, Baden-Württemberg that bears his name. It seems that on this point the TechTex expertise in the network was most helpful: “The PV thin film modules are mounted on textile lightweight panels made from 3D spacer fabrics that we developed ourselves and for which we have filed a patent application”, adds the trained plant fitter and master metal worker. These support panels were the key to a tough but lightweight and inexpensive solution.

The first prototype will be produced as soon as the final details of the control and connection technology have been resolved in cooperation with the company AlarmPartner SicherheitsTechnik from Winnenden. Then the caravan outfitters intend to take their creation to the trade fairs.

www.inoretex.de

**RENEWABLE ENERGY IN THE VEHICLE**

It sounds positively paradoxical, but energy has to be managed particularly carefully in e-cars. All (battery) power must go to the power unit including the headlights – and as little as possible for interior lights or seat heaters. Since future models can be expected to feature more interior light and orientating light effects, this raises the question of an additional power supply for these purposes. In this context, solar energy generation becomes interesting – though not with rigid, fragile PV modules. If the rear shelf and instrument panel (and possibly jackets, tents, tarpaulins or awnings, for example) are to be converted into micro-power plants, science must therefore be looking out for new, highly flexible solar-active materials. One promising approach was reported from Krefeld as long ago as 2004. It was there at the Deutsches Textilforschungszentrum Nord-West e. V. (DTNW) that the world’s first textile solar cell with a CIGS basis (a thin film technology that uses copper, indium, gallium and selenium) was launched. Three years later, under the auspices of the programme 14 partners from seven countries and DTNW as the technical project coordinator successfully used the technology to manufacture a textile-based PV cell from organic materials and dyes. They created Dye-sensitized Solar Cells (DSSC) and modules with a light yield of two percent (conventional cells output easily delivers ten times this amount). The most noteworthy feature of this dye-sensitized solar cell: it is flexible and lightweight, yet mechanically stable.

DTNW project manager Dr. Klaus Opwis talks of a “breakthrough in textile DSSC technology”: The individual cells, with sizes up to six square centimetres, exhibited photovoltaic activity with constant efficiency for several months. He concluded that as soon as the light yield climbs above three to four percent and long-term stability in routine daily use is achieved, market introduction can begin.

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**ALTERNATIVE ELECTRICITY**

- **Solar Textiles**
  - **Flexible solar-active materials.** One promising approach was reported from Krefeld as long ago as 2004. It was there at the Deutsches Textilforschungszentrum Nord-West e. V. (DTNW) that the world’s first textile solar cell with a CIGS basis (a thin film technology that uses copper, indium, gallium and selenium) was launched. Three years later, under the auspices of the programme 14 partners from seven countries and DTNW as the technical project coordinator successfully used the technology to manufacture a textile-based PV cell from organic materials and dyes. They created Dye-sensitized Solar Cells (DSSC) and modules with a light yield of two percent (conventional cells output easily delivers ten times this amount). The most noteworthy feature of this dye-sensitized solar cell: it is flexible and lightweight, yet mechanically stable.

- **Breakthrough in Solar Textiles**
  - **Flexible and lightweight solar cells.** The DTNW project manager Dr. Klaus Opwis talks of a “breakthrough in textile DSSC technology”: The individual cells, with sizes up to six square centimetres, exhibited photovoltaic activity with constant efficiency for several months. He concluded that as soon as the light yield climbs above three to four percent and long-term stability in routine daily use is achieved, market introduction can begin.

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ment of complete seat assemblies including the textile and leather materials here.

Consequently, Lemgo has now also become the design centre for the car/van/commercial vehicle, train, bus and aircraft sectors, and is linked to the regional design and development offices in 14 countries with 27 locations. In all, the group employs over 50 designers, led by Colour & Material Design Manager William Franke. Their creativity, combined with the company’s own research and development potential – which is growing almost constantly in collaboration with institutional textile research as well – has created an innovation record unrivalled anywhere in the world. AUNDE only very recently developed different processes for creative surface design, including TexTrim for creating 3D surfaces on seat upholstery from, for example “VW Polo” and “Opel Corsa”, using high frequency welding. With TexTab on the other hand, various materials are applied to the fabrics to produce creative and functional effects. This process is currently being used for “Fiat Punto” and “Lancia new ypsilon” among others.

What is there about car seats that still needs improvement? Tobias Lüpfert could deliver lengthy lectures on this question, but contents himself with saying: “We still have lots of plans inspired by the keywords functionality, environmental compatibility and improved seat feeling; to some degree we will also be working together with textile research.”

GLOBAL PLAYER

Many large German enterprises like the AUNDE Group can trace their origins back to the 19th century. Founded in Mönchengladbach in 1899 and trading under the name Achter und Ebels, the company initially specialised in fabrics for men and women. As the age of the motor car dawned, by about 1920 the full-service fabric business was already supplying upholstery materials for automobiles. During the Wirtschaftswunder, the material manufacturer carried out a strategic realignment with an eye to the exploding car market.

In the late 1970s, leadership passed to Rolf A. Königs, who initiated a fundamental change in the nature of the company: he transformed the regional business AUNDE into a global player, and with the takeover of seat manufacturer ISRINGHAUSEN and the Spanish company ESTEBAN (seats for buses and trains) he secured its position as a system provider.

AUNDE is a world-renowned supplier to the automobile industry and is represented at 86 sites in 25 countries on all continents. Supreme quality combined with decades of experience in all phases of production, such as textile finishing (equipment) shown here, are hallmarks of the corporate group.

AUNDE Group among the top 100 automotive suppliers

We’d be willing to bet that unless you were an expert you would have a hard time naming a single automotive marque that does not receive its textile and leather coverings, and even entire seats, from AUNDE. This is a source of great pride to Development Director Tobias Lüpfert and his team, but it is also a challenge to a company that is ranked among the one hundred most important suppliers to the automotive industry in the world: they have to be on the ball and talking to customers everywhere at once, note the customers’ wishes and suggestions, and they themselves must follow, apply and offer the trends of the world in terms of material, design and styling.

Anyone who intends to represent himself as a supply partner from concept to series-volume product to the likes of BMW, Daimler, VW, Chrysler, Fiat, Hyundai, or Renault – to name but a few – had better have the necessary muscle themselves, must be able to call on locations all over the world – at least that is the intention of CEO Rolf Königs, who in 1982 began transforming the family business into a global force. “We are set up for international operations, just like the big car makers – in organisational terms and with regard to communications, we are on the same level as they are”, says Tobias Lüpfert, whose responsibilities also include the Innovation Centre in Lemgo and its staff of 150. As a specialist in vehicle interiors, AUNDE has concentrated the predevelop-

Pictures from left: What was a research project until a short time ago is produced by machine and in large numbers, often within just 18 months | Two brand new processes for creative surface finishing on seat upholstery that have already been embraced by the automobile industry: TexFilm and TexTrim
An intimate connection for 34 years

The world’s leading car manufacturers can rely on the AUNDE Group. Its 14,000 employees develop and produce yarns, technical textiles, seat coverings in textile and leather, and even entire seat assemblies. We talked to Rolf A. Königs who has led the globally active corporation since 1978:

Germany has an extremely dense network of textile research institutions, and most of these are also occupied with automotive issues. How does AUNDE use this potential? Product development and commercial success are two sides of the same coin. Surely you can imagine, when it comes to Research and Development (R&D) we take full advantage of all the possibilities that are open to us: centralised and local, in-house and in cooperation with institutes and the car manufacturers. We also cooperate with organisations in other industries, with market leaders like BASF or 3M.

At what issues are the institutes working at the moment?

We always have several research projects on the go, the moment? At what issues are the institutes working at when it comes to Research and Development (R&D)?

An intimate connection for 34 years

We also cooperate with organisations in other industries, with market leaders like BASF or 3M. At what issues are the institutes working at the moment?

Every car has dozens of them: Straps and belts. They hold, restrain and secure. Except the well known safety belts Gütersloh-based traditional manufacturer Güth & Wolf produces nearly every other mostly invisible textile strip in the car: seam reinforcement and side airbag strips, hose, tunnel and retaining straps, noise damping and mat border tapes, – not to mention the hand and seat unlocking loops. Hermann Güth, managing director of the 125-year-old company family-run for four generations, explains the need for development:

"For years, our band weaving mills have contributed to bringing the industrial society forward in matters of electrification, communication and mobility. Regardless of the mode of transport, aircraft, rail or road vehicles: textile belts and straps are not only used to secure structural elements, they are safety devices of the highest order. As a medium sized-enterprise, we supply our products to almost 30 industries. Our widely diverse customer groups and their application specifications constantly challenge our 320 employees to use an enormous variety of materials: natural fibres (cotton, linen, paper), natural polymers (viscose, acetate, polyacids), synthetic fibres (polyester, polyamide, polypropylene, elastane) and high-strength, high-performance fibres.

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Even though Güth & Wolf is regularly recognised for its responsiveness and adaptability, as well as for the superior quality of its products, we also see this as a commission not to stop innovating. Our shipments to car manufacturers account for 15 percent of our production volume, and above all they are looking for compact yet lightweight solutions. Belts, straps, loops and strips are often needed as design elements when elegant, flexible detail solutions or mechanical functions tucked away in the farthest corner of the car body are at issue. With all of our products for seat cushioning and interior furnishings made entirely in Germany, which constantly involve a degree of research and development work, we command a large share of the market. At the same time, it is essential to respond to coming trends and the requirements of our customers quickly and with a constant reference to the market. This applies to recyclability as well as to product development on the basis of renewable raw materials.

A huge topic, which is regarding to the safety technology in automobile industry growing yet more important precisely for our Automotive development department is the use of fibre composite materials. Güth & Wolf is working together with textile research organisations on these and other R&D questions. At the moment, we are participating in eight projects, for example we are involved in a project promoted by the EU relating to regenerative fibre materials. Also we have very active project and commercial relationships with the STFI in Chemnitz, the ITA at the RWTH in Aachen and the TITV in Greiz.”
SMART TEXTILES ON FOUR WHEELS

Author: Sabine Gimpel, Marketing Director TITV Greiz

A car is a car, once and always – and it will never cease surprising us with new technical and design details. This also applies to the passenger compartment. In the future, innovative textiles will bring more warm light into the cabin and will surely provide other technical surprises. *Smart textiles are no longer just the subject of every conversation, they become reality, as the first applications are filtering gradually onto the market. The basis for luminous textiles, textile heaters, or switches integrated into the fabric are electrically conductive threads, stitched circuit boards and textile sensors. As an institute for special textiles and flexible materials, the TITV has been occupied with this subject for well over ten years – and it is proud to place its solutions at the disposal of the automobile industry as an innovative partner. Our patents, such as the one for luminous textiles based on the ELITEX® threads, developed and manufactured in Greiz, attest to our expertise. The industry sees four general areas of application for these “smart textiles”: since people generally are spending more and more time on four wheels, new technical opportunities to support health or wellness aspects in the vehicle are assuming greater importance, as are portable electronics for monitoring vital functions or personal safety. With e-mobility it is very important as well to consider energy-efficient components regarding interior lighting and heating, that will become possible with new electric conductors made from textiles. And last but not least, in future manufacturers will place more emphasis on invisible functions, which will be integrated in the surface of the side panelling, the upholstery or headliner. Four examples to show which ideas our textile researchers have taken up from the automotive industry to develop further with their application expertise:

**Woven heating surfaces:** Upholstery fabrics that warm up and radiate a cozy surface warmth without blowing air. Based on invisible, unnoticeable electrically conductive threads woven directly into the seat surface.

**Sensitive textile panels:** One day we will be able to change gears, turn the radio up, or adjust the lights with just a wave of the hand. A sensitive matrix in which electrically conductive textile threads are embedded as tiny antennas converts hand movements into switching signals. At the moment, 14 signals are possible.

**Luminous textiles:** Woven LED threads with bright, non-glare lighting power will light up the inside of your car exactly where light has an orientating function, such as on a textile button in the seat or on the instrument panel. In future, it will be possible to manufacture the material needed for this by machine and in large volume with a technology developed at the TITV.

**Biosignal monitoring:** Tomorrow’s vehicles will also use textile expertise to monitor the current physical condition of the driver. Textile sensor systems can detect dangerous conditions such as over-tiredness or stress and transfer this information to an on-board alarm system. Electric cars without smart textile materials for lightweight construction and new, integrated functions are already inconceivable. In future, this will spread to new vehicle models with hybrid drivetrains as well.

www.titv-greiz.de

FUNCTION INTEGRATION FROM THE LIGHT LABORATORY

Light is one of the elementary determinants of the human environment. At the Institute of Textile and Process Engineering (ITV), researchers are helping to shape the future of the automobile, and it is literally glowing. Here, a team led by Christoph Riethmüller is studying and presenting the properties, hitherto largely unsuspected outside of the scientific community, of the new luminous yarns he created himself at Denkendorf and the textile products that have been manufactured from them: elements that illuminate brightly in any desired shape or colour, whether lighting up themselves or backlit by large area LEDs and possibly even with a three-dimensional effect. This workshop of the future led by Riethmüller also happens to be the place where the light-animated interior presentations by the big brands first take shape using structured brainstorming methods. Even manufacturers of buses and rail vehicles work with the textile experts.

One of the questions that is constantly arising in the light laboratories is: How can high-tech textiles help to produce construction components that are ultimately cost-neutral after all from the really very expensive lightweight construction elements that are designed to reduce the weight of motor vehicles? This is where the phrase “technology integration” is heard. In this context, for example, seat surfaces or interior trim are endowed with smart functions, such as sensor-based textile switches or luminous surfaces or strips. Even colour changing effects in the head-liner on other interior elements to reduce stress and tension for the driver are possible. “Our institute has been investigating luminous textile materials for about ten years, and with hybrids and partially interactive construction elements like this we are one of very few organisations worldwide that are helping to define a completely new approach”, declares the 42-year-old. Textile visual effect possibilities based on active and passive light threads can inspire new ideas for the mobility of tomorrow that transcend the car. “We are also doing some very exciting research for lorries, buses and aircraft at the moment”, says Riethmüller, referring to industry-financed projects. He goes on to describe a technical light project that is directed at tour buses in a little more detail: with the working title “Emotional light”, the project is exploring a new kind of light design, which is coordinated with the optimum temperature in the bus. In this way, the subjectively differing perception of temperature by the passengers should be largely harmonised on a common denominator via the light guide. The result they are hoping for: With suitable light scenarios, it should be possible to reduce or even eliminate entirely the number of passenger complaints that the air inside the bus is too hot or too cold for others, says the researcher from denkendorf.

www.itv-denkendorf.de

Bottom picture: Developed in the light laboratory at Denkendorf – light effects on a textile base
Specifically in the automotive industry, the need for lightweight construction materials made from carbon fibres is growing. But with prices per kilo hovering around 20 euro, the high-performance material very often is much too expensive for mass production. Prof. Dr.-Ing. Thomas Gries (TG), Director of the ITA (Institut für Textiltechnologie) at the RWTH Aachen, and Uwe Merklein (UM), Managing Director of the ITA spinoff business 3T TextilTechnologieTransfer GmbH, talked about alternatives.

One of the options under study in Aachen is performance optimised materials, such as fibre-reinforced ceramics and aluminium composites. You are even working on an entirely new lightweight construction concept. Why?

TG: Industry is demanding lighter and lighter components, but they must still be extremely strong. Carbon fibres would be the material of first choice, but for many applications it is too expensive. It is the car makers themselves who have begun calculating using prices per kilogram component. Sheet steel is currently at eight to ten, aluminium costs 12, and carbon is 75 euro. So we need alternatives … 

UM: … like a holistic approach. Our concept is applicable not only to the origination process of the components, including the research, it is also directed at lowering energy consumption with optimised production cells and sensor-based component monitoring using smart textiles.

What does that mean in this specific case?

TG: According to this cross-section approach, in early 2014, together with our RWTH colleagues and industry partners, we plan to present a new light construction concept for the automobile industry that reduces weight by 40 percent compared to conventional metal construction and that reduces consumption and vehicle emissions correspondingly. Forty percent is an ambitious target. How is that to be achieved?

TG: Therefore, we have to combine three different material systems: Innovative, inexpensive carbon fibre non-wovens and also cost-effectively produced carbon fibre composites, which are heat mouldable, are bonded using a metal structure. Besides the weight, this also reduces the costs of the components significantly. Strength is still high. If we’re successful, we can demonstrate: “It doesn’t always have to be carbon. Sometimes the essential parameters can also be assured with intelligent alternatives.”

What is the role of 3T in this?

UM: New knowledge is implemented in practical applications: we are the link between institutional research and partners in industry. When the ITA solution yields successful material combinations, as a business we can respond more flexibly to current market requirements – also, with regard to the batteries in e-cars for example, which are still extremely heavy, perhaps it may be possible to reduce their weight with alternative material combinations. At the same time, besides the undeniable impetus from the automotive sector, degrees of freedom will be created in other areas as well: after all, mechanical engineering for example is also intensely interested in learning how components can shed a substantial amount of weight and still retain their strength. Perhaps this will also help to inspire entirely new approaches to design engineering. Moreover, with industrial cooperations of this nature we help to carry roughly a third of the ITA’s financing, so we are again supporting the advance of research …

TG: … and we are preparing not only the next generation of scientists for their duties but also young technical experts for life in industry. If our new materials preserve the competitive situation, jobs and sales, there are only winners. And that is how it should be.

www.ita.rwth-aachen.de
www.3t-gmbh.de
THE INDUSTRY’S VIEW
How will we drive tomorrow?

Since dependence on imports or technology from undergoing many, many charging cycles.

It must offer short charge times, large storage capacity for long ranges, and it must be capable of cheaper through mass production; but above all, companies want to become lead suppliers of technology, and to do this they must be able to deliver very compatible that the new vehicles are able to bear comparison with the classic cars on equal terms.

We cannot predict which technologies will dominate on the roads in the future. This is why the German automobile industry, together with partners in science and other branches of industry is actively encouraging research and development in all areas of interest – electric, hybrid, hydrogen and combustion engine efficiency – at the same time.

Given the initially modest market share of electric and hybrid vehicles (2011: 0.5 percent of vehicles registered for the first time), manufacturers and suppliers very often pay in advance. This is the only way that we will succeed in drawing ever closer to the objective of emission-free driving – and at the same time safeguard thousands of valuable jobs in Germany.” www.vda.de

Dr. Friedrich Preißer
Verband der Automobilindustrie e. V.,
Managing Director of the Forschungsvereinigung Automobiltechnik

Interior textiles:
Market pressure demands cooperation

Germany is the leading export nation – and much credit is due to the car manufacturers for this. They monitor rising quality and environmental requirements, also with regard to interior textile components, based on the information received in local markets all over the world.

New cars are built accordingly to global platform concepts at plenty of sites besides Adam Opel AG. After all, they have to comply with the statutory regulations and customs in North America just as they do in Central Europe or the Far East. This results in plenty of requirements just with regard to textiles that are used in the passenger compartment – for the headliner, the pillar or door covering, the sun visor, the rear window shelf or floor covering materials in the trunk and cargo spaces or the side walls. The supplier organisations to the industry are mostly medium-sized companies and they find themselves facing real challenges: for example, all interior textiles must be odour-neutral, low-emission and able to withstand hot light up to 115 degrees, and they must be shrink-resistant. Rhinestones or metal applications on cushions can lead to snags, but are still desired and must therefore be integrated. Opel/GME is very keen to ensure that vehicle occupants do not experience any electric discharge upon leaving the vehicle – regardless of the material from which the upholstery is made. This can only be remedied with special antistatic equipment.

US customers look upon the inside of a car as a kind of “extended” living room. Therefore, the textiles used in cars must attract as little dirt as possible, and they must be easy to clean – with commercially available cleaning agents as well as certain kinds of chemicals that the user may or may not use. Sun creams or insect sprays can also have a relatively aggressive action: but the cushions and mats must withstand them. The mats must also be highly resistant to soiling, easy to clean, and as far as possible abrasion- and scratch-resistant too. And they must not shrink excessively. Another requirement applies specifically to centre armrests: they must be resistant to Velcro strips because outer clothing often features such closures.

These few examples show already that textiles and cars are a successful, but demanding combination. The objective was, and is still, to prevent any visible change in the material from occurring for defined periods of time or kilometres travelled, and to prevent failure of the component for twice the defined value in each case.

But since customer behaviour is changing constantly, the quality specifications of our industry that apply to textiles as a material, are dynamic and becoming ever more stringent. As has been presented in detail on earlier pages, the only way to comply with them is to ensure the continued, close cooperation among manufacturers and suppliers, industrial researchers and university scientists, research institutes and specialises R&D service agencies.” www.opel.de

Eveline Weber
Interior Material & Supplier Quality Adam Opel AG
Greiz and Hohenstein: Two research and development solutions from technology and material are by no means exhausted. Every new model, the possibilities of technology and material are by no means exhausted. Two research and development solutions from Greiz and Hohenstein:

**“SEATSEN” OCCUPANCY SENSOR CONTROLS AIRBAGS**

In future, collision damage should put a slightly lighter burden on the finances. To ensure that not all airbags are deployed at once in the event of a crash, textile scientists in Greiz have developed intelligent sensors that will detect seat occupancy. If the worst should happen, they only enable those airbags that must be deployed in order to preserve passenger safety. The heart of the “SeatSen” project, which is sponsored by the German Ministry for Education and Research (BMBF), is the纺织sensor system. The sensor system is based on textile circuit substrates, the surfaces of which are covered with microelectronic components that have been attached using a mounting and connection technique developed specially for the purpose. This technique ensures that the sensor probe is positioned precisely and that the electrically conductive threads are connected to the monitoring system of the car. The textile processable components can be produced on an embroidery machine. The components are positioned precisely and also contacted at the same time. In this way, it is assured that in future the textile electrical system can be manufactured “on the roll”, cheaply, and in large quantities.

The research subject, the results of which may also be used in lorries is becoming smarter and smarter. The latest achievement: actively air conditioned seats with either seat heating and ventilation fans. This ensures comfort in both summer and winter taking both weather extremes into account: The self-adjusting air-conditioning system under the cushion improves sitting comfort considerably. But are the measuring methods that were developed for passive seat heaters according to the On/Off principle at the time good enough to give the manufacturers the values and criteria they need in order to make decisions regarding mass production and further development of this innovation? Furthermore: How must the seats be constructed to ensure that energetically optimised cosiness and gentle cooling actually reach the driver without loss? These questions interested the industry and prompted scientists at the Hohenstein Institut für Textilinnovationen (Baden-Württemberg) to join forces with colleagues specialising in energy efficiency and microsystems engineering at the Friedrich-Wilhelm-Bessel-Institut (Bremen) in a BMBF-sponsored project. First they tested several active temperature-controlled seats for cars and lorries. These were grouped according to the number of operating levels, installed output, construction concept and covering material. Then physiological laboratory measurements and sitting trials with human testers in varied climate conditions (temperature, relative humidity and heat effects, which were recorded at various measurement points between the driver, the seat and the vehicle interior) followed. When the research project ended in 2010, a new measuring method was presented. This can display the effect of seat heating and ventilation on the driver’s physiology and feeling of comfort in detail. As a result of this research, it was possible to provide the automobile industry with standardised laboratory measuring procedures and performance indicators derived therefrom regarding, for example, the most effective air conditioning of vehicle seats. For project leader Dr. Bianca-Michaela Wölfling, who indicated that further research is needed for example with regard to warm-up behaviour, the construction recommendations that were made in parallel with the project are particularly valuable. They would enable the production of high-value seats and the small components needed therefore to be improved systematically and inexpensively.

www.hohenstein.de

Sitting tests for optimally air-conditioned car seats – a research project by the Hohenstein Institut für Textilinnovationen
A missed stop red light, a ball rolling onto the road, the blind spot when turning: a moment’s loss of concentration by drivers, pedestrians or cyclists can often cause serious accidents. According to the Global Status Report published by the World Health Organization in early 2012, 1.27 million people are killed on the roads every year. Half of these (a quarter in Germany) are pedestrians or cyclists, which means they belong to the most vulnerable groups of road users.

The automobile industry has begun introducing ways to address these statistics technologically. In 2010, braking assistance systems were introduced to cushion the impact of a crash. One German car maker has begun experimenting with a kind of cat-apult arrangement: a car bonnet that pops up slightly as soon as an impact occurs, increasing the available deformation space so that the Head Injury Criterion (HIC) remains within the norm as far as possible, and the worst consequences of an accident may perhaps be mitigated. At the same time, textile researchers from Saxony and Northrhine-Westphalia have been working with car experts from Aachen on a completely different concept.

In cooperation with the Institut für Textiltechnik in Aachen (ITA) and the Institut für Kraftfahrzeuge (Ika) in Aachen, researchers at the Institut für Textilmaschinen und textile Hochleistungswerkstofftechnik (ITM) in Dresden have developed a device for pedestrian collision protection made from textile spacer materials and integrated it for test purposes in the bonnet of the VW “Golf V”. The cushioning structure incorporates not only mechanical but also acoustic and thermal modes of operation, and if the worst should happen it is designed to absorb the impact of a collision between man and machine to such a degree that the HIC values critical for survival remain within the limits defined by EU regulations.

Based on the outcome of this project, which was co-financed by the German Federal Ministry of Economics and Technology through its research stimulation programme Industrielle Gemeinschaftsforschung, textile impact dampers in the form of knitted and woven spacers with exceptionally high compressive strength were designed. Additional improvements to this parameter were also obtained by infiltrating the clearance space in the high-volu-ume textile composite with a foam or soaking the covering surfaces with epoxy resin, among other measures. This maximises the efficiency with which the material, which has been installed in a sandwich structure over a large area under the bonnet, absorbs the dynamic load of a collision.

Dr.-Ing. Olaf Diestel, who coordinated the project in Dresden, hopes that now the basic feasibility of the following material groups: steel (49 percent), plastics (13), iron (10), aluminium (9). These are followed by elastomers with 3 percent and glass and non-ferrous metals with 3 percent – textiles are grouped under “Other” (8 percent) together with other construction materi-als. Even though much is still in flux in this regard, one thing now appears certain: the car of tomorrow will have an entirely different material mix. An (incomplete) view of the offerings of candidate materials from a number of textile institutes confirms this trend:

The Sächsische Textilverarbeitung Chemnitz (STFI) is supporting this trend with the basic development of an innovative non-woven stitch-bonded fabric, called a “multiknit”, which is already in use at the institute’s industry partner Techtex Vliesstoffe GmbH in nearby Mittweida. The material, of which 3.5 million square metres are already delivered every year, is manufactured with thermoplastic fibres and can be used as the padding in car seats instead of the only partially recyclable PUR foam. The material lends itself well to laminating, its fibres are resilient under pressure and can be reprocessed together with the seat covers subsequently. They also ensure improved seating comfort and are free from the other-wise normal chemical evaporation.

One research result that is also based on a multiknit material is aimed directly on the visible portion of the vehicle’s interior fittings. Initially, it may not sound particularly impressive: 3D non-woven composites for back-moulded interior panelling. With this injection moulding technology it would be pos-sible to create decors from textiles, synthetic leather (PVC) or leather with a soft surface, the look and feel of which differ fundamentally from the materials that have previously been used for vehicle interiors. At the same time, the typical soft-touch effect is achieved with a special mixture of polyester fibres with various degrees of fibre fineness, length and crimp.

www.stfi.de
High-performance fibres made from ceramic (oxi-
dic fibres with sustained resistance up to 1100 de-
grees Celsius), carbon or customised polymers are
a matter for everyday discussion at the ITCF Insti-
tut für Textilchemie und Chemiefasern (Denk-
endorf). The special fibres are notable for their
remarkable properties and are therefore ideal for
innovative applications in the automotive and
aerospace industries as well as the power engi-
eering and building sectors. Whereas self-healing
structures (see page 13) are already “creeping” to-
wards mobility, other economically significant proj-
}
ects are still very much in their infancy. In this
context, Deputy Head of the Institute Dr. Bernd
Clauß is announcing an ambitious project: research
into the production of carbon fibres from renew-
able raw materials. Since obtaining the precursor fi-
bres accounts for half of the costs of producing the
classic, polyacrylonitrile-based material, he ob-
serves, alternatives are being sought all over the
world. Now, the ITCF intends to be much more ac-
tive in this field of research, in cooperation with in-
dustry partners. The question is already under
intensive study in the USA. Besides experience, the
ITCF is already superbly prepared with the tech-
ical facilities to undertake such a venture.

The institute’s chemists and textile engineers have
so far succeeded in conducting the entire process of
manufacturing carbon fibres on a laboratory scale,
but are still facing challenges in the production of flat
component structures for door panels (see page 13). The
subject of lightweight construction that is so im-
portant for mobility is also pursued at the ITCF in
Rudolstadt with intensive material studies supported
by a quite immense fund of experience. One of the
main fields of study for 15 years now has been the
one of sustainable natural fibre composites. In terms
of vehicle interior components, they are used for
door paneling, the instrument panel, boot trims and
the headliner. According to information from the
Nova Institute, European automobile manufacturers
already consume about 40,000 tons of these sub-
estances every year. Thanks to intensive research,
new surface effects are constantly being created for
natural fibre composites. This is welcomed by the
automotive industry, which, for example, values in-
novative light-refracting surface effects as much as
textures that are pleasing to the touch or scratch-
resistant materials.

Against this background, since 1999 the ITCF has
been a co-organiser of the International Symposium
on natural fibre composites. This symposium is con-
tinued every year. Thanks to intensive research,
new surface effects are constantly being created for
natural fibre composites. This is welcomed by the
automotive industry, which, for example, values in-
novative light-refracting surface effects as much as
textures that are pleasing to the touch or scratch-
resistant materials. The mechanisms triggered by this in the interior of the
material are complex: The viscosity of the molten
matrix is affected significantly by temperature – the
textile layers must be draped and slide over each
other all at the same time. These processes and the
solidification of the matrix take place in split seconds.

After countless experiments and statistical studies
as part of a ZIM project, in which the Institut für
Textiltechnik (Aachen) and the Institut für Werk-
stofftechnik (Bremen) also participated, the param-
eters necessary for controlling these processes are
now predicted mathematically. For this, both ex-
ternal and internal influences on the panel must be
considered. The methods and technologies devel-
oped in the course of the subsidised project ProToN
are now opening up the way to thermoforming for
component applications for the automotive and
aviation industries. The simulation tool for thermo-
mechanical forming compensates for the material-
related fibre deviation, which would otherwise
prevent the material from being used in large-scale
production of flat component structures for door
sills, side impact elements such as door stiffeners,
seat pans or frontal structures. Other products
yielded by the project include new releasing agents
and a method for contactless temperature measure-
ment of parts, and a tool for better process control.

www.fibre.de
Nowadays, up to 40 kg of textiles are packed into cars – nonwovens account for a significant fraction of this weight. The unobtrusive “nonwovens”, textile structures made from initially loosely deposited fibres or filaments that are solidified mechanically, by heat, needles or water pressure, are exceptionally efficient and are always optimally “formed”.

The family-owned Sandler company based in Upper Franconia has been active in this segment for many years, and expects substantial growth to continue.

“We completed our first products with car manufacturers back in the 1980s”, states Chairman of the Board Dr. Christian Heinrich Sandler. In all, 50 car models, including marques such as Audi, BMW, Ford, Mercedes or VW, are on the road all over the world carrying products inscribed with “made in Schwarzenbach”.

In accordance with the car manufacturers’ specifications a wide range of application options for nonwovens helps to lower vehicle weight and consequently fuel consumption as well. In the area of acoustic damping, for instance, Sandler AG offers a very wide range of products for noise absorption, continues the company boss, representing the fourth generation of family ownership. The nonwovens used are made from PET. These damp annoying engine and road noise inside the car even at high speeds. Highly effective fibre absorbers are installed from the head-liner to the seat recess, from the instrument panel to the rear parcel shelf, making for an odour-neutral, cosy ambience. Nonwoven trims on pillars or even boot floors hug each part closely and conform precisely to its shape. Nonwoven engine or transmission encapsulations also help to conserve fuel. Not only do they reduce the sound of the engine and transmission block, at the same time they also slow its cooling, thereby reducing the number of cold starts significantly, and facilitating efficient combustion. Under the bonnet, the nonwovens withstand oils and petrol and are resistant to extreme temperature variations. And when used as textile wheel arch liners or sump guards, the water and oil repellent “exterior absorbers” make effective shields against weather and dirt.

Executive Board Chairman Sandler, who is also President of the Bayerischer Textil- und Bekleidungsverband e.V. now intends to take his technical nonwovens into new areas: “Of course, we are also involved in the question of electric mobility. New solutions are needed with regard to noise sources and the points that have to be damped. Significant changes are also coming with regard to absorption performance, installation space allocation or weight.” New challenges like these will lead to development projects, which will be undertaken jointly with car manufacturers and their partners.
What is driving textile research?

Now, discussing this with the textile industry and professional organisations from the affiliated industrial branches and from the regions, the Kuratorium is prepared to identify new challenges as milestones. In order to be able to catch a glimpse of tomorrow, the textile experts are using a method of predicting the future called retropolation. In this, images from the future, in this case 2050, are collected and an attempt is made to outline the prerequisites for such a situation to exist that will be in place at a time already in a not too distant future – that is to say in 2025. Professional assistance is provided by the Munich company FENVIS GmbH, which specialises particularly in “future roadmaps” of this kind as a strategic aid.

The question of what will or must be different in 40 years, serves initially to illuminate relevant thematic areas: humankind, food, health, mobility, consumer behaviour, energy, resources, climate change. With regard to the food situation, for example, which is intimately linked to the fact that by then 70 percent of the 9 to 10 billion people on the planet will be living in cities, and 50 percent will live in seven countries: China, India, the USA, Indonesia, Pakistan, Brazil and Nigeria, enormous textile challenges begin to emerge at the mere mention of a few problem areas.

If one wishes to stop the climate-threatening spread of farmland, and therewith relocate the production of food to exactly where it is needed, without much transport or logistical infrastructure – that is to say in the megacities –, new farming concepts must be found: According to the new order, the field as a horizontal tract of land for cultivation, preferred for millennia, is now arranged vertically, and is part of a system of agricultural skyscrapers. Experts are already talking about “vertical farming” today. Irrigation mats, shading systems and lightweight construction segments for these new requirements will be made from textile materials, as will hoses, hanging gardens, optical fibres …

The more than 50 participants after three regional events of the FKT in Aachen, Denkendorf and Düsseldorf agreed that similar need for research and development into fibres, fabrics and non wovens existed in the other future images as well. Even before the final theses on the topic had been presented and development directions not previously considered by the institutes had been listed, the discussion had established requirements, some of which were new, for the research itself, and went far beyond the need to work more efficiently, and on a more interdisciplinary basis in the future. Dr. Jansen summarises: “In order to be able to assist with social developments consciously, we must intensify excellent research to a greater degree and at the same time campaign for greater acceptance with respect to subjects such as nano engineering or genetic engineering throughout the EU.”

With reference to human resources, it will become more and more important to train skilled technicians and keep them in the research institutes for as long as possible. This is the only way to ensure that the international lead held by German textile research will be preserved and extended in many areas.

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According to the FKT, an interim review of the Mobility prediction area has yielded thoroughly positive conclusions, but also shows that textile integration and material replacement in vehicle bodies, interiors and functional elements will remain a colossal undertaking for several decades to come. Advances in this area will depend heavily not only on national and Europe-wide interdisciplinary research projects into key questions but also on a strong commitment by industry and a state that is prepared to set a framework with appropriate funding. Jansen believes that, on the threshold of e-mobility, one thing is clear above everything else: “Without fibre-based lightweight construction and the reduction in weight and fuel consumption associated with such, important mobility objectives for society would retreat into the distant future. Even so, the technologies for manufacturing, recycling and reprocessing that are at our disposal today are still in their infancy, which means they are much too expensive, they consume too much energy, and the details thereof have not yet been fully thought through with regard to environmental compatibility.”

FOCUS ON THE ENVIRONMENT

It is precisely the ecological aspect – that is, the economic use of resources and energies, the use of environmentally tolerable chemicals for production, and the avoidance of modes of transport and the effortless reprocessing of textile materials – that serves as a vital incentive for all key areas. Advances in environmental conservation due to new textile materials have created their share of headlines in recent years: irrigation mats, high-efficiency filters, and not least the “mist catcher” from Denkendorf, which can recover up to 50 litres of water per square metre every night close to the seashore.

Many of the textile highlights of today, such as fibre-reinforced concrete or fibre-based implants, are the results of research that has been started ten or more years before. Conversely, projects and topics that are being started now in the textile institutes and their partners in industry will not find their way onto the market until the 2020s. So what megatrends of the future must the research of today take into account? The project “Guidelines for 2025” initiated by the Forschungskuratorium Textil e. V. is intended to find the answers to this question.

The “Perspectives for 2015” prepared by the textile research community in 2006 are still current. In the opinion of FKT Managing Director Dr. Klaus Jansen, the independent predictions made back then, which have similarities with the high-tech strategy of the federal government, serve as a “helpful framework for research”. The five key issues identified in the Perspectives - health, mobility, safety, communication and emotionality - still serve as a guide and inspiration for the 1200 textile researchers in their projects investigating sustainable, economic resources.
In Germany, the quantity of mobile textiles as a fraction of the total technical textiles market counts about 22%, which makes it the largest subsegment, and it is growing. The sustained global trend towards lightweight construction with carbon and glass fibres, as well as offcuts and production waste from these materials is spurring the scientific and industrial communities to develop appropriate recycling technologies. These must be established and available for materials of all kind, when mass-produced full and partial car bodies, rotor blades and machine casings are not used anymore – in a very few years, in fact. The solutions are expected to be environmentally compatible and extremely economical. Particularly carbon fibre stacks, that is to say those that do not originate from continuous material but also from recycling, are being studied in subsidised projects at the Thüringische Institut für Textil- und Kunststoffforschung (TITK). Since 2002 the institute concentrates on projects regarding the recycling of aramid fibres, as used in protective clothing and helmets, police vests or vehicle armour or concerning dry waste from carbon offcuts. As early as the middle of the last decade, with the recycling method available at the time, the institute served notice of its position as the technology leader in this field of the future. Project manager Dr. Renate Lützkendorf confirms that the automotive industry has been interested in this process for several years. The recycling technologies for a second life

Innovations and internationalisation as success factors

In car building, technical textiles are used, for example, to improve the safety and comfort of the passengers or to reduce the energy consumption of the vehicles. Known examples of technical textiles in the automobile industry include the airbag, seatbelts, seat covers or cabrio roofs; textiles are also processed in car tyres. Moreover, conductive textiles can be used (instead of metal wires) in seat heaters in the car; spacer fabrics can be used in seat coverings and ensure increased thermoregulatory comfort. Carbon fibre-reinforced plastics (CFRP) are often used in aeroplane building because of their low weight yet high strength and low susceptibility to temperature fluctuations. In car making as well, there are plans to use CFRP-based bodies more frequently in the high-volume segment because of these positive product properties (particularly low weight). A weight reduction of 100 kg in a midsize car reduces its fuel consumption by as much as 0.3 litres per 100 km travelled.

Technical textiles make cars lighter, more efficient, safer, and more comfortable

Deutsche Bank Research dated 6th July 2011
### Automotive expertise x 13 (selection)

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<tr>
<th>Primary research field</th>
<th>Focus/Questions</th>
<th>Institutes</th>
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<tbody>
<tr>
<td><strong>NEW MATERIALS</strong></td>
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<td>DTNW, FIBRE, ITA, ITCF, ITM, ITV, STFI, TITK, TITV</td>
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<tr>
<td>Carbon and glass fibre-reinforced plastic (CFRP and GFRP)</td>
<td>Product lifecycle analysis, design, construction</td>
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<td><strong>SMART TEXTILES</strong></td>
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<td><strong>HYBRID COMPOUNDS</strong></td>
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<td>PROCESSING TECHNOLOGY</td>
<td>Joining, separating, production, processing</td>
<td>FIBRE, ITA, ITM, ITV, STFI, TFI, TITK, TITV</td>
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<td>At the moment, almost all lightweight parts are manufactured manually, which is slow and expensive. For high-volume use, cutting to size, handling, performing and consolidation as a composite part must be automated. Fibre composite components are used in load-bearing aircraft parts (e.g. passenger cabin), facing parts, (including mudguards, cabrio roof) or as reinforcement of existing designs (for side impact protection, floor covering reinforcement, crash absorbers in the front area)</td>
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<tr>
<td><strong>MATERIAL SAFETY OF COMPOSITE MATERIALS</strong></td>
<td>Simulation, monitoring, repair, failure</td>
<td>FIBRE, ITA, ITM, ITV, TITK</td>
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<td></td>
<td>In future, component and functional simulations on the computer will become more and more important, as will non-destructive test processes, and long-duration monitoring, integrated as far as possible in the structural part.</td>
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<td><strong>VALUE ADDED CHAIN</strong></td>
<td>Quality Assurance, testing, training, advanced training, innovation management, knowledge management</td>
<td>DITF-MR, FIBRE, FTB, HIT, ITA, ITV, STFI, TITK</td>
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<td></td>
<td>Interdisciplinary teamwork from research to production will become increasingly important. Textile research will work more and more with experts at interfaces to other industries. Preliminary and advanced training must also be adapted accordingly. Knowledge transfer between individuals, teams and from one generation to the next will be particularly important.</td>
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<tr>
<td><strong>RESOURCE EFFICIENCY</strong></td>
<td>Renewable raw materials, Recycling</td>
<td>ITA, ITV, STFI, TFI, TITK, TITV</td>
</tr>
<tr>
<td>Search for alternatives to carbon fibres, because although they are strong they are very expensive and only small quantities are available. Possible alternatives: Aramids, PEEK, natural fibres. Development of efficient recycling technologies for CFRP/GFRP with no residue.</td>
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Forschungskuratorium Textil e. V. cooperates closely with the Gesamtverband Textil und Mode e. V. and is a member of the Arbeitsgemeinschaft industrieller Forschungsvereinigungen Otto von Guericke e. V. (AiF).