Fraunhofer magazine

1/15 special issue

Water – a vital resource

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Efficient manufacturing processes

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Sculpture designed by Hans-Dieter Godolt

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APPLICANT MANAGEMENT

UMSICHT-Förderverein
Osterfelder Straße 3 ▪ 46047 Germany

Office (only in the morning)
Telephone +49 208 8598-1152
wissenschaftspreis@umsicht.fraunhofer.de

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Overcoming challenges together

Prof. Dr. Reimund Neugebauer. © *Axel Griesch*

We all saw the headlines last summer: a record drought in the U.S. Southwest and a water shortage visible even from space. In addition to these news stories, the UN has also published its 2014 World Water Development Report, throwing the spotlight once more with renewed intensity onto that vital resource, water. The reports leave one thing quite clear: shortages of this precious liquid are not restricted to developing and newly industrialized countries; it's a problem for mature economies such as the U.S., too.

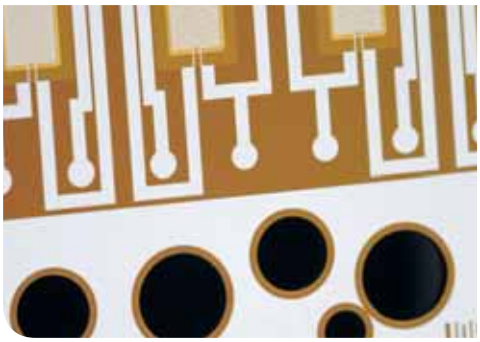
As populations around the world grow in size – and their food and energy requirements with them – the demand for water is set to rise still further. Experts at the UN anticipate that global consumption will rise by more than 50 percent by the year 2050. If we are to keep people supplied with drinking water, food, power and goods, we will need innovative water treatment technologies – which is where the Fraunhofer Water Systems Alliance (SysWasser) comes in. Read our lead article to find out more about the solutions our researchers are working on for both developing and industrialized countries.

The Alliance brings together scientists from various different disciplines. This sort of interdisciplinary teamwork is essential to innovation, since new ideas often arise at the points at which individual disciplines and sectors overlap. Given that the pursuit of discoveries and knowledge is now something conducted on a global scale, it is also important that activities extend across borders. That is why, as early as 1994, Fraunhofer took the decision to take the leap across the Atlantic and found Fraunhofer USA. This fall, Fraunhofer's U.S. subsidiary will celebrate its 20th anniversary. It has always been one of our goals to build on our knowledge and expertise through intensive collaboration with other research institutions of top international standing. We now operate seven centers and two representative offices in the U.S. that collaborate with a number of renowned U.S. universities.

Within Germany, Fraunhofer wants to expand and intensify networking between business and its basic and applied research activities. It also intends to pursue its strategy of national high performance centers, in which hotspots of research excellence are cultivated in collaboration with local universities in order to achieve international standing. The aim is to combine top-quality research with teaching and training opportunities and to create a dense network in which to transfer knowledge and build up business links.

Innovation is the key to overcoming the big challenges of the future – such as the dwindling supply of resources or the issue of population growth. By fostering interdisciplinary collaboration, pursuing scientific excellence, forging partnerships with other research centers of international standing, building networks with basic research and establishing close links with industry, Fraunhofer is taking crucial steps to provide us with the tools we need.

Yours,



Content

Correcting unwanted deformations

When using lasers to cut materials or weld components together, the laser light is focused to a point using various lenses and mirrors. The smaller the focal point and the higher the energy, the more accurately operators can work with the laser. But when the laser power increases, the mirror heats up accordingly, causing it to deform – with the result that the focal point gets bigger and the power diminishes.

Researchers at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena have come up with a solution to this problem by developing a mirror that doesn't prevent deformation by the laser, but corrects it. Working with colleagues from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS and Ilmenau University of Technology, the IOF scientists designed a ceramic mirror with a copper layer on the front and built-in temperature sensors and filaments. When a laser beam heats up the mirror, the sensors detect the change. Software calculates how strongly the mirror is deforming and sends a corresponding current of electrical power through the filaments. On the back of the mirror, the scientists have fitted a piezoelectric layer that can also deform the mirror and correct all further errors that could disrupt the laser beam.

Thermal-piezoelectric deformable mirror designed for use with high-power laser systems. © *Fraunhofer IOF*

What do environmental hormones do?

You cannot see, smell or taste them – and yet environmental hormones are components of many common materials and products. With their hormone-like structure, these molecules also behave like hormones and can be found in such products as dyes, pesticides, cosmetics, plastics and pharmaceuticals.

Environmental hormones are blamed for declining fish populations, among other things. Whether the stocks of fish and amphibians are actually threatened by hormonally active substances in bodies of water has been a point of disagreement among experts for over two decades. Now, studies conducted by the Fraunhofer Institute for Molecular Biology and Applied Ecology IME reflecting the complete life cycle of fish shed new light on this question.

In comprehensive studies, IME researchers have analyzed the life cycle of the zebrafish (Danio rerio), a freshwater fish. Negative effects were observed for many of the hormonally active substances when the animals were exposed to them. For example, aromatase inhibitors, which are employed as a fungicide in plant protection products, led to a masculinization of the fish. Exposing the fish to synthetic estrogens can cause the loss of reproductive capacity.

Flow system: each test basin can house fish in both the adult and larval stage. © *Fraunhofer IME*

Nano-supercapacitors for electric cars

Innovative new nano-supercapacitors can store considerably more energy than today's capacitors. Rapid energy storage devices are distinguished by their energy and power density characteristics – in other words, their energy or power per unit of mass. Although supercapacitors have a high power density, their energy density needs to be optimized. The EU-funded ElectroGraph project (www.electrograph.eu) brought together ten partners from research and industry to develop new supercapacitors that are capable of storing far more energy. ElectroGraph was coordinated by the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart.

Electrodes with larger usable surfaces can store more energy. In numerous tests, the IPA researchers investigated graphene – a nano-material consisting of an ultra-thin monoatomic layer of carbon. Using graphene as an electrode material enabled the researchers to greatly increase the electrode's usable surface area. By arranging the graphene layers so that there is a gap between the individual layers, the team was able to maximize the surface area available for energy storage.

These new electrodes already offer 75 percent more storage capacity than the commercially available electrodes used to date in supercapacitors.

Demonstrating a new kind of graphene electrode developed for use in supercapacitors. © *Fraunhofer IPA*

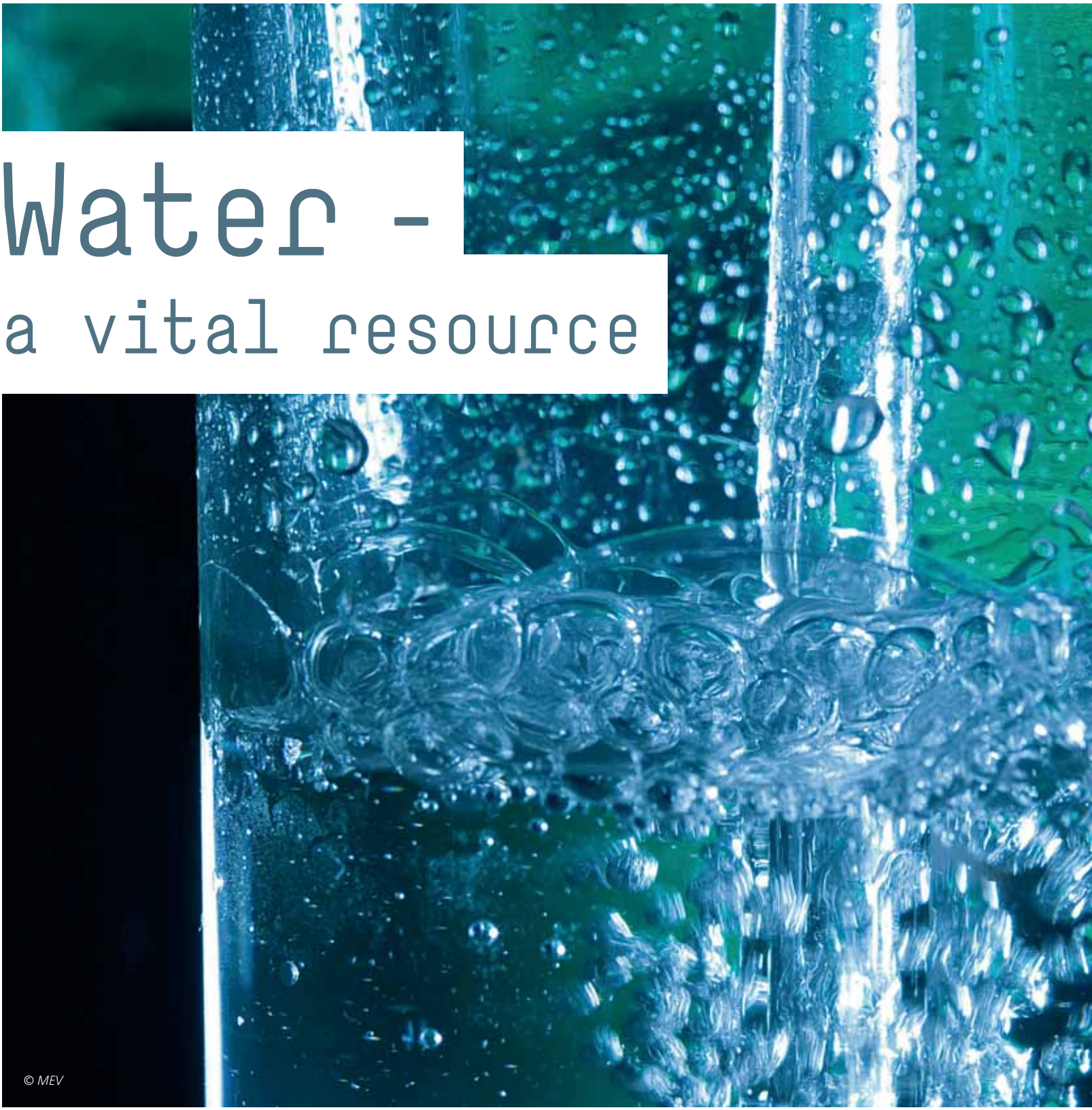
Divining diamonds with X-ray technology

Diamonds are one of the world's most expensive raw materials. But finding them is an arduous business. Researchers at the Development Center for X-Ray Technology EZRT in Fürth, a joint department of the Fraunhofer Institute for Integrated Circuits IIS and the Fraunhofer Institute for Nondestructive Testing IZFP, have developed a demonstrator that can divine diamonds hidden inside volcanic rock.

Based on dual-energy X-rays, the process requires producing two images of the same object using two different X-ray spectra. An algorithm at the EZRT filters out the data relating to the material from both images. The new technology is capable of detecting tiny diamonds inside grains of kimberlite ore that are up to 50 millimeters in size. The demonstrator has already passed initial practical tests in a diamond mine. Together with colleagues from the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB in Karlsruhe, the researchers are now working on a prototype for fully automatic examination of the igneous rocks on a conveyor belt.

Kimberlite ore carries diamonds from the interior of the Earth to the surface. Now a new X-ray technology promises more efficient extraction. © *Fraunhofer IIS*

Water – a vital resource



© MEV

Water is a valuable commodity. It is the basis for all life and an essential factor of any business location. But in many places, this precious resource is in short supply due to climate change and population growth. Fraunhofer is currently working on system solutions and innovative ways to make the water industry sustainable.

Text: Birgit Niesing

Four years ago, the UN General Assembly declared that people have a right to clean drinking water and sanitation. Yet today more than 768 million people worldwide still have insufficient access to clean water, and some 2.5 billion have no sanitary facilities, according to the UN World Water Development Report WWDR.

The precious liquid is a significant economic factor, too. Today, around four-fifths of the world's water is used by agriculture and industry, and demand will continue to grow in the coming decades. UN experts expect that water consumption will rise more than 50 percent by the year 2050, due to escalating demand from industrial production (an increase of 400 percent) and from thermal power generation (an increase of 140 percent). In the future, more and more people will need to be supplied with drinking water, food, goods, and energy. Certainly the changing climate will play a role – the UN's Intergovernmental Panel on Climate Change IPCC forecasts that global warming will lead to more extreme weather conditions, resulting in more floods and droughts. Overcoming these challenges requires innovative water treatment techniques. The Fraunhofer Water Systems Alliance (SysWasser) brings together eleven institutes to develop sustainable solutions. The researchers are working on powerful technologies for water and wastewater treatment for industrialized, emerging and developing countries alike.

Drinking water is one of the most closely monitored commodities in Germany. Despite this, the public water system is not immune to accidents, wear and tear or targeted attacks. That's why water is tested regularly. Until now, the method was to take random samples and test for impurities in the lab – a time-consuming process that doesn't deliver immediate results. Another disadvantage is that the analysis finds only those contaminants that it is looking for.

"Taster" identifies contaminants

With the AquaBioTox broad-spectrum toxicity sensor, hazardous contamination can be caught early. Based on the "taster principle," the online test procedure uses bacterial strains that change their fluorescence if they come into contact with poisonous substances in the water sample. A camera automatically detects the change and the system immediately sets off an alarm. The broad-spectrum toxicity sensor was developed jointly by experts from the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB, and the Berlin waterworks.

Another method is being used at the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg. Researchers there are using molecule spectroscopy to analyze drinking water, employing lasers to examine the optical spectra of the molecules in the water. The key feature of the analyzer is a powerful quantum cascade laser. Located directly at the waterworks, the system continuously tests for dangerous substances.

An extensive network of pipes ensures that clean drinking water reaches our homes. How to protect this extensive infrastructure against potential chemical, biological or radioactive accidents or attacks has been the focus of research by the Fraunhofer Institute for Systems and Innovation Research ISI and the IOSB. Researchers working on the project, entitled "Protecting the supply of drinking water with regard to CBRN scenarios (STATuS)," have summarized their findings in the "Risk Management for Drinking Water Supplies" guidelines.

Pulling water out of the air

Finding sufficient drinking water in rainy Germany is no problem, but many other countries suffer from a severe shortage. This is not expected to change any time soon – by 2050, the OECD anticipates that more than 40 percent of the world's population will live in areas where water is scarce. But even in arid regions with little or no surface water or groundwater, there is often a good amount of water in the air. Together with the University of Stuttgart and small- and medium-sized industry partners, researchers at IGB are working on tapping air moisture as a water source. They employ a combined absorption and desorption technique. First, a highly concentrated salt solution absorbs moisture from the air. This moisture is then desorbed from the now dilute salt solution by a process of vacuum evaporation that re-concentrates the brine. Once the water vapor condenses, it can be used as a source of drinking water.

"By working under a vacuum, we lower the temperature at which water vapor forms. Simple thermal solar collectors provide the necessary power," explains Mike Blicker from the IGB. The concentrated salt solution is then ready to bind more water from the air. "The process is a way to sustainably extract drinking water from the air in localized, self-contained facilities, which is especially important in arid and semi-arid regions where urban sprawl and often poor infrastructure dominate," stresses Blicker. The idea sounds good, but does the process also work outside of the laboratory? It does: in 2013, the researchers built a demonstration plant that delivered water under real conditions. Now the plan is to optimize the plant for continuous operation and work with partners to make it market-ready.

Monitoring pipelines

The Kingdom of Saudi Arabia is increasingly banking on desalination plants to make sure its population has enough water in the future. A vast network of pipes will transport water from the coast to large cities inland. One such project is the SHOAIBA III Water Transmission Project; with five pumping stations, three reservoirs and a 340-kilometer pipeline, water is conveyed from the desalination plants to the cities of Jeddah, Ta'if and Mecca. Scientists in the Advanced System Technology AST branch of the IOSB in Ilmenau, Germany are also at work on the project. Commissioned by ABB, an energy and automation technology company, they are creating a leak detection and simulation system that, in combination with modern process-control technology, will maintain a highly reliable water supply network.

Fraunhofer's HydroDyn software will also be used in the project to simulate pipeline operation. The software's projections make it possible to optimize the coordination between pump operation and filling the reservoirs. The program is directly connected to ABB's process control system and allows for an online comparison of simulated and measured values. This helps detect potential defects in the pipeline infrastructure and minimize water loss.

The Fraunhofer researchers in Ilmenau are also working on a mobile and self sufficient facility for purifying drinking water. The modular system can be adapted to different water qualities. The aim is to create a lightweight system that can be integrated into a standard shipping container. "The system's flexible size means it can produce 100 to 2000 liters of drinking water per hour," says Fraunhofer AST's Buren Scharaw. Solar cells or a wind turbine deliver the required electricity. Once assembled, the system functions autonomously and can be monitored and serviced remotely via mobile or satellite connection. It can withstand temperature extremes from -20 ° to +50 ° Celsius and also works in dust and sand storms.

Treating and reusing wastewater

In many industrialized countries, people are incredibly wasteful in using drinking water. Each person in Germany uses some 120 liters of water a day – only three of them for drinking. One-third of the total is flushed down the toilet. Production and manufacturing also need water, sometimes resulting in heavily polluted wastewater. Moreover, agricultural runoff may carry pesticides and fertilizer residues into the water supply. New technologies make it possible to clean wastewater effectively with the aim of reusing the treated water.

But what can be done if wastewater, and especially industrial process water, contains cleaning agents, pesticides or pharmaceutical residues? Breaking down such persistent substances calls for new solutions. One innovative approach is to form highly reactive hydroxyl radicals from the water molecule itself. "These hydrogen-oxygen compounds have an even higher propensity to react than, say, atoms of oxygen as provided by ozone. That's why they are able to break even very stable hydrocarbon compounds," explained Dipl.-Ing. Siegfried Egner, head of Fraunhofer IGB's Physical Process Technology department. The necessary energy for activating this can be provided photonically by a UV light source,

SHOAIBA PHASE III:
Supplying drinking water
for Saudi Arabia. © *Alstom*

Fraunhofer Water Systems Alliance (SysWasser)

The demand for water will continue to increase over the coming decades, because in the future, more and more people will require food. Industry's need for water will also grow. These challenges can be overcome only with innovative technologies. The Fraunhofer Water Systems Alliance (SysWasser) brings together eleven Fraunhofer Institutes to pool their expertise in researching and developing the entire water cycle. The aim is to create practical applications for transferring sustainable system solutions for water usage, water treatment, water management and the water economy and to devise novel urban water infrastructure concepts. What's more, the researchers are developing powerful process technologies for water and wastewater treatment, including the necessary measurement, control and regulation technology as well as processes for monitoring and renovating water supply and sewerage systems.

The participating institutes are:

- Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
- Fraunhofer Institute for Ceramic Technologies and Systems IKTS
- Fraunhofer Institute for Laser Technology ILT
- Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB/Branch Advanced System Technology AST
- Fraunhofer Institute for Production Systems and Design Technology IPK
- Fraunhofer Institute for Solar Energy Systems ISE
- Fraunhofer Institute for Systems and Innovation Research ISI
- Fraunhofer Institute for Surface Engineering and Thin Films IST
- Fraunhofer Institute for Transportation and Infrastructure Systems IVI
- Fraunhofer Institute for Nondestructive Testing IZFP
- Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT

www.syswasser.de

DEUS 21, the Decentralized Urban Water Infrastructure Systems project, is of particular interest to communities that are not yet connected to central sewage treatment works. © *Fraunhofer*

The flat roofs of many buildings are perfectly suited for growing vegetables. If greenhouses are installed, the building's residual heat and treated wastewater can be used for crops. © *Fraunhofer UMSICHT*

Seepage water samples – what is the most efficient way to remove pollutants and trace substances from heavily contaminated wastewater? © *Fraunhofer IGB*

electrolytically on an inert anode, or by igniting plasma above the water's surface. In collaboration with international industry partners, experts at the IGB have developed a reactor system with a new UV lamp specifically for treating process water. Photons split the water molecules so that they form the hydroxyl radicals. The researchers have already produced the first industrial prototype, which can treat up to 2.5 cubic meters of wastewater per hour.

Hydroxyl radicals can also be generated using diamond-coated electrodes. Specifically, the radicals form an electrolytic cell on a diamond-coated anode. This technology was developed by the Fraunhofer Institute for Surface Engineering and Thin Films IST in Braunschweig. The process is already being used by the rail, aviation and shipping sectors.

Hospital and industrial wastewater can be contaminated with halogenated compounds, pharmaceuticals or cyanide compounds that are difficult to break down biologically. In the Wasserplasmax project, IGB researchers are investigating whether these pollutants can be neutralized using a plasma method. Plasma is an ionized gas that contains shortwave radiation, chemical radicals and other excited particles in addition to ions and electrons. The scientists were able to build on the EU's successful WaterPlasma project in which they managed to reduce cyanide levels using plasma.

Another possibility for treating wastewater involves using microsieves or membrane technologies. To remove micro-pollutants from the water – such as Bisphenol A, which is found in many plastics – researchers at the Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT in Oberhausen are using activated microsieves. The fine metal sieves, with pore sizes between 1 and 20 micrometers, are coated with titanium oxide. When the coating is subjected to UV rays, it produces radicals that remove contaminants. The scientists integrated LEDs to trigger this reaction. Thanks to this functional surface, the sieve works as both a physical and a chemical barrier against dissolved micro-pollutants.

Water for cities

Still another trend has to be factored into planning sustainable water resources management – increasing urbanization. Soon, up to five billion people will be living in cities. In the Morgenstadt: City Insights innovation network, under the direction of the Fraunhofer Institute for Industrial Engineering IAO, many of the Fraunhofer-Gesellschaft's institutes have been visualizing a future for sustainable, livable and versatile cities of tomorrow. Together with partner cities and industry, they are making those visions come true. "Using water as an example, researchers at the ISI and the IGB have shown how tightly interlocked various sectors – security, transportation,

energy, etc. – are, and which aspects have to be considered for a strategic city development plan," says Dr. Ing. Harald Hiessl, spokesman for the Fraunhofer Water Systems Alliance SysWasser. In a project entitled "Integrated Resource Management in Asian Cities: The Urban Nexus," the IGB researchers worked with the German Society for International Cooperation (GIZ) to identify exemplary solutions that were adapted for specific locations.

Providing enough drinking water for increasing numbers of people in large cities is not the only concern, however; water will also be needed to grow food directly in metropolitan areas. As part of the ROOF WATER-FARM project, researchers at the Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT in Oberhausen are developing a system that uses a building's wastewater to supply plants with liquid and nutrients. A preliminary test system being built in Berlin processes water from the shower, bathtub and washing machine (gray water) so that it can be used for watering strawberries, tomatoes, lettuce and so forth. Wastewater from the toilet (black water) will also be reused in the production of fertilizer solutions for hydroculture.

Experts working on the TWIST++ project (Transition of Water InfraSTructure Systems) are investigating how water infrastructure can be adapted to meet future challenges. Under the direction of ISI in Karlsruhe, TWIST++ draws together 15 partners from research institutes, local authorities, waterworks operators, wastewater managers and companies. Together, they are developing integrated technical solutions that intelligently combine wastewater management and water supply. Taking three model regions as a basis, the partners are devising clear approaches for pioneering water infrastructure system solutions. The project is also developing two software tools. One is a planning support system, which will help experts in designing and implementing innovative system solutions. The second tool is a serious computer game aimed at policy makers and stakeholders; it will illustrate the need for sustainable water infrastructure concepts as well as the options.

An affordable and ecological alternative to conventional wastewater cleaning systems has been developed by researchers at the IGB and the ISI. The Decentralized Urban Water Infrastructure Systems project, or DEUS 21 for short, is especially interesting for communities that are not yet connected to central sewage treatment works, or for developing and emerging countries. Domestic wastewater is biologically processed in an anaerobic high-performance membrane system. What sets this system apart is that the bioreactors convert the organic matter into biogas, a mixture of methane and carbon dioxide. "The system can be exported to areas where water is scarce, because it can be specially adapted to the needs of arid and semi-arid regions," explains Professor Dieter Bryniok, managing director of SysWasser.

Generating electricity from hydropower

We need water for more than just drinking, washing, cleaning, manufacturing or agriculture – we also increasingly use it for producing electricity. The International Energy Agency estimates that in 2010, 583 billion cubic meters of water were already being used for this purpose, most of it for cooling thermal power plants. Electricity can of course also be generated directly with hydropower. However, this renewable generation method has one disadvantage: the construction of hydropower plants is usually associated with substantial changes to the environment and landscape.

Despite this drawback, China is banking on hydroelectric power more than any other means to reduce its fossil fuel consumption. One government program involves building more than 1000 small hydropower plants in rural areas by 2015. In HAPPI, a German-Chinese research project, experts from the IOSB and the ISI are developing new approaches for evaluating the sustainability of planning, building and operating small hydropower plants.

Water technology and the global economy

Worldwide, the scientific community and industry are working on new solutions for water treatment. On behalf of the Office of Technology Assessment at the German Bundestag (TAB), ISI has examined this global innovation trend in a study entitled "Requirements for a Sustainable Water Economy." In particular, the researchers have pinpointed the most important challenges and trends facing industrialized and developing countries. In summarizing the results, Dr.-Ing. Thomas Hillenbrand, Coordinator of the Water Management Business Unit at the ISI, says: "The growing demand for water, the decreasing supply in many regions due to climate change, and the enormous decline in water quality make new and better water technologies a necessity."

The study also highlighted the economic aspect. Germany possesses impressive expertise in water technology, which has become an important pillar for foreign trade. However, in recent years, the number of patents and of publications has dropped substantially. Other countries are catching up. This highly attractive market is growing continuously – estimates place the demand for future investment at more than 500 billion euros annually.

Consequently, the advances being made by Fraunhofer Water Systems Alliance SysWasser will not only contribute to a more sustainable water management system, but will also help position companies in the growing market. ■

Together we are strong

Environmental protection and energy efficiency pays off for companies. Switzerland offers a model for successful networks.

Text: Klaus Jacob

Everywhere you go in Germany, there are signs of an energy transition in progress. In the north of the country, wind turbines whirl, while solar panels glitter in the south. But the green energy that these systems generate is just one side of the coin; to make a success of the "Energiewende", as the transition in known, calls for efforts to use energy more efficiently, too – not least because wind power and solar energy drive electricity prices up. At the moment, though, politicians, companies and society at large are still dragging their feet. Industry in particular has been half-hearted in its efforts to make energy savings. Over the past twelve years, the efficiency of industrial facilities has risen by a mere 0.5 percent year on year – a figure that Prof. Dr. Eberhard Jochem from the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe reckons ought to be more than twice as high.

The example of Switzerland

Switzerland has already demonstrated the sort of success a change in attitude can bring about. As early as 1986, several companies in Zurich banded together to form a network in which they could learn from each other. It was an exchange of experience that proved extremely profitable. In Switzerland today, there are over 85 of these networks encompassing some 2000 companies and helping to achieve a significant reduction in energy costs. One of the reasons that the concept was so popular was pressure from the Swiss state: companies that collaborate in a network are exempt from Switzerland's CO_2 levy, which has stood at 50 euros per ton since the beginning of this year. Germany lacks this kind of incentive, since the system governing CO_2 emissions is different: the current price of CO_2 emissions certificates, which are freely traded, is just five euros a ton. Even so, energy-efficiency networks still have the potential to become a successful model in Germany too, since they save companies cash.

Jochem, an energy expert who has worked at the Swiss Federal Institute of Technology (ETH) in Zurich for many years, saw the opportunity and in 2002 started up the first German network in the Hohenlohe region. There are now 60 such efficiency alliances in Germany as well. After providing expert advice for 30 of them over a period of five years, the ISI has now pro-

duced a summary to show that the 366 companies taking part were able to reduce their energy requirements by around 10 percent over the five years. CO_2 emissions were down by around 350,000 tons a year over the same period. On average, each company invested 580,000 euros to achieve annual savings of 180,000 euros in energy costs. In other words, each year the savings made recoup some 30 percent of the outlay, meaning that the investment paid for itself in slightly over three years.

www.30pilot-netzwerke.de

But how exactly does this sort of network work? Together with its project partners, the ISI team has standardized the process for setting up a network and – to safeguard these standards – founded LEEN GmbH, the company for "Learning energy networks." The first step is for the party backing the enterprise – which can be an energy provider, business platform, commune or chamber of industry and commerce – to find around a dozen suitable participants. Participants should have energy bills in excess of half a million euros a year to make the effort of working as part of the network worthwhile. The business sector participants are active in is irrelevant, since almost every company uses compressed air, cooling, steam or hot water, needs lighting and can make use of waste heat. An external moderator takes responsibility for organizing regular meetings, and each network also has access to a certified energy advisor who can draw on tried-and-tested calculation aids. After an initial assessment of production operations, the group agrees on a joint network target for reductions in energy consumption and CO_2 emissions. Over the next three to four years, network meetings are held once a quarter, with each meeting including a visit to a company's premises and an expert presentation to exchange the insights gained.

Most networks continue to operate beyond this time, even if their membership sometimes changes. There are several reasons for their success, the most important of which are the exchange of experience between those responsible for managing energy consumption and the opportunity the network gives all participants to visit each other's operations. Many companies simply don't realize how much money they can save if they tackle their energy consumption. "There is hidden potential in every company," says Lars Greiner from Vigar Deutschland, a manufacturer of rubber compounds. The advice offered also changes attitudes. Until now, when it comes to energy-saving measures, the only thing most companies have considered is the time it will take for an investment to pay off. The expectation has been that the outlay should be recouped within three years at the most, and even within a year in some cases. Most often, this has nothing to do with wise investment decisions. "Given that an air compressor will run for 15 years," says Professor Jochem, "then basing a decision on a three-year period hardly makes sense." Going by a realistic amortization period of four years for an extremely efficient compressor, this equates to an internal rate of return of 25 percent. This absolutely pays off when interest rates for borrowed capital are six or eight percent.

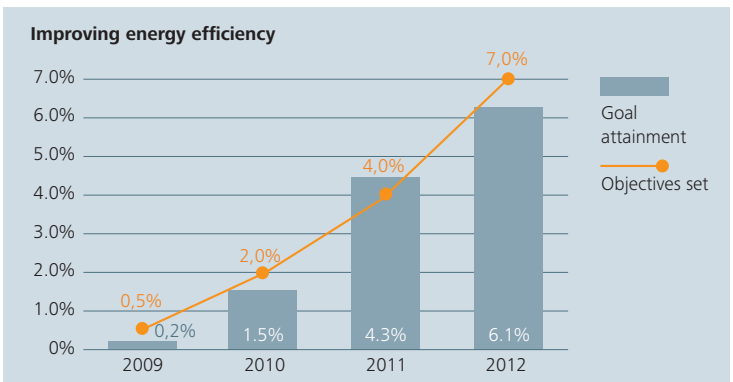
It's not just expert advice that counts; peer pressure also plays a role, giving rise to a kind of contest of ideas that pitches energy management representatives against each other to achieve the best results. Though they generally go unnoticed in companies, they suddenly come to the fore for all the right reasons by delivering savings in energy costs that contribute to the bottom line. Representatives particularly benefit from visits to other companies' operations, as shown by a survey conducted among the representatives in the 30 networks studied, because these visits are a chance for each representative to ask specific questions and get practical answers from the respective energy expert. Of course, it's important to stop confidential data falling into the wrong hands during the collaboration process. This is why competitors that share the same customers are barred from collaborating in the same network. Specific data relating to individual companies – their target energy savings, for example, or the result of their yearly review – remain confidential. The only freely available figures are the group targets, that is to say the sum of all the individual targets.

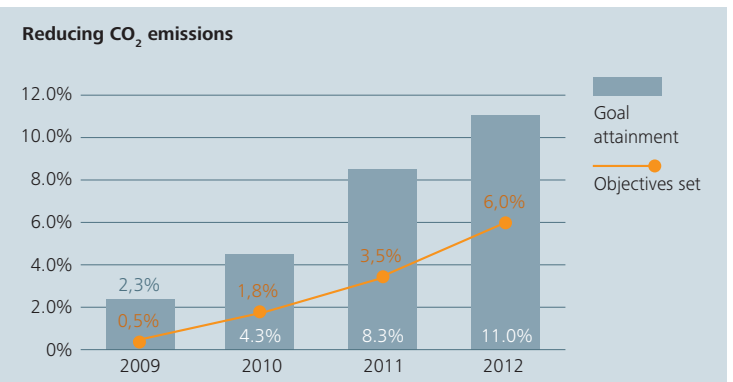
www.leen.de

Around 750 companies currently belong to a LEEN-certified network – but that number could be more than 10,000. Fraunhofer ISI and the Institute for Resource Efficiency and Energy Strategies (IREES) in Karlsruhe have calculated how the future would look if the numbers were to be scaled up. Even just 100 networks, each with 13 participants, would help to avoid 1.3 million tons in annual CO_2 emissions after three to four years. Going by an optimistic assessment, by 2020 the number of networks could rise to a total of 400. This would mean a reduction of some five million tons in emissions of CO_2 per year.

To make the most of the opportunity, we need the support of politicians and industry associations. We also need to raise awareness of the concept since – despite its documented success – many companies are still hardly aware that it exists. ■

Three years after coming into being, the Karlsruhe energy efficiency network has fallen just short of its seven-percent energy efficiency target with an improvement of 6.1 percent. However, it has clearly exceeded its CO_2 emissions target, going five percentage points beyond its six-percent goal. Source © *LEEN GmbH*





A peek into the solar oven

For the ITER international fusion research project, Fraunhofer scientists are working on a sensor capable of withstanding extreme conditions.

Text: Monika Weiner

In theory, solving the energy problems posed by our planet's ever increasing population isn't that hard. All you really need is hydrogen, an element that is abundant throughout the universe. Fusing the nuclei of hydrogen atoms together produces helium – and releases energy. Lots of energy. A single gram of hydrogen contains as much energy as more than eight tons of crude oil. And since this fusion process has been generating light and heat within stars for millions of years, we know that it works.

No surprise, then, that scientists all over the world dream of tapping into this virtually inexhaustible energy source here on Earth. As you might expect, the only way to do it is to create conditions similar to those found in a solar oven – the hydrogen has to be heated to over a hundred million degrees Celsius and then compressed. It takes such extreme temperatures and pressures to overcome the repelling force that normally keeps the positively charged atomic nuclei apart.

Small-scale research reactors have already managed to concentrate hydrogen briefly to the point at which it fuses to form helium. But these efforts failed to have the desired effect – it took more electricity to power the reactors than the reactors themselves produced. The search continues for proof that hydrogen fusion can actually be used to generate power for the grid.

Fusion on Earth: an expensive goal

Hopes for a breakthrough are now pinned on ITER, the International Thermonuclear Experimental Reactor. ITER is a huge project bringing together the expertise of research partners from Europe, Japan, Russia, the USA, China, South Korea and India. Together the partners are investing 5.5 billion euros in ITER, and hundreds of international teams are involved in planning and execution. The reactor is scheduled to go into operation at Cadarache in the south of France early next decade. If all goes according to plan, each ignition of the reactor will be followed by up to 60 minutes of stable fusion.

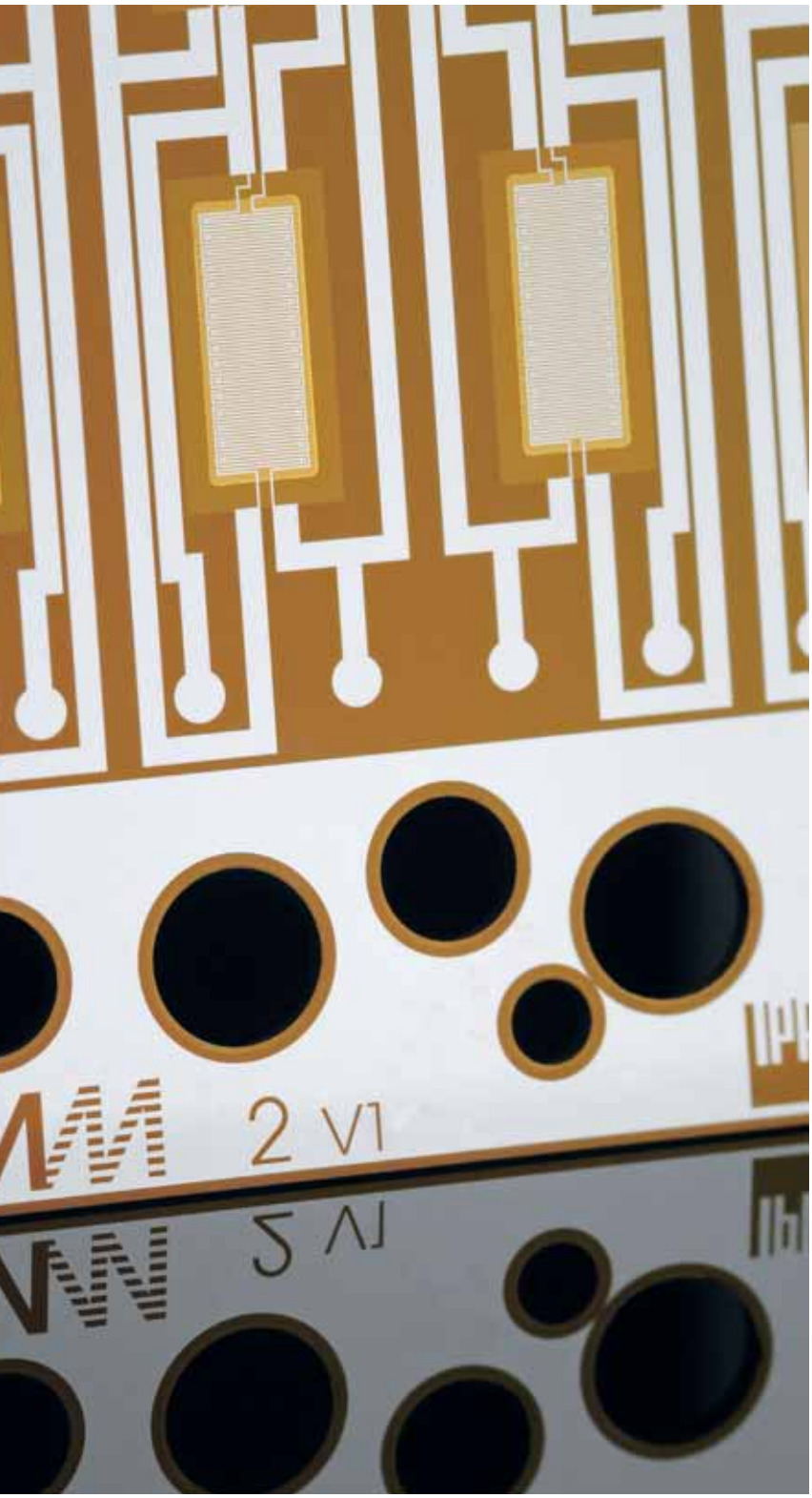
The centerpiece of the reactor is its circular vacuum vessel – which on the blueprints resembles an oversized donut – surrounded by superconducting magnets. Scientists plan to create sun-like conditions inside this donut by using microwave radiation to excite the gas inside the vacuum vessel. This will cause the hydrogen present to discard its electrons and become a plasma composed of positively charged ions, which in turn will be accelerated around the magnetic field loop as if they were cars going round and round a racetrack. The increasing temperatures and pressures will ultimately cause the nuclei to fuse.

Ions on the racetrack

None of this is possible, however, except under precisely the right conditions. "When operating a fusion reactor, plasma confinement has to be monitored and controlled. The conditions inside can be adjusted by varying the strength of the magnetic field, the level of input energy, or the particles themselves," explains Dr. Peter Detemple, a physicist at the Fraunhofer Institute for Chemical Technology ICT-IMM in Mainz, near Frankfurt. "It's particularly important to make sure there's no sudden collapse in plasma confinement. This would cause all the energy stored in the plasma to be transferred almost immediately to the vacuum vessel wall, which would damage the reactor."

On behalf of European ITER partner Fusion for Energy, Detemple's team is working with scientists from the Max Planck Institute of Plasma Physics (IPP) in Garching, near Munich, on a measuring technique for the new reactor. This is no easy task, considering the sensors have to be able to withstand the extreme conditions inside the vacuum vessel – wall temperatures of 450 degrees Celsius and the constant

Prototype of the bolometer chip. © *Fraunhofer ICT*



bombardment of neutrons and X-rays unleashed by the fusion reaction. "There's no doubt about it: these are harsh conditions," says Detemple.

Exceptional conditions call for exceptional technology. Bolometer cameras – developed at the IPP – turned out to be ideal. Each one features an elaborate aperture system that keeps out scattered light and concentrates on a tiny area. "This lets us observe the plasma in a certain direction," reports Detemple. His team is developing the chip that goes inside the bolometer camera to detect the plasma's radiation and convert it into measurement signals. This, too, is by no means easy – the spectrum involved ranges from long-wave infrared to extremely hard X-rays.

Small sensor, huge insight

The prototype is now finished – a small silicon chip, measuring approximately 2.5 by 3 centimeters, with window openings covered with an ultra-thin membrane. On the front of this membrane is an absorber made of platinum, a material capable of resisting the neutron radiation released during fusion. On the back is a precise resistance thermometer.

When radiation strikes, the platinum absorber heats up and the detector on the reverse shows increased resistance. "This allows us to determine the intensity of the radiation the plasma is giving off over a broad spectrum," explains Detemple. "Knowing these values is essential for properly controlling and monitoring fusion reactors." The plan is to install several hundred of these bolometer cameras in ITER. Positioned all around the vacuum vessel, they will determine the plasma's position and intensity distribution.

At research facilities across the world – including Garching, home of the ASDEX Upgrade fusion device – the sensors have already passed the first round of endurance tests. The next challenge is to make the technology more robust, mainly with a view to withstanding ITER's extreme temperatures. "Luckily we can draw on our experience in developing thin film sensors for customers in the medical technology and chemical industry sectors, where sensors also have to work under extreme conditions," says Detemple. But he and his team are now having to push themselves further than they have ever gone: "We've never had to meet higher demands than in the ITER project."

And let's not forget that we're dealing with something really important: this technology is a key piece of the vast research puzzle that is ITER. Hopes are high that the sensors will someday have a hand in solving humanity's energy problems. ■

Learning from friends – 20 years Fraunhofer USA


Frank Treppe.

Frank Treppe was there right from the start: following the founding of Fraunhofer USA in 1994, he was Vice President and Chief Operating Officer for four years. Now, on the occasion of the 20th anniversary of the Fraunhofer subsidiary, he will be taking over the presidency from Prof. Georg Rosenfeld.

The interview was conducted by Monika Weiner.

What was your motivation to take the leap across the pond twenty years ago?

At that time I was Managing Chief Engineer at the Fraunhofer Institute for Production Technology IPT in Aachen. It was the boom years of the automotive industry in the USA. And America was a benchmark of production engineering for Germany. It was home to the Big Three – the major automobile manufacturers General Motors, Ford and Chrysler. What's more there was enormous R&D interest among these technological giants, so the potential market for us as an institute was very attractive.

The proximity to outstanding research institutions with world-famous experts was also enticing. We already had active contact with many professors, in particular with Taylan Altan at Ohio State University. However, we wanted to network even more effectively, so it was necessary for us to be present there. We quickly realized that other institutes had an interest in collaborating with us in the USA, so following a three-year evaluation of the pros and cons, we decided to jointly found a subsidiary company. That was the birth of Fraunhofer USA.

Up to that point, Fraunhofer was purely a German research institution. Was there opposition to founding a foreign branch outside Europe?

Naturally, questions were posed. On the German side, the Ministries for Research and Technology, Commerce and Finance, as well as renownd companies and associations wanted to know why we were going. Some feared that know-how developed with taxpayer funding would flow abroad. The Americans were also skeptical, in particular the pertinent ministries in Washington such as the Department of Commerce and public regulatory authorities downstream such as NIST. They were concerned that we came only in order to siphon off knowledge. The negotiations were drawn out for years. We finally succeeded in dispelling the concerns though and founded Fraunhofer USA – the first foreign subsidiary. Today there are seven – besides the one in the USA, we have subsidiaries in the UK, Sweden, Austria, Portugal and Italy, as well as one in Chile.

Was there already an internationalization strategy at Fraunhofer back then?

At the corporate level, Fraunhofer USA was the beginning. We had no master plan, no model we could follow. However, by that time we already had established the same objectives that all the foreign centers follow: networking with excellent scientific partners and developing new markets for the benefit of German commerce. Back then the idea was called a "win-win situation". Looking back, Fraunhofer USA was the seed of our internationalization strategy.

Under the roof of Fraunhofer USA several Faunhofer Institutes founded institutions in the United States. Were they able to meet the high expectations?

Obviously there were ups and downs. We had a lot to learn. Nevertheless, the story of Fraunhofer USA overall is one of success – and certainly one showing that the flexibility is an advantageous characteristic of Fraunhofer. Of the original five Centers and two Teaching Factories, the Center for Materials Research in Delaware and both Teaching Factories in Florida and Wisconsin were closed because the business models did not meet Fraunhofer standards. Despite this, we simultaneously opened three additional Centers in the USA. In Delaware, for example, the Fraunhofer Institute for Molecular Biology and Applied Ecology IME opened the Center for Molecular Biology CMB which has been very successful. The closures and newly founded Centers demonstrate that Fraunhofer had to find its own place in the New World. We are now no longer a nobody there. Fraunhofer has become a widely recognized brand in the USA, and the Centers that exist today are well-established in the market.

When you look back, are there things you would do differently?

We always learn from experience! In retrospect, it would have perhaps been better to initially concentrate on one site instead of following the German model of creating a decentralized structure. At a time when no one in the USA was familiar with Fraunhofer, we founded half a dozen smaller units separated by long flight times – seedlings spread in the expansive forest of the New World. It was difficult to garner any attention. Yet this is a critical factor for success in the US. People there think in different dimensions than we do. Visability is important. And size matters. We Germans have difficulties with the American approach of „Think big".

What do you want to do to position Fraunhofer even better in the USA?

We will focus our expertise even more effectively in the future. Laser engineering which has been divided between two Centers, the Center for Coatings and Laser Applications CCL and the Center for Laser Technology CLT, will be merged into a single Center for Laser Applications. We also intend to expand on our locations. The Fraunhofer Center for Sustainable Energy Systems CSE building in Boston, Massachusetts, is extremely suitable as a location for showing our achievements, capabilities and services in the USA, for example. We can considerably enhance the presentation of our deliverables and therefore our market opportunities through these kinds of initiatives.

What are your objectives as future President of Fraunhofer USA?

Fraunhofer is a well-established brand in the USA today. The Fraunhofer model is regarded as exemplary. President Obama's Manufacturing Initiative was inspired by European research institutions led by Fraunhofer. If you inquire, you quickly realize though that almost no one knows what Fraunhofer is all about, what we do, and what our achievements are. I intend to improve this. We need to communicate how application-oriented research works in partnership with commerce and science, what can be achieved, and what the benefits are for America and Germany. This is the only way we can position ourselves as valuable partners for industry. At the same time, we should enter into additional strategic partnerships with the best research institutions in the USA while strengthening our existing ones – with universities as well as numerous non-university institutions.

To what extent do German companies profit from this?

Commerce has long been global. Fraunhofer Centers in the USA have enormous know-how with which they can assist European companies if it involves developing the American market or positioning themselves even better there. ■

Happy Anniversary! Fraunhofer USA Inc. at 20.

Fraunhofer USA is celebrating its anniversary: 20 years ago, Germany's Fraunhofer-Gesellschaft, the largest European institution for applied research, established its first subsidiary abroad. Today, the incorporated non-profit organization boasts seven research facilities and two marketing offices in the United States. With a staff of some 180 technical specialists, Fraunhofer USA designs and develops new technologies and commercially viable solutions for customers in the USA and abroad. A network of excellent cooperation partners – including a number of renowned American research universities – ensures a steady supply of fresh ideas and talented young scientists.

The history of Fraunhofer USA is a success story: In 2013, Fraunhofer USA had a turnover of almost 39 millions US Dollar. The Fraunhofer Centers are collaborating with excellent universities such as the University of Maryland, Michigan State University and Boston University. Together, they engineer new production techniques, materials, medical solutions and software tools. They contribute to some of the most challenging nationwide research programs, like the US Department of Energy's "SunShot" Initiative, the DARPA "Accelerated Manufacture of Pharmaceuticals" program, or NASA's "Software Assurance Research Program".

In short, the Fraunhofer Centers follow the model of their German counterparts, positioning themselves at the gateway between university-based exploration and commercially feasible solutions.

The Global Precipitation Measurement GPM satellite is measuring the precipitation in form of snow, rain, or hail.
© *NASA*

A view through the clouds

Automated software testing protects NASA satellite from bugs.

Text: Monika Weiner

Tanegashima Space Center, February 28, 2014. The countdown is running, and in a few seconds the Japanese H-IIA rocket that is supposed to catapult a new satellite into space will blast off. Tense engineers at NASA in Washington, D.C., more than 10,000 kilometers away, are following the event on their monitors. A few hours later, the Global Precipitation Measurement GPM satellite is orbiting. It is the first of its kind that can precisely measure precipitation – regardless of it being snow, rain, or hail – around the clock, around the globe, and at different altitudes above the earth. While meteorologists in the past have had to laboriously evaluate data from weather stations on the ground whenever they wanted to investigate the influence of precipitation on weather and climate, they will soon have access to comprehensive data: the satellite measures precipitation around the globe, from pole to pole, and even through the clouds.

Engineers have prepared for this moment for years, checked systems, and gone through check lists. A specialized measurement technology was developed for the mission: the Global Precipitation Measurement system consists of a multi-channel microwave radiometer that detects microwave radiation being emitted from the Earth's surface and the atmosphere. The amount of water present in the atmosphere in the form of rain and snow can be calculated from these values – but only if everything works as planned, of course. Small mishaps can endanger the entire project. Once a satellite is in orbit – 400 kilometers above the surface of the Earth – to fix a problem is complicated, expensive, and possibly impossible. Dependability therefore, has highest priority, and the software is no exception. "The satellite can only fulfill its mission if the software is working flawlessly in normal as well as in unforeseeable situations," explains Dr. Mikael Lindvall, computer scientist at the Fraunhofer Center for Experimental Software Engineering CESE in Maryland, USA.

Dr. Lindvall, together with Dr. Dharma Ganesan, have developed a new software testing method under a grant from the Office for Safety and Mission Assurance at NASA. The testing methods has been developed in collaboration with the flight software lead Dave McComas who is responsible for NASA's Core Flight Software, a reusable piece of software used in many of NASA's satellites as well as GPM. The testing method works for almost any type of software including satellite software. Lindvall has been working with the space agency for years. The Fraunhofer Center is located on the University of Maryland campus, 16 kilometers northeast of Washington, D.C., not far from NASA's Goddard Space Flight Center. Over the years, Lindvall and his team has gotten to know the people involved in the various NASA projects and regularly meet to discuss how to test NASA's software. Lindvall knows therefore exactly what problems the NASA engineers face: "To avoid malfunctions, every section of the software must be tested – which is often a largely manual job."

Specially trained software testers work through assigned testing protocols that prescribe, for example, how the software must respond to certain situations and commands. All suspicious behaviour found during testing are recorded. They are sent back to the developers, who then look for possible errors – the bugs – and try to weed them out. "Overall, traditional testing is an enormously time-consuming process that becomes more expensive with every new generation of software. The software becomes increasingly large and complex, and therefore there are always an increasing number of things that can go wrong," Lindvall says. "And every time the software developers go back to improve something, new bugs can slip in. Then the testers must test the software again. Altogether, this form of traditional testing takes a lot of time and effort.

Don't give bugs a chance

The computer specialist worked with his team to develop the Fraunhofer Approach for Software Testing (FAST), an automated method based on "model-based testing" that is faster, more effective, and more efficient than previous manual testing methods: "Using FAST, we can generate millions of tests in a matter of seconds instead of manually writing each test case by hand. The advantage is that we can test the software systematically and for conditions a human tester would not have the time to come up with, or even could imagine. Using FAST, we are able to automate many steps of the process and know at the end exactly what we have tested and where the bugs are. In addition, next time the software has changed, we can automatically run all the test cases again, without any effort, to check that no new bugs were inserted."

Every three hours, the Global Precipitation Measurement satellite passes over the ground station at NASA's Tracking and Data Relay Satellite System (TDRSS) in White Sands, New Mexico, USA. The measurement data from the last pass must be retrieved within a few minutes and be passed on to the mission operation center, which is based on another NASA infrastructure called GMSEC. No problem, as long as everything goes as planned. However, the communication between the different components has to be reliable and therefore needs to be systematically tested. However, testing eventuality in advance would have been virtually impossible previously – you would have needed to carry out thousands of tests. With the new model-based testing procedure, the Fraunhofer researchers were able to test critical parts of the flight system as well as the ground system. "The number of users and the number of messages could be randomly varied because the testing as well as the evaluation runs automatically. In addition, we could repeat the tests following every software change that the programers made," explains Lindvall. "NASA was able not just to save time and money, but also achieved enhanced dependability and confidence in their data."

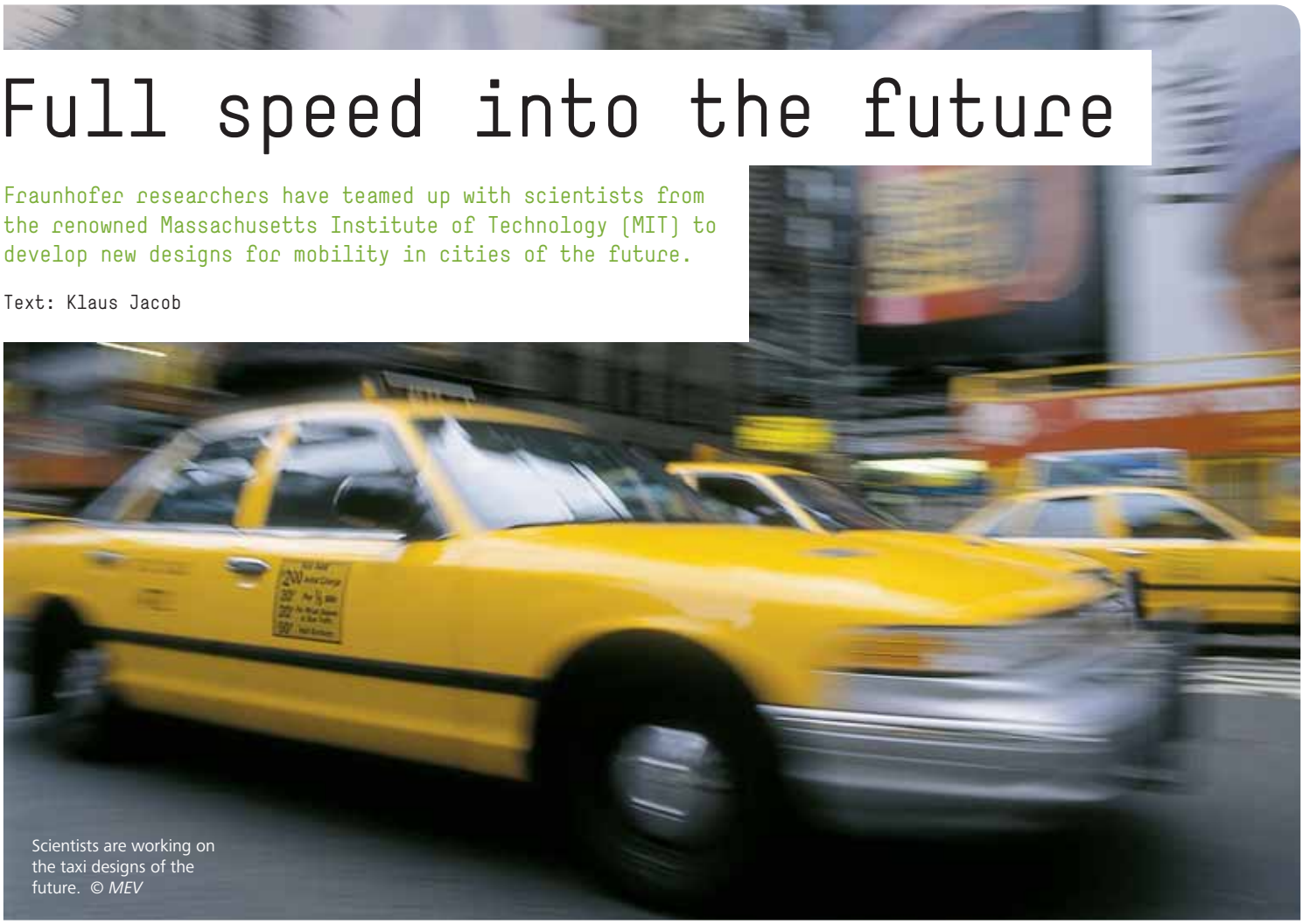
Affordable model-based testing is new. Until now, the technology has been complicated and expensive. It was used almost exclusively by scientists and software testing enthusiasts, while most software developers and testers in industry were deterred from using it – due to the high costs associated with learning and using it. But this may change soon: Lindvall's team has succeeded in simplifying the process and therefore making it economically feasible to adapt for most software projects. The tools, ased on free open-source software, best practices and the software Lindvall's team added, are easy to use. "You only have to understand the systemized approach. Any software tester can learn the basics in 90 minutes," says Lindvall.

The new testing process is not limited to space-based applications. It can be employed for almost any computer program that needs to be dependable, such as software in the automobile industry, medical technology, and telecommunications. "All software development can be enormously improved with FAST," the Fraunhofer researcher is convinced. If programers could test whether their systems really work prior to roll-out, bugs could be avoided that annoy the users, embarrass the software provider, and even cause harm to politicians. The most prominent example: the error-prone webpage "healthcare.gov" that went on-line in the fall of 2013. Millions of Americans tried to sign up for insurance in the first days – and couldn't. It was an embarrassing setback for Obamacare. "If they had tested the software in advance really carefully, this would not have happened," Lindvall sums up. ■

Full speed into the future

Fraunhofer researchers have teamed up with scientists from the renowned Massachusetts Institute of Technology (MIT) to develop new designs for mobility in cities of the future.

Text: Klaus Jacob



Scientists are working on the taxi designs of the future. © *MEV*

Cities everywhere are fighting with the same problems: congested streets, polluted air, noise, and a shortage of parking. New designs for transportation are needed. The Fraunhofer Institute for Industrial Engineering IAO and the Massachusetts Institute of Technology MIT have now established the "Ambient Mobility Lab" for just this purpose. The collaboration is intended to provide ideas that not only improve the quality of life in cities, but also make mobility affordable for everyone. Both MIT and the IAO are world leaders in this field and "complement one another perfectly," says Dr. Anke Hellwig, assistant head of International Business Development at the Fraunhofer-Gesellschaft. While the IAO works more on field applications, collaborating closely with industry, MIT primarily conducts pure research. With their enormous computational capabilities, the Americans are also able to present the results of the research in a very comprehensible form and apply them to new situations.

Research in motion

The topic takes on even greater importance because of fundamental changes in transportation we are seeing. "The automobile as a private possession is continuing to decline in importance, especially among young people," says Jochen Verhasselt, who is in charge of the new lab. Whereas before a fast car was proudly displayed, today someone whips out a smartphone with a mobility app. And while everyone just had to take their drivers' test by age eighteen, today people are taking the test later and later, if at all. Meanwhile, car sharing is increasing in importance. Even the automobile itself is undergoing fundamental changes. Hybrid, electric and fuel-cell powered cars are pushing their way into the market.

"The automobile of the future will be electric, intelligent, lightweight and networked," says Günther Leßnerkraus, Undersecretary in the government of the State of Baden-Württemberg, Germany, which provided 2.65 millions euros in funding for the collaboration. Even now, the automobile is becoming increasingly intelligent and is already practically a computer on wheels. More and more driver systems are electronically

assisted and cut in while driving. Engineers are already playing around with a car that doesn't even need a driver. And social changes accompany these technological changes: the world is becoming more urbanized. Currently, half the population lives in cities and soon it will be two out of three inhabitants of the planet.

Anyone searching for solutions to tomorrow's urban problems must take all of these developments into account. The Ambient Mobility Lab may provide the impetus to prevent the car imposing its tempo on the metropolis any longer, threatening to bury any human quality of life there. No idea is off-limits and unusual ideas are encouraged. "Not everything we develop will hit the streets," says IAO Director Florian Rothfuss. "But we mean to be provocative."

www.ambientmobility.org

The initial projects that have already started demonstrate how the German-American collaboration will operate. For example, the researchers are working on Future Urban Taxi. "Taxis do not always have to be yellow, as they are in New York, or cream-colored like in Germany," says IAO staff member Susanne Schatzinger – meaning more than just color. The cars could be designed entirely differently on the inside compared to conventional limousines of today. For example dividers would allow several passengers going the same way to sit in the same space without disturbing one another. Environmental loading would be considerably reduced by these kinds of communal taxis. MIT investigated 170 million taxi trips in New York over a two-year period and determined that almost half of them could have been more efficient. And as a beneficial side effect, passengers would save money.

Electric mini-bus

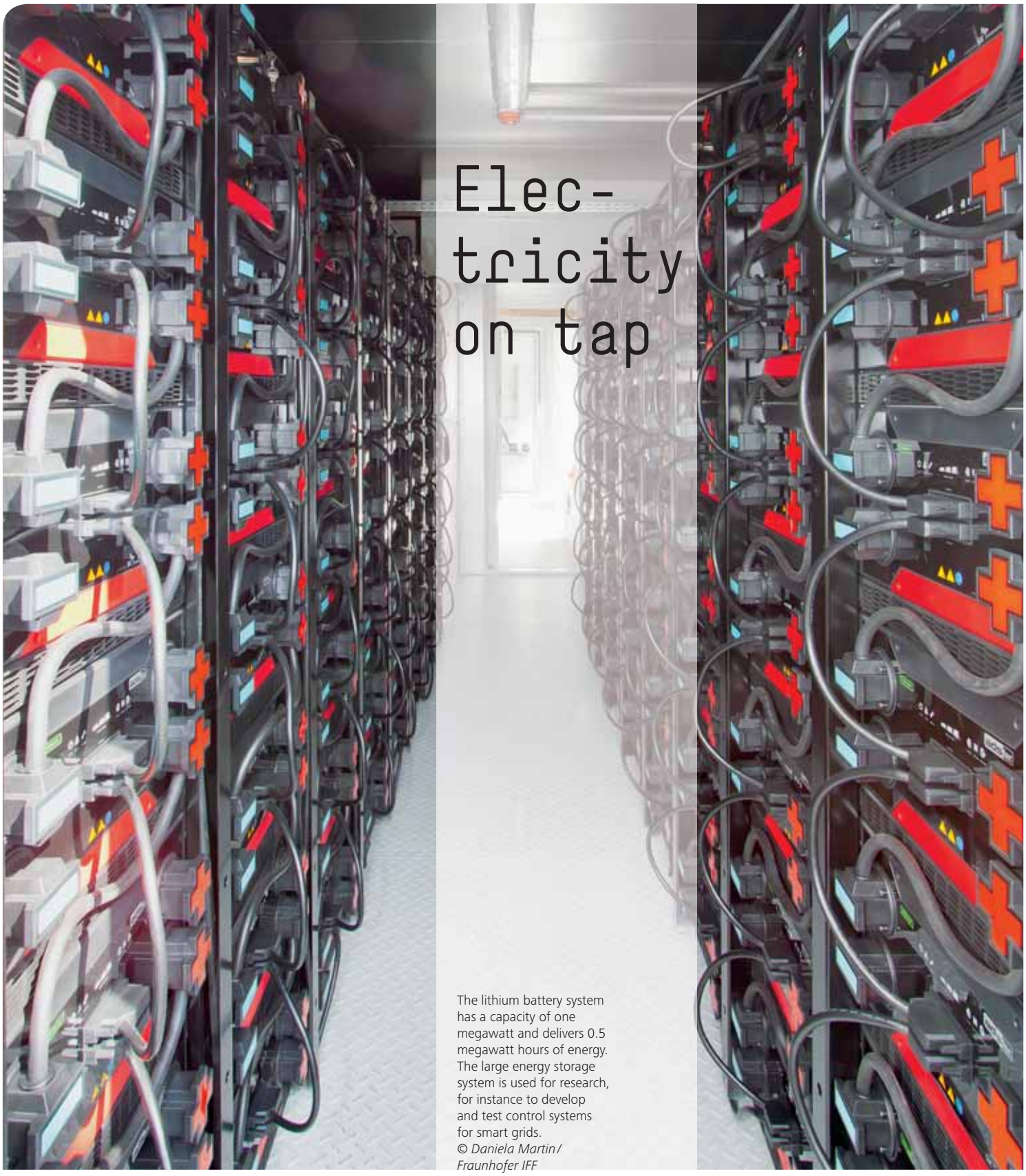
An "eMover" – a mini-bus with an electric power train – could complement the traditional taxi. Called via smartphone, it could chauffeur passengers with larger pieces of luggage. Its preferred area of operation would be near furniture stores, shopping centers and public events, for example.

The traditional automobile will change as well. At the moment corporations construct models for the world marketplace and customers can only select options. By contrast, the German and American partners in the Urban Driven project want to tailor a model for every city. This is because there are considerable topographic and cultural differences from city to city. For example, Naples has a lot of narrow alleys, St. Petersburg often experiences temperatures so low that running on batteries becomes a problem, and there are hordes of bicyclists in Amsterdam. Experts imagine the following solution: the ideal automobile would be built on a standardized platform with the help of different modules – from two-seaters up to eight, from drive-by-wire steering to an autonomous driver. Obviously, these specialized vehicles will not displace all conventional automobiles, but they could be utilized for customized car-sharing plans. It is also conceivable that they could use lanes and routes that are blocked to conventional cars.

The thinking becomes extremely futuristic in the Physical Apps, or "Phapps" project. This term relates to the apps you download to your smartphone. However, phapps are not computer programs matched to an operating system, but instead are tangible objects that dock to a standardized interface. For example, a phapp could be used to customize an electric bike for the given user in no time. A variety of accessories can be attached to the interface – a cooling bag, a smartphone charger, a heated cup holder, or bottle warmer. You can even change the design of the bicycle, in that many popular options could be produced quickly by a 3D printer. The concept of a phapp can be applied to a wide variety of mobility products. And why not equip shared vehicles with various interfaces as well, so that every user gets the specialized auto of their choice?

The Ambient Mobility Lab opened officially on July 9 and is still in its launch phase. Scientists and students will be flying across the Atlantic for several months at a time to collaborate in future. Interested companies such as automobile manufacturers and suppliers will also be brought in. The German-American collaboration holds great promise for national policy development. "The Ambient Mobility Lab is the first step in transforming Stuttgart into an international center for mobility," says Undersecretary Leßnerkraus. ■

Elec-tricity on tap



The lithium battery system has a capacity of one megawatt and delivers 0.5 megawatt hours of energy. The large energy storage system is used for research, for instance to develop and test control systems for smart grids.
© Daniela Martin/ Fraunhofer IFF

Anyone relying on wind and solar power needs to be able to store energy for times when conditions are unfavorable - when it's cloudy or still, for example. Researchers have developed a new battery storage unit that is now manufactured in South Korea.

Text: Andreas Beuthner

Factories require electricity – their conveyor belts have to keep running, sometimes 24 hours a day. Ideally, they get the power they need from renewable energy sources. But wind turbines and solar cells provide enough electricity only under certain weather conditions. Whenever demand outstrips supply, companies are forced to buy electricity from conventional power plants at premium prices. These costs are difficult for companies to calculate.

High-capacity energy storage is a possible solution, as it allows companies to store surplus electricity generated from renewable sources for use when their demand is high and the only power available is expensive electricity from the conventional grid. Companies can reduce costs even further by generating this surplus electricity themselves, for example from plants that convert manufacturing waste into power or from rooftop photovoltaic systems. Energy storage has an important role to play in optimizing grid utilization for the supply infrastructures of tomorrow. But what form should these storage solutions take?

"We're at the beginning of a learning curve," says Dr.-Ing. Przemyslaw Komarnicki, expert for electric power at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg, Germany. Dr. Komarnicki and his team specialize in battery management and the development of storage system subcomponents. For example, they are working to achieve effective communication between the latest large energy storage devices and the power grid. Overall, the objective is to set up the output capacity and control technology of tomorrow's electrical grids in such a way that they can respond flexibly to bottlenecks and power outages, thereby providing a secure energy supply around the clock while still maintaining high grid quality.

Optimizing energy consumption

There are still several hurdles to overcome before this vision becomes a reality. One important step is to analyze and optimize the amount of energy companies require. Researchers at the IFF created the Smart Grid Energy Storage System (SGESS) to enable companies to control their energy consumption according to the actual amount of power they require at any given time. Local large-scale electricity storage is a key part of the system; companies can use it either to draw power as needed or to store electricity bought in from external suppliers. Yet at the moment, no one really knows exactly what capacities and charge characteristics these electricity storage devices need to have if smart grids are to be cost effective and reliable. "We need more insights into models, processes and methods for energy-optimized production planning and control," says Carsten Keichel from ER-WIN®, the Fraunhofer innovation cluster for smart energy and resource-efficient regional value chains in industry.

So what would a consumption-based intelligent power supply system look like? The research team at the IFF is currently developing a smart grid that can store large amounts of electricity in a battery system and is able to adapt to network environments with different power requirements and load profiles. They plan to have a one-megawatt storage system up and running by the end of this year. Containing some 5000 lithium-ion battery cells, the storage system – which is the size of a railroad car – will supply the neighboring IFF Virtual Development and Training Centre VDTC with electricity. The unit is already jacked up into position next to the building.

The battery storage system is manufactured by SK Innovation, a South Korean company and IFF partner. SK Innovation develops energy storage systems based on lithium-ion batteries for vehicles and large-scale applications such as the establishment of smart grids. At full power output, the IFF's large storage system can supply one megawatt of electricity for a period of 30 minutes. Assuming that one house requires three kilowatt hours of power, the unit could supply about 160 homes for 60 minutes in isolated operation without drawing power from the conventional grid. The capacity of the VDTC's battery is limited to 250 kilowatts, delivered within two hours.

The large-scale energy storage system connected to the VDTC is an ideal test environment as the IFF building is already equipped with an intelligent energy management system. At present, IFF reseachers are systematically "feeding" the building's energy storage unit with energy collected from the photovoltaic system on the roof. They also plan to feed in electricity derived from VECTOR, the experimental run-of-river hydropower plant on the Elbe that reseachers are using to study the most effective ways of obtaining electrical energy from natural river currents.

Connection to solar installations

"We did not optimize the battery to suit a specific application," Dr. Komarnicki emphasizes. "Instead, our aim is to take a practical approach in examining a wide range of research topics." One of the ideas on the table is for the transportable storage container to be used by companies and their industry networks. It is possible to connect wind or photovoltaic generators to the battery, as well as rapid charging stations for electric vehicles. Each individual case has its own conditions. For some applications the dominant factor is withdrawal capacity, meaning battery cells have to recharge quickly. In other cases, it might be the compensation of reactive power that is more important, or finding out how to circumvent unnecessary loads in the mains power supply.

To date, the main research priority has always been the cost effective use of large electrical storage systems for businesses. The plan is for private households to also benefit from the findings in the future. "We'll see storage technology being tailored to suit each consumer's own particular field of application", emphasizes IFF project manager Dr.-Ing. Christoph Wenge. One thing is already certain: As more and more electricity is fed into the power grid from renewable energy sources, efficient energy storage is set to become a crucial component in smart grids of the future. ■

A lightweight future

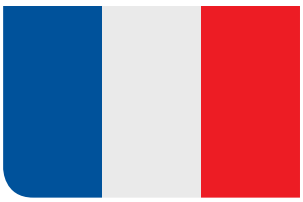
The less something weighs, the less energy it consumes. At a time when resources are becoming increasingly scarce, the demand in the automotive, ship and aircraft construction industries for feather-light yet stable fiber composite materials is greater than ever before. Whoever possesses the best and most cost-effective production techniques for manufacturing these new materials stands to do best in world markets. But developing and making new fiber composite materials also calls for interdisciplinary thinking, since lightweight components must meet the same safety standards as traditional body parts while being recyclable and as cheap as possible to produce.

Now German and French researchers want to work together to develop technologies that will boost the competitiveness of European industry. On March 12, Andreas Büter, spokesperson for the Fraunhofer Lightweight Design Alliance, and Gérald Lignon, President of the Jules Verne Technological Research Institute in Nantes, signed a memorandum of understanding. The research center in the university town of Nantes counts Airbus and Renault among its partners, along with numerous other suppliers and manufacturers from the automotive, ship, aviation and wind energy sectors. In a series of research projects, the Fraunhofer Institutes intend to work with their colleagues in Nantes on new techniques for the laser processing, joining, handling and surface treatment of lightweight components.

Renewables

In the wake of the reactor accident in Fukushima, there has been a sharp uptick in interest in renewables in Japan, and in April a new research center, the Fukushima Renewable Energy Institute, opened its doors. Researchers at the center will be working in close collaboration with scientists and engineers at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg after a memorandum of understanding was signed in February.

"Applied research is key to companies' technological development, especially when it comes to renewables, and will reestablish industrial competitiveness in the region," stressed Fumio Murata, vice governor of the Fukushima prefecture. Prof. Eicke Weber, director of the ISE, explained that solar energy is one of the pillars that will ensure a sustainable and carbon-free supply of energy in the future: "That's why researchers need to collaborate internationally and why we are happy that we are now able to intensify our collaboration with Japan."



Mini diesel

How far can you shrink a diesel engine? This is the question that Fraunhofer researchers set out to investigate along with scientists from the Paris Carnot Institute ipf energies nouvelles. "The call in the market is for small, extremely fuel-efficient engines that burn less fuel than traditional designs yet offer the same performance," explains Björn Haffke from the Fraunhofer Institute for Structural Durability and System Reliability LBF in Darmstadt. "While there are a whole array of mature gasoline hybrid models offering low fuel consumption, until now there have been very few hybrid vehicles featuring diesel engines – which is a pity, as these are particularly efficient."

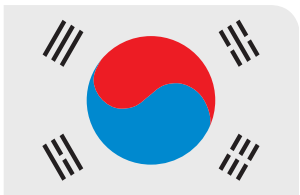
By using a refined simulation technique, the Franco-German research team demonstrated that diesel engines can be miniaturized, too. The experts from Darmstadt supplied the mathematical model, while researchers in Paris provided the software that calculates fuel consumption and pollutant emissions.

Findings showed that diesel engines can be made much more compact by using two cylinders instead of four. But making the engine smaller does cause changes in vibration behavior that must be compensated – for instance by connecting a hybrid motor that generates the necessary counter-vibrations. Reduction in size also comes at a price – a price that increases the smaller you want the engine to be, explains Haffke: "In this project, we went to the limits of what is technically possible. This allowed us to show the point at which a further reduction in size is no longer economically viable."

Web access for all

Savannah, lakes and a landscape that stretches as far as the eye can see – it's easy to see why the expanses of Tanzania make for an unforgettable tourist experience. Those who live there, however, know that there are also downsides, with internet access problematic in many areas. "Laying fiber optic cables is too costly, particularly in rural areas, while the distances involved are too great for copper cables. Nor are there any existing mobile networks fit for the purpose," explains Eric Schütz from the Fraunhofer Institute for Open Communication Systems FOKUS.

Schütz and his team are now building up a network along Lake Victoria that will provide remote hospitals, schools and administrative centers with access to the World Wide Web. The central controller for the network is located in the town of Bunda, from where data can be transmitted quickly, cheaply and securely to the surrounding region via radio link. All that is required are WiBACK nodes; these can be placed up to 20 kilometers apart as long as there is a line of sight between them. WiBACK stands for Wireless Backhaul, a decentralized and wireless relay system that can serve huge areas, since each node in the network can act as a hub for a regional WLAN network or be used to establish further connections.



Printed production

South Korea is currently investing in R&D for printed electronics. Two foreign partners are involved in this initiative – Finnish research organization VTT and Fraunhofer Institute for Electronic Nano Systems ENAS located in Chemnitz, Germany. The contract governing this collaboration over the next four years was recently signed in Korea.

ENAS's Printed Functionalities department will work with engineers from Korean company HICEL Co. Ltd. to optimize the manufacturing process for flexible printed circuit boards with the help of printing technologies. As well as being cheaper than the conventional production process, the new method also opens up new technological avenues. In contrast to the rigid circuit boards of the past that had to be built into solid housings, these printed, flexible electronics components allow for a wide range of novel designs.

Innovation institutes

Brazil is booming. It has long ranked among the top ten biggest economies, and it is increasingly pulling its weight in science and research, too. There are plans to create 23 innovation institutes in coming years that will act as centers for applied research and train specialist staff. The first wave of institutes will specialize in automation technology, electrochemistry, renewables, surface technology and virtual product development.

Researchers from the Fraunhofer Institute for Production Systems and Design Technology IPK will be providing setup support, and a cooperation agreement was recently signed between Fraunhofer and Brazil's National Service for Industrial Training (SENAI for short).

The Fraunhofer experts are currently in the process of developing business plans for the new innovation institutes. Five further Fraunhofer Institutes will then also contribute their expertise on the setup of the new institutes at a later stage.

Targeted treatment

Ideally, medicines should help patients as efficiently as possible without causing any side effects. It is this goal that drives pharmacologists around the world to constantly look for new active ingredients and ways to administer medication.

The research work involved is laborious, but can be speeded up if scientists manage to optimize the action of promising substances early on during the development phase.

Achieving this goal calls for interdisciplinary approaches. Research scientists at the Fraunhofer Institutes for Interfacial Engineering and Biotechnology IGB and for Applied Polymer Research IAP are working in close collaboration with one of the world's leading pharmacological research institutions, the Hebrew University of Jerusalem's Institute for Drug Research. In this collaborative project, the specialists in Israel are investigating new ways to administer medication – for instance an anticancer medication that, instead of being injected intravenously, can now be swallowed in pill form and then finds its own way to the diseased cell. Meanwhile, Fraunhofer scientists are testing the effectiveness of the new medications on cell models.

Smart cities

More and more people are moving to the cities – and this expansion presents administrations with almost insurmountable challenges. Ensuring everyone has access to water and power is a herculean task in itself, only compounded by growing demand on sewer, telephone and road networks.

Digital technologies can help them find quick, efficient and sustainable solutions. Now researchers at the German Fraunhofer Institute for Open Communication Systems FOKUS in Berlin are developing smart city concepts for Indonesia in collaboration with PT Telkom Indonesia and its affiliated enterprise Telkom University. A cooperation agreement was recently signed by the partners.

The Fraunhofer Institute's Next Generation Network Infrastructures NGNI competence center has been working closely with Telkom Indonesia for a decade now. Their new research findings will benefit companies, public bodies, city dwellers and tourists.

Automated assembly of aircraft wings

Even today, aircraft wings are still assembled manually; but this process could soon be automated thanks to a novel snake-like robot that is being developed in an EU project.

Text: Britta Widmann

Like a snake the robot can rotate in order to reach the furthest extremities of the wingbox cavities. © *Fraunhofer IWU*

The volume of air traffic has soared in the past few decades, and aircraft manufacturer Airbus expects to see this figure triple by 2030. On a single day, more than 1,300 take-offs and landings are handled by the flight tower at Frankfurt's international airport. This represents no less than 155,000 passengers who pass through this airport each day. To provide sufficient planes to cover this need for air transportation capacity, aircraft manufacturers will have to modernize their production processes.

Until now, aircraft assembly has involved a high proportion of manual processes, which limits production output. These processes must be automated to increase the rate of production.

In certain cases this can be achieved easily, but wing assembly remains a major challenge. Why is this so? The main reason lies in the complicated internal structure of the wings, which consist of a series of hollow chambers. The only access to this space is through narrow hatches with a length of 45 centimeters and a width of 25 centimeters; this makes it extremely difficult for assembly workers to climb through these openings in order to fit the bolts that hold the parts together and seal the joints. This drilling and sealing operation has to be repeated around 3,000 times for each wingbox. This is time-consuming work that demands intensive physical effort that quickly leads to fatigue, not to mention the health risks resulting from the volatile organic compounds released by the sealing materials.

Multi-jointed robot system for use in narrow spaces

Conventional industrial robots are too inflexible to pass through narrow openings. Their rigid arms are not capable of reaching the outermost regions of a workspace that extends up to five meters in length. What is needed is a slim robot with articulated arms. Researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz are currently working on an automation solution based on articulated robot arms. "The robot is equipped with articulated arms consisting of eight series-connected elements which allow them to be rotated or inclined within a very narrow radius in order to reach the furthest extremities of the wingbox cavities. That's why we often refer to the system as a snake robot," says IWU project manager Marco Breitfeld.

The tool is attached to the first in the series of eight limbs, or can be replaced by an inspection camera if required. In total, the robot arm measures 2.5 meters in length and is capable of supporting tools weighing up to 15 kilograms in addition to its own weight.

The kinematics used to drive the robot are based on a sophisticated mechanism including an innovative gear system for which a patent application has been filed. Conventional motors are not an option for the individual sections of the robot arm, due to their compact design. Breitfeld's team has therefore integrated a very small motor in each of the eight sections of the robot arm, which together are capable of generating a very high torque of up to 500 Newton-meters. Used in conjunction with a cable-and-spindle drive system, each section of the robot arm can be moved independently and turned through an angle of up to 90 degrees. "The drive concept allows this solution to be used in any situation requiring the application of high forces and torque within a limited space," Breitfeld says. "There is a need for compact automation solutions of this type in aircraft manufacturing, automobile construction, and power plant design."

The next stage in the project involves installing the 60-kilogram robot on a mobile platform or rails, allowing it to travel along the length of the wingbox and penetrate each chamber. The mobile robot platform developed by the Fraunhofer Institute for Factory Operation and Automation IFF as part of the EU-funded VALERI project would be a suitable option. At present, the IWU researchers are testing the mechanical design and control functions. A demonstration model of the robot has already been presented. Now the full version of the system equipped with an eight-part articulated robotic arm is created. ■

Cultural journey through time and space

Climate change is endangering centuries-old murals and frescos, paintings, furniture and textiles. Can this deterioration be halted? Researchers are searching for solutions in the "Climate for Culture" EU project.

Text: Monika Weiner

Research can be heavy going – especially when the object of study is 1,868 meters up. The hike to the royal alpine lodge on Schachen takes three hours. Ralf Kilian would be able to find the way in his sleep. He has been marching up it regularly – originally to attach sensors, later to read their measurements. What an atmosphere for climatology: a fairy tale castle from 1001 Arabian Nights. Ludwig II, King of Bavaria, had the building constructed at the end of the 19th century for extravagant oriental parties. The upper floor of the wooden house is festooned with tinted glass windows, Persian carpets, golden chandeliers, fans of ostrich plumes and even a fountain.

Kilian and his colleagues from the Fraunhofer Institute for Building Physics IBP in Holzkirchen, Germany, have been using more than a dozen sensors to measure the relative humidity and temperature in the Turkish Room of the royal abode over the years. Highly sensitive glass sensors – developed by the Fraunhofer Institute for Silicate Research ISC in Würzburg – in addition detect atmospheric pollutants and microorganisms. In order to be able to compare measurements in the interior against the external conditions, a weather station was constructed in the garden that regularly transmits information about wind, sunshine, precipitation and temperature. "With the help of these data, we can precisely document and evaluate changes to the interior conditions over the course of the year," reports the researcher.

The surprising outcome: despite the rough conditions high up in the Wetterstein Mountains, the relative humidity in Schachenhaus remains stabile most of the time at 40-70% – within the range considered acceptable for museums and collections. The murals, carpets and furniture are actually quite well preserved. Lucky thing. Other historic buildings like Linderhof Castle that the researchers have also investigated are in much worse shape. The plaster is crumbling, and paint and gilding are becoming detached from the underlying surface. The cause of this is the drastically increased humidity resulting from the breath and perspiration of thousands of visitors. The measurements taken in the royal Bavarian castles are small but important pieces of the puzzle for the EU's Climate for Culture project. 27 teams from 14 countries in the EU as well as Egypt have examined more than 100 cultural monuments – including Skokloster Castle in Sweden, a Slovenian fort in Brežice, an English manor house in Knole, a private Venetian villa and a Norwegian wooden-pillared church in Garmo. Florian Antretter from the Fraunhofer Institute used specialized software named WUFI®Plus to create simulations of the interior climate based ofnthe measurement data at these various locations. The results document how different climatic conditions affect the state of buildings and art objects throughout Europe.

The royal lodge on Schachen.
© *Sebastian Grünwald*

Combating harmful substances in museums together

What kind of environmental loads are art objects in museums exposed to? How do you create an interior climate that prevents damage? How can artistic treasures that have already been attacked be cleaned? Experts from the Forschungsallianz Kulturerbe (a cultural heritage research alliance of Fraunhofer, Leibniz institutions and the Prussian Foundation of Cultural Property) presented their findings at the Symposium on Air Pollution in Museums that took place not long ago in Dresden.

Experts from twenty-four Fraunhofer Institutes, the research museums of the Leibniz Association, as well as institutions from the Stiftung Preußischer Kulturbesitz have been working together in the interdisciplinary alliance since 2008. The objective is to recognize hazards to which unique manuscripts, paintings, and sculptures preserved in museums are exposed early on and to develop preventative strategies and methods of restoration. This should incorporate knowledge from both the natural sciences and humanities.

In future, the Staatlichen Kunstsammlungen Dresden (state art collections of Dresden) and the Sächsische Landesbibliothek – Staats- and Universitätsbibliothek Dresden (Saxony state libraries in Dresden) will be collaborating with the Forschungsallianz Kulturerbe. A corresponding Memorandum of Understanding has been signed by Fraunhofer President Reimund Neugebauer.

www.forschungsallianz-kulturerbe.de

With the help of the enormous database that resulted, the researchers are now able to peer into the future. The goal of the Climate for Culture project is to predict what effects climate change will have on cultural treasures. The concentration of carbon dioxide in the atmosphere has been climbing ever since the beginning of the industrial revolution due to the combustion of fossil fuels. The models developed by climatologists demonstrate that these greenhouse gases produce extreme weather, a rise in sea level and a shifting of climatic zones. The initial changes are already being observed – an indication that the simulations are valid – and are expected to intensify in future. However, climate change can have quite different effects regionally. The models developed by researchers at the Max Planck Institute for Meteorology in Hamburg demonstrate that it will become hotter and dryer in the Mediterranean region, but considerably wetter in northern Europe, especially between the North Sea and the Baltic above 55th degree latitude. Risk maps of Europe worked out by the international interdisciplinary research team show what these prognoses mean in detail, down to a resolution of 10 km x 10 km. Detailed climate predictions of hourly temperature and humidity up to the year 2100 can be called up for every one of the more than five hundred grid points.

Coupled with the indoor climate simulations of the WUFI software, the consequences of climate change can be predicted in detail. “The combined model provides us with prognoses about what temperature and humidity values will predominate within the interior of an historic building at a particular place,” explains Prof. Klaus-Peter Sedlbauer, head of IBP. “If the climate models for southern England predict a three-degree rise in average temperature and an increase in humidity of ten percent, then

Linderhof Castle.
© *MEV*

the software sends a warning of a heightened risk of mold based on the data gathered in the project, for example. In southern Europe, where conditions will become dryer, there is instead a threat of damage from objects drying out."

www.climateforculture.eu

The model even permits travel through time and space. With the click of a mouse, the scientists can catapult the Church of St. Margaretha in the Bavarian village Roggersdorf today into the year 2050 and move it to Provence or to a Norwegian fjord. The simulation program promptly provides values for temperature and humidity in the interior resulting from this displacement in time and space. The type of construction is also taken into account. The church, with its thick walls and small windows, creates a different interior climate than a building that is flooded with light such as Schönbrunn castle. All of the information resulting from these virtual journeys has been collected by the researchers into a database. It will be available online in late 2014. "Owners of castles and administrators of museums and collections can enter their location as well as select the characteristics of their buildings, then receive predictions about what climate changes are expected up to the year 2100 and what consequences these will have, all without charge," explains Dr. Johanna Leissner, coordinator of the EU project. At the same time, the database provides recommendations about how art objects can be protected from deteriorating, and how much it would cost if increased heating or cooling is necessary.

These results are especially useful for those considering renovations, emphasizes Leissner: "If costly steps are going to be taken, then the interior conditions should be stabilized to preclude further damage." The administration responsible for state castles, gardens and lakes in Bavaria already intends to use the results of the project for renovations planned in Linderhof.

At the royal lodge on Schachen, everything will remain as it is. The Turkish room will remain in pristine condition. The double-walled construction of the wooden structure and its seclusion have a positive effect on the interior climate. The influence on the interior climate from the large numbers of visitors in Neuschwanstein is not present on Schachen – the trade-off of the climb is not worth it for everyone. ■

Medical care during disasters

When large-scale emergencies occur, it often takes far too long for victims to receive the care their injuries demand. As part of an EU project a new electronic system has been designed to support helpers during the initial assessment of victims and to speed up patient care.

Text: Britta Widmann

When a major disaster occurs, every second counts. During instances such as natural disasters, terrorist attacks, accidents in chemical plants, or train crashes, many human lives depend on how well the rescue services are coordinated. The better relief forces communicate with each other, the more victims they can rescue. The swifter the initial assessment of those affected by the disaster, the faster they can be evacuated and taken to the right treatment centers. At present, this initial assessment – or "triage" as the professionals call it – is carried out using colored paper tags which first responders attach to victims. The color coding (green, yellow, red and black) indicates the severity of the injury and the treatment priority. Pulse and respiratory rate are noted on the tags by hand.

Better first response medical care, optimized emergency management and a more effective operation of rescue forces in response to large-scale accidents are the goals that the EU's BRIDGE project is trying to promote (www.bridgeproject.eu). The EU is funding the project to the tune of 13 million euros, and the Fraunhofer Institute for Applied Information Technology FIT in the German city of Sankt Augustin is responsible for its overall technical coordination. With eTriage, FIT researchers are developing a system to replace the paper tags. The system will locate casualties and transmit their vital signs such as pulse, respiratory rate and blood oxygen to emergency response control centers in real time.

Emergency management with GPS and RFID

eTriage consists of several elements. Instead of using paper tags, first responders put color-coded armbands made of light, bendy plastic on casualties. These triage bracelets are the cornerstone of the system and comprise a GPS sensor, an RFID chip and a network component for communication with the data network. Unharmed people receive only a bracelet with GPS sensor, whereas unstable and severely injured victims have sensors attached to their bodies that transmit vital signs to the emergency response control center. The bracelet functions as an interface and network node. The data can be transmitted via a ZigBee – a slow but far-ranging radio network – but also via WLAN or the cellular network.

"This is a big advantage, because communication is often the first thing that breaks down during a disaster. We use the other networks when they're available, but when they're not, we simply build our independent, fully functioning ZigBee network. The required infrastructure is already there in the bracelet. It works automatically – there's no extra work involved," explains Erion Elmasllari, a scientist at FIT. Triage relays attached to first responders' belts additionally function as caches, data backup and data transmitters should the ZigBee network ever collapse.

Data transmitted by triage bracelet is displayed on a tablet PC or smartphone. A map view and an augmented reality view give first responders and coordinators a quick overview of the situation on the ground. They receive all the information available about the location of victims, their state of health, degree of injury and physical signs. Rescuers see at a glance where the majority of severely injured casualties are located. They can decide immediately which hospitals victims should be taken to, whether on-site care is sufficient or whether helicopters should be requested. ■

Researchers were able to test the system's reliability in a live situation during a five-hour major disaster exercise – a simulated terrorist attack on a ferry terminal in Stavanger in Norway. © *dpa*

High-tech viniculture

People have been cultivating and pressing wine for millennia, but even the oldest of traditions can be improved. Using sophisticated technology, researchers have developed a way of preserving wine that uses far less sulfur.

Text: Tim Schröder

Europe is steeped in wine tradition. For thousands of years, regions all across the continent have been producing wines – from the earthy, rich notes of France's Bordeaux to the zingy Rieslings of Rhenish Hesse and the fruity Trollinger of Baden-Württemberg. Although the growing of vines and the pressing of wines is a long-practiced art, there is still room to optimize how wine is made. Fraunhofer is currently involved in several collaborative projects that demonstrate just how this could be done.

For instance, experts are looking to find an alternative to sulfur compounds as a preservative. Adding sulfur not only prevents yeast and mold fungi from growing and spoiling the wine, but also protects the wine's natural coloring and aromas from oxidation. Still, drinking wine that has sulfites dissolved in it can trigger allergic reactions. And across Europe, the cap on permissible sulfur levels has been lowered. But there is still no viable alternative. The EU-funded PreserveWine-Demo project brings together an international consortium to work on an alternative physical method that preserves wine using far less sulfur.

This method is based on the process of cold pasteurization, which was first developed by Dresden-based company Edecto for preserving fruit juice. Researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart have adapted the system to preserve wine and built an initial, small-scale demonstrator on their premises.

Pressure change kills bacteria

Ana Lucía Vásquez-Caicedo and her team at the IGB redesigned the original single-chamber system from Dresden, turning it into a flow device that can process wine continuously. This means that vast amounts can be processed in a short space of time – a must for any commercial application. In the IGB's system, the wine is mixed with a chemically inert gas such as nitrogen or argon before being subjected to a pressure of 500 bar – around 200 times the pressure of the average car tire. Under these conditions, much of the gas dissolves in the wine and also infiltrates any bacteria and yeasts. In the next step, the pressure drops abruptly with the result that the gas expands out, rupturing and inactivating the microorganisms. This plunge in pressure also bursts open the protein structures of oxidizing enzymes.

"Initial tests and tastings by wine experts in France concluded that wines processed this way don't lose their aromas and colorings," says Salima Varona, a member of Vásquez-Caicedo's team. Now that the demonstrator has been successfully tested at a flow volume of two liters a minute, construction work is starting on two large-scale prototypes that will be able to process ten to twenty liters of wine a minute. "The

Applying the latest research to the wine industry. © *panthermedia*

demonstrator phase showed us where the system needs to be improved and we'll factor in these changes when building the prototypes," says Varona. These are expected to enter trial operation at wineries in France in the coming year.

Using algae to inhibit fungal growth

A second IGB research group is working on developing another alternative technique for winemakers as part of another EU-funded project – ProEcoWine. This project's eight cooperation partners are trying to find a substitute for the copper solutions that have for decades been used as a form of fungicide to protect vines. Copper ions in the solutions kill off mildew fungus and other pathogenic agents that would otherwise attack the vines and ruin the harvest. But the copper can also kill off the microorganisms found in the soil and drive out earthworms. Over time the soil degrades and winemakers are forced to use more fertilizer.

ProEcoWine's solution is to use algae that produce antifungal substances – and researchers at the University of West Hungary know just which algae are suitable, thanks to the large algae database they have built up over decades. Ulrike Schmid-Staiger, Daniel Frank and the rest of their IGB team have the job of developing a technique to produce these algae on a large scale. To do this, the team is using the flat panel airlift (FPA) reactors that the IGB already has in operation. These feature a clever air current transportation system that makes it possible to grow algae cultures with high cell density.

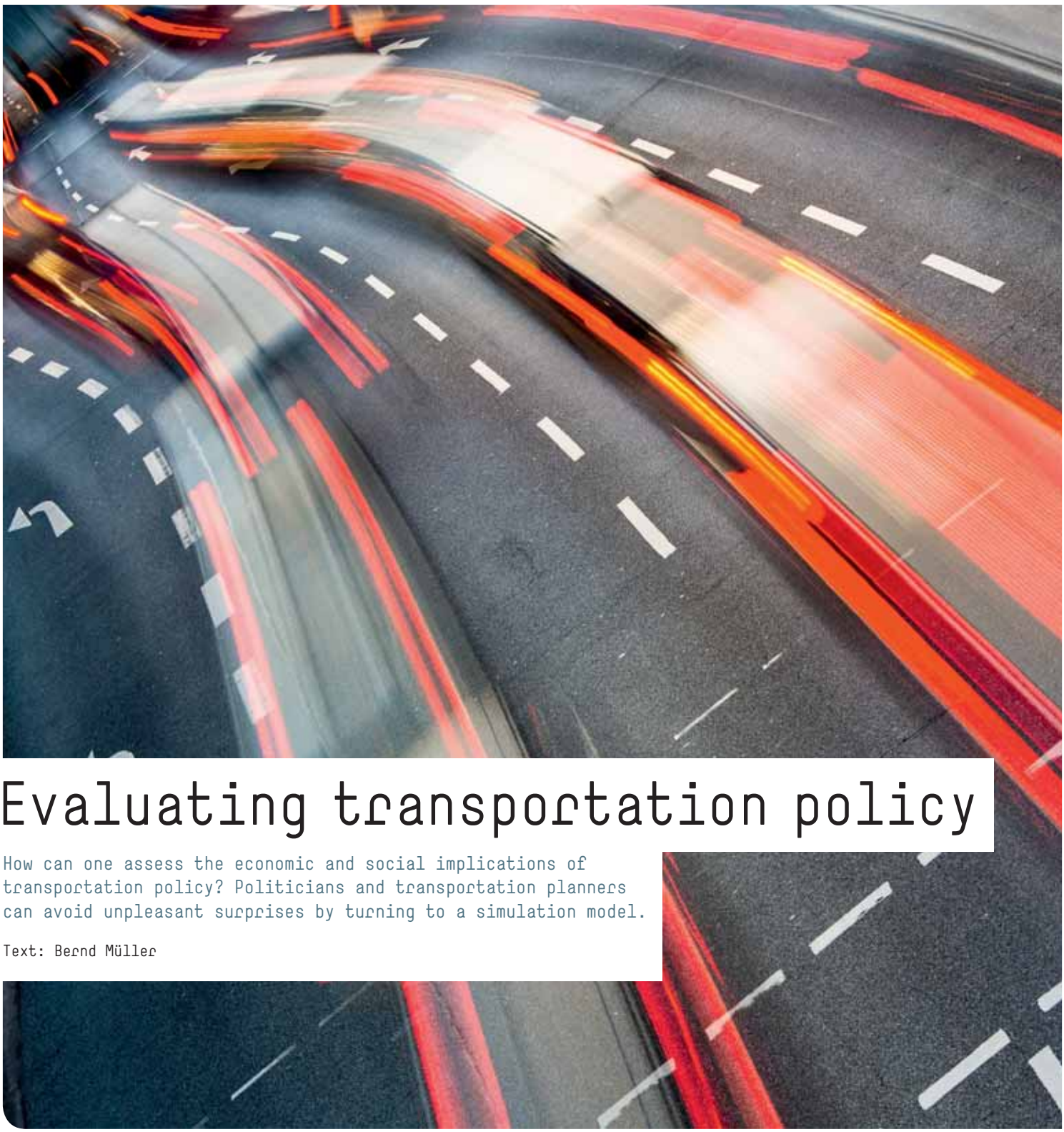
Over at the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB in Karlsruhe, researchers are also working on a system to help optimize wine production – a sorting machine that separates the picked grapes from twigs, leaves or insects that would spoil the wine's purity. The fully automated system draws on a camera positioned above the conveyor belt that transports the grapes. Analyzing the images in mere fractions of a second, the system's software identifies any unwanted objects and triggers a strong blast of air that knocks them off the belt.

Automatically sorting the harvest

"We've been tasked with developing the inspection system complete with image analysis and user interface, as well as how the machine's valves are controlled in real time," says project manager Kai-Uwe Vieth of the IOSB. Two medium-sized mechanical engineering companies are in charge of developing the bulk of the system's mechanics. In collaboration with Geisenheim University near Frankfurt, the IOSB researchers are currently working on a way to use the camera to automatically assess the quality of the grapes as well. For example, light aimed at grapes with differing sugar content will be scattered back at different wavelengths.

While partner researchers at the university are attending to aspects such as the chemical analysis of the grapes, Vieth and his team are working on how to interpret the light spectrum. All in all, the system will help winemakers to further improve the quality of their products and provide mechanized assistance to increase the volume of top-quality wine on the market. ■

On behalf of the European Commission, researchers investigated how future developments will impact the European transportation system, as well as the social, economic and environmental implications of transportation policies. © *panthermedia*



Evaluating transportation policy

How can one assess the economic and social implications of transportation policy? Politicians and transportation planners can avoid unpleasant surprises by turning to a simulation model.

Text: Bernd Müller

Will we or won't we see a road toll for cars in Germany? It's a contentious issue. Critics attack the convoluted calculation process and how it discriminates against certain groups. But the real impact of such a toll has hardly been investigated. Imagine the federal and Länder governments actually used the increased revenues to invest in improving roads or maintaining existing infrastructure: how would this impact construction companies and jobs? Would we see fewer Austrian and Dutch motorists on German roads? What would the implications be for tourism? Every transportation policy decision brings with it a whole range of consequences – and the social ramifications in particular are almost impossible for politicians and transportation planners to gauge given the complexity of the factors at play.

Now the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe is offering them help. Fraunhofer experts working on the ASSIST project (Assessing the Social and Economic Impacts of Past and Future Sustainable Transport) have created a model that sheds light on the impact a given transportation policy might have. The project is being undertaken on behalf of the European Commission, which is providing 1.22 million euros of funding as part of its Seventh Framework Programme. Approximately a quarter of this funding went to the ISI, which coordinated the work of the six partners taking part in the project and developed the simulation model with an Italian partner.

In all, the partners produced 61 fact sheets, each one focused on a transport policy measure falling under the eight categories of pricing, taxation, infrastructure, internal market, efficiency standards and flanking measures, transportation planning, research and innovation, and other measures, which are taken from the EU's white paper on transport. Each action impacts particular societal groups in specific ways, and these effects are clearly laid out in table form. Politicians and transportation planners use the online fact sheets to find out about specific effects or the particular societal groups affected.

At the heart of ASSIST is the ASTRA-EC model, which simulates the full impact of transportation policies by calculating their effect on transportation, on the economy and – for the first time – on different social groups. This makes it possible to assess the consequences of, say, offering tax relief to compensate for toll payments, as foreseen in German Minister of Transport and Digital Infrastructure Alexander Dobrindt's toll plans.

Project partners did not need to reinvent the wheel, since more than 300 research studies looking at the impact of transportation policy already exist. The ISI experts used these to produce the fact sheets and the ASTRA-EC model. However, the researchers did notice that while there are a whole array of studies examining the related ecological and economic effects – factors such as CO_2 emissions, and jobs gained or lost – only a few consider the social impact as listed in the EU's "Handbook of social and economic impacts of sustainable transport policy." The fact sheets and the ASTRA-EC model are one way to close that gap.

Politicians involved in transportation policy on the national level will find the model helpful, but it has its limits when applied to local decisions. "The effects of transportation policy measures can vary widely from region to region," says Michael Krail, project manager at the ISI and coordinator of the ASSIST consortium. While effects can be modelled on a smaller scale, this takes much more work and results are not as reliable as for national policies.

Collateral damage: rising rents

To cite an example, if a community decides to build a bypass, the immediate effect is positive, since those living on what was the main thoroughfare are no longer exposed to as much noise. However, property prices and rents also rise as a consequence. Some residents can no longer afford to live centrally and are pushed to the outskirts – altering the town's social fabric. "When it comes to transportation policy decisions, there are always winners and losers," says Krail.

A new feature of the ASTRA-EC model is the option to combine various transport policies. Previous models often operated on the assumption that you can simply add impacts of one individual measure after another – even though that isn't the case. "To a certain extent, different measures will cancel each other out," says Krail.

In their studies, the Fraunhofer experts also identified effects that nobody would have expected and that go against what politicians are trying to achieve. In 2009, for instance, the European Union decided to bring the CO_2 emissions limit for new cars down from today's average of 135 grams per kilometer to 95 grams per kilometer by the year 2020, with the aim of bringing about a 30-percent reduction in CO_2 emissions. Modeling shows that the real reduction is only 15 to 20 percent, since a rebound effect cancels out the rest of the savings: drivers who have exchanged their old car for a new, fuel-efficient model will drive more and use up some of the fuel savings on longer journeys or additional mileage.

The model can calculate just how high the fuel price would have to be set to prevent this rebound effect and ensure that more fuel-efficient cars really do benefit the environment. It remains a theoretical question however. "Raising fuel prices to this extent would be an unpopular move and hard to implement, politically speaking," says Krail.

Hotspots of societal change

ASSIST has also identified certain future transportation policy hotspots. According to the project partners, the dwindling supply of fossil fuels and increased use of modern information and communication technologies will have the biggest impact on the transportation system. The researchers also anticipate that electromobility will spread and that, in the long term, cars and trucks will drive themselves. Climate change, public and private debt, globalization, urbanization and urban sprawl present further challenges – as does Europe's aging society. Krail calls for an assessment of the European Road Safety Action Programme (ERSAP) to determine whether it does enough to meet the needs of an aging population. But he points out that ERSAP is a positive example: "By promoting active safety technologies, this guideline is already helping older people." ■

Have no fear of Big Brother

How do you protect yourself from theft and improper use of data? Fraunhofer researchers have received a prize for outstanding applied research awarded by the European Association for Research and Technology Organisations EARTO for an advanced data security program.

Text: Monika Weiner

It is not just intelligence agencies that have been busy spying for some time. Data of all sorts are being stolen, hacked, intercepted and manipulated. Unauthorized access can have dramatic or disastrous consequences. It is annoying when internal commercial data are carelessly copied and provided to third parties, damaging when your newly developed software suddenly appears from a competitor, and ruinous if hackers break the code to a bank card and empty an account. And if something goes wrong with the brakes in a networked automobile while driving, it can even become life-threatening.

So it is not surprising that companies, clients and end-users are unsettled. "Many companies restrict access for fear of losing data, having it improperly used, or even carelessly transmitted to third parties. The consequences are overly-complicated operational procedures that can inhibit innovation and its benefits," asserts Prof. Dieter Rombach, head of the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern.

Data protection without side effects

So how can you protect your data without risks or unintended consequences? "Agreeing to general terms of business with a check mark is hardly sufficient today because information can be duplicated and provided to third parties," according to Rombach. "Encryption of data and data streams offers basic security.

EARTO Innovation Prize

Research can have a positive impact on our lives. The European Association for Research and Technology Organisations EARTO began in 2009 to award three prizes each year. An independent jury selects projects that have the potential to trigger social or economic change. Fraunhofer has received the distinction now for a third time.

With almost 150 members, EARTO is Europe's largest association for applied research. The total revenue of the member organizations is 23 billion euros annually. Approximately 100,000 small, medium, and large corporations benefit from the work of research institutions every year.

However, in modern business processes, where large amounts of data must be exchanged, this measure is often no longer sufficient. In the age of Big Data, we have to find new ways."

Researchers at IESE are developing solutions for Smart Ecosystems, complex networks that transceive data among various participants. These smart systems already provide for exchange of information between vehicle fleets and traffic systems today, allowing companies continents away to collaborate. And that is just the beginning. Rombach anticipates increased networking in future – for example in energy management, car-to-car communication, medical applications, and in Ambient Assisted Living to support persons in need of care. Smart Ecosystems have saved money in all of these instances.

Trust 4.0

Brave New World 4.0 will only become a reality, however, if the technology can win the trust of users. "Many users and companies are still concerned about the security of their data in networks or in the cloud. We can only counter this Big Brother syndrome through unambiguous security standards," sums up Rombach. "Users

New software that was developed in an EU project allows users to retain control over their data. © *istockphoto*

need to know that they retain control." New software makes this possible. In the Integrated Distributed Data Usage Control Enforcement project IND2UCE, a team from IESE together with researchers from the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB, The Technical University in Munich, as well as three industrial partners have developed an approach for protecting sensitive information from abuse in the future. "We are no longer relying exclusively on conventional access monitoring and control or encryption, but instead implement additional self-monitoring and control within the data itself," says Christian Jung, who heads the IND2UCE team. The trick: all data are augmented with small supplementary information packets containing data usage rules. Exactly what is or is not allowed in future is in these packets. With them, the owner can precisely define which files may be read, copied, and/or forwarded, as well as how often, whether they can be read on a smartphone and if so, whether this is allowed in public locations or only on company property.

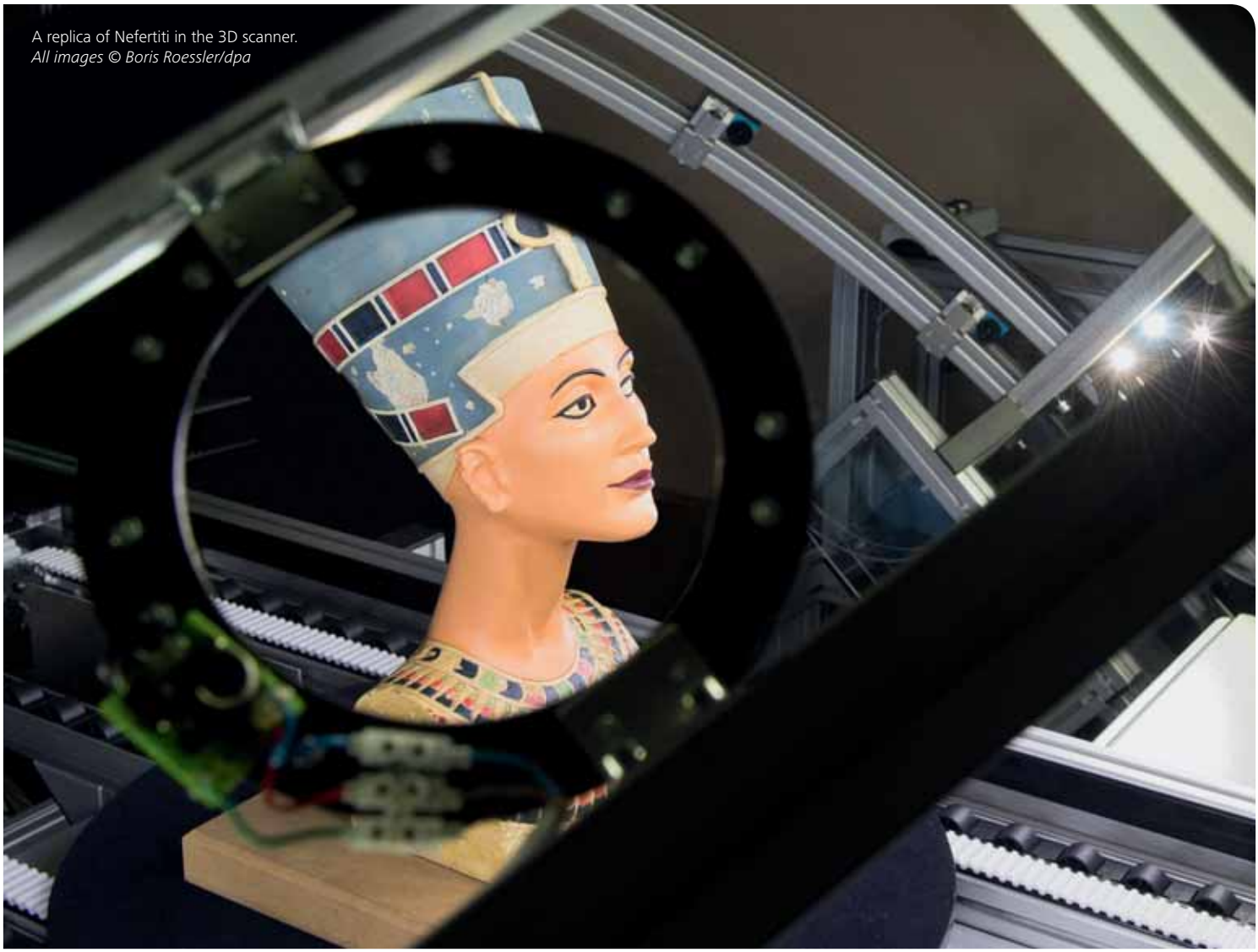
An example of intercompany collaboration: the manufacturers of conveyor belts and robots are collaborating with suppliers and temporary employment agencies in the assembly of automobile components. To optimize the fabrication process and be able to locate a fault quickly in case of a malfunction, information needs to be exchanged. At the same time, all of the participants are concerned about their data security and do not want to provide access to their complete corporate data.

It is for exactly this case that a solution has been developed in the IND2UCE project. "We started by taking a close look at production processes in order to identify potential security issues. We are now solving those in a systematic manner," explains Jung. As a result, for example, a technician looking for possible causes when the assembly line stops does not obtain access to all of the data belonging to the temp agency, but instead only to those data pertaining to staff who were present at the time in question. It is similar in the case of the robot manufacturer: only the control data crucial to the operation of the conveyor may be retrieved. At the same time, the IND2UCE project takes care of attaching additional security notices to all of the information that the technician has retrieved. After a specified number of days, the data self-destruct, even if they are stored on a third-party computer or smartphone. This way, an employee is hindered from inadvertently forwarding the data due to carelessness.

Security ready for market

"The software is expandable and largely compatible with currently available systems, e.g. Android, SAP, and Windows," Jung emphasizes.

Various prototypes of this new security solution have been completed. One commercial partner that markets financial analysis software wants to integrate this solution over the coming years and bring it to market. "This will provide a competitive advantage for system integrators," Eisenbarth is convinced. "Customers themselves can finally control the fate of their data again." ■



A replica of Nefertiti in the 3D scanner.
All images © Boris Roessler/dpa

Cultural treasures in 3D

All over the world, wars and natural disasters threaten the continued existence of our cultural treasures. 3D digitization is one way to preserve them for posterity, at least in the virtual sense, but it has always been an expensive and time-consuming process. CultLab3D is the first conveyor-belt solution that is able to efficiently scan and archive artifacts at a fast rate. To achieve this goal the results of various EU projects were combined.

Text: Ulrike Zechbauer

Nefertiti gazes into the cameras like a seasoned celebrity posing on the red carpet. After a few minutes, the bright burst of flashing lights subsides. Now there are exactly 6561 extremely high-resolution, 300-micrometer images of the world-famous star on file, taken from every camera angle and direction of incident light. This 30 gigabyte package of images is quickly processed by a computer to create a virtual 3D copy of the ancient Egyptian beauty. But the photo shoot doesn't end there. Nefertiti is on a tight schedule, having to move from one carefully timed appointment to the next just like any popular celebrity. She is promptly transferred to the next stage – albeit along a steel conveyor belt rather than a red carpet – where a scanner projects a series of stripes onto her face. This pattern of structured light collects additional data needed to close any gaps in the 3D image, capturing even the tiniest details at a scale of 15 micrometers. The scanner is attached to a flexible robot arm that manoeuvers it automatically into position according to precise coordinates calculated in advance. In this way, the light can accurately scan the bust on a point-by-point basis.

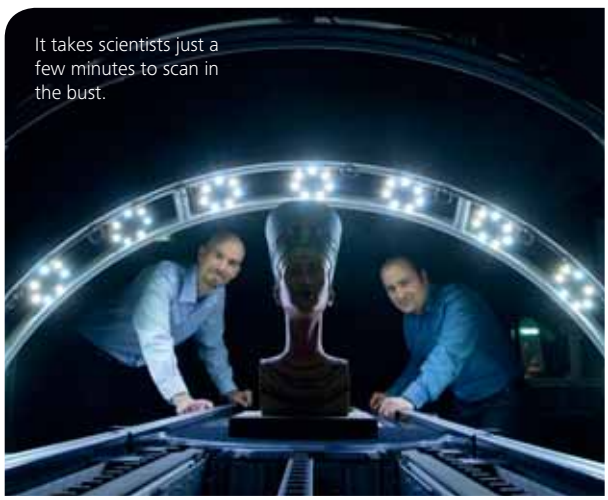
Just as with Nefertiti, this cost-effective and above all fast process will be used to industrially scan and archive millions and millions of museum exhibits and newly discovered artifacts in the future. While similar initiatives have been around for ten years or so, the majority are concerned with archiving 2D artifacts such as book pages, paintings and photographs. But what about our 3D global cultural heritage? How can we digitally preserve things like busts, statues and coins? There are at least 250 million three-dimensional artifacts waiting to be digitized in Germany alone. The handful of existing 3D digitization solutions are expensive, and what's more they have one serious disadvantage: they work very slowly. Current technologies take hours to scan just a single object. "With such long scan times we'll never be able to process all the objects waiting to be archived," says Pedro Santos, computer scientist and head of the Competence Center Cultural Heritage Digitization at the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt.

Radically faster scan times

The competence center, which was founded in 2012, has its roots in the departments for industrial applications and medical technology. "Solving today's problems requires us to create more and more synergies. Having a multi-disciplinary team allows us to realize new solutions not only in terms of software but also, notably, in terms of hardware. The days of conducting research in ivory towers are definitely over," says Santos. This arrangement allows research results from completely diverse industrial and EU projects to flow together and be combined – with great success. In developing CultLab3D, the world's only 3D digitization process to run on a kind of conveyor-belt system, the team has created the technological basis for fast, efficient digitization of cultural treasures. With CultLab3D, the entire process from classification through to archiving takes only a few minutes.

CultLab3D captures and records not only artifacts' geometry and texture but also their optical material properties. For example, the same point on the surface of a mineral can differ in appearance depending on perspective and the angle of incident light, as its absorption and reflection properties are different in each direction. "With our process, we're able to replicate all this photo-realistically," Santos is keen to emphasize. "The 15 years of preliminary research behind CultLab3D are now bearing fruit." For certain objects the technology can even "see" far more than the human eye can. For one of the only 26 surviving Rongorongo artifacts from Easter Island, for instance, looking at the 3D model on the screen reveals previously undiscovered characters (glyphs) to the viewer. By using special filters during the scanning process, CultLab3D can also bring to light artistic representations found on ancient coins. "The surface structure of old money is often subject to alterations, such as color changes, that can obscure our view of the relief work. With the digital model, we can strip away such surface textures to reveal the object's original shape," says Santos.

That being said, a 3D model alone is relatively worthless without a connection to further information to help make sense of it. "That's why we also developed a special annotation system with which to link the virtual 3D replica to cultural and historical information such as the artist and period, and to other related artifacts. The beauty of attaching virtual scientific notes directly to the relevant part of the model is that they remain there forever – unlike the handwritten index cards still used in many museum warehouses today, which can sometimes go missing. At worst, this can result in valuable



It takes scientists just a few minutes to scan in the bust.

Two computer-controlled, semi-circular curved sensor arms use digital cameras to capture the very finest details of the original.

information being irretrievably lost," Santos explains. But how good are the data storage technologies available today? After all, this is a question of safeguarding virtual cultural treasures together with complete records and all available background information – meaning huge amounts of data – for hundreds of years. The sober truth: no one has yet come up with a storage technology solution that is able to do so. "That's why here at CultLab3D we're also carrying out intensive research into the issues surrounding data storage," Santos summarizes.

Clarifying rights to the model

Another difficulty is posed by the ambiguity surrounding legal rights to the products of the 3D digitization process for cultural heritage objects. Do they belong to the artifact's owner? And what about scans of loaned items? "We're determined to avoid finding ourselves in the position, a few years down the line, of having a technical solution that is ready to go but being unable to use it because of unresolved legal issues," Santos points out. "That's why we intend to design an entire ecosystem, so to speak." One part of this system is the recently established Culture in 3D forum, which aims to bring together representatives from the fields of research, industry, culture and politics twice a year to work up the necessary requirements and outline a framework for implementing them.

There are plans for a prototype of the mobile scanning facility to be put to work later this year, archiving objects in five German museums in order to show how well, and in particular how quickly, CultLab3D works in practice. Four museums in Berlin and the Liebieghaus in Frankfurt will take it in turns to use the technology, and results will then be compared with those from conventional digitization systems. Corresponding reference data is already available, collected last year by student helpers who used commercially available structured-light scanners to map and digitally record various art objects at each of the participating museums.

CultLab3D is currently able to process objects up to a maximum of 60 cm in height and 60 cm in width that weigh a maximum of 50 kilograms. The scientists' medium-term goal is to offer a whole range of different digitization technologies. By the end of 2014, they want to design and build a robotic system that will be able to scan and digitize statues up to two and a half meters in height. They are also working on systems for autonomous drones that will be able to digitally document extensive archaeological sites from the air.

But the Fraunhofer researchers' plans go even further: the Competence Center 3D Printing Technology is currently developing an innovative 3D copier that will one day be able to print actual 3D models that will be able to replicate the original's optical material properties such as translucence or how glossy the surfaces are.

Who knows, maybe one day we'll see museum visitors taking a deceptively realistic replica of Nefertiti home with them – or, as a matter of personal preference, perhaps a copy of the ancient beauty with both eyes intact. ■

High-tech shoe for more running pleasure

Jogging keeps you fit. However, beginners easily overdo it. A new high-tech running shoe developed by a European research team will evaluate running form in real time and thereby avert injuries.

Text: Britta Widmann

Hardly any sport is as popular as jogging. Millions of people are training regularly. No wonder, because running is the ideal way to reduce stress, lose excess fat, and improve endurance. Running stabilizes the immune system, prevents cardiovascular disease, and builds muscle. However, despite its numerous positive effects, jogging is a desirable sport with undesirable side effects – and the number of running injuries and joint complaints is increasing. Runners run risks of twisting or injuring an ankle, especially on uneven ground or when fatigued. Pulled ligaments or even a broken ankle can result. If muscles are not warmed up or a person overestimates their condition, training is often interrupted due to knee pain and pulled or torn muscles.

To prevent these kinds of injuries, researchers from the Fraunhofer Institute for Photonic Microsystems IPMS, in collaboration with five partners, are developing a specialized running shoe in the EU Project RUNSAFER. Sensors and microelectronics integrated into the sole of the shoe will measure the biomechanical data of the athlete and evaluate the runner's form with the help of measurements in real time. "Pulse-rate watches and chest straps only record vital signs like breathing and heart rate. In contrast, our running shoe medically evaluates and monitors training while jogging. It informs the runner for example of incorrect foot position, asymmetric loading, or warns of exhaustion or overload. There has never been a comparable device before," says Dr. Andreas Heinig, a scientist at IPMS.

Smartphone app gives feedback

The measurement system can be easily installed and removed from the soles of the shoes. To charge it, the pair of shoes is placed on a charger that is included. Besides the microcontroller, the RF module and batteries, the system comprises accelerometers and GPS sensors that capture the biomechanical signals from the body as well as the runner's speed and transmit it via Bluetooth to the runner's smartphone. A smartphone app evaluates the data in a split second with the help of specialized algorithms and gives the athlete feedback on training performance. If necessary, the app makes suggestions about running form or the training routine.

"The app could recommend running more slowly, for example, or rolling off the foot differently, suggest seeking a different running surface or stopping if necessary," as Heinig describes the different guidance. In addition, the measured values are transferred during the run from the smartphone to a website for further processing, evaluation and display. A customized training program can be set up based on this data with personalized performance goals that are constantly updated.

www.runsafer.eu

A prototype of the running shoe is already done, as is the cell phone app. The researchers are presently working on a still smaller version of the microelectronics and sensors – a big challenge, particularly since the system must be waterproof, light and durable. The high-tech shoe should be available for sale by the beginning of 2015. RUNSAFER-Project partner New Millenium Sports SL, the Spanish manufacturer of athletic shoes and sportswear and owner of the Kelme brand, will be bringing it to the market. ■

Joggers will be able to prevent future injuries like pulled ligaments or torn muscles thanks to the specialized running shoe.
© *Fraunhofer IPMS*

Telemedicine for chronic liver disease

Although telemedicine could improve the quality of life for patients with chronic liver disease, viable home care systems are still lacking. Scientists working on the EU-project "d-LIVER" mean to remedy this situation. Initial results have now been released.

Text: Tobias Steinhäußer

Telemedicine involves doctors and patients communicating with each other via an IT platform. Researchers are working on technology to extend the benefits of telemedicine to liver patients in the near future. © *Fraunhofer IBMT*

The liver is one of the most important organs in the human body. Its job is to ensure that we utilize our food properly – this is its synthesis function – and that toxic substances are removed from our organism – this is its detoxification function. Lack of exercise and too much alcohol, stress, and unhealthy food all damage the liver.

Cell-based systems that assist liver function can tide patients over until they can receive a liver transplant, or accelerate regeneration of the liver after surgery, or even render a transplant unnecessary. They can carry out both the synthesis function and the detoxification function of the liver. To date, however, there are no medically approved cell-based systems. What are also lacking are telemedicine platforms that allow patients with chronic liver diseases to be monitored and treated outside of the hospital. "Telemedicine is something that would greatly improve the quality of medical care and patients' quality of life," says Stephan Kiefer, a computer scientist at the Fraunhofer Institute for Biomedical Engineering IBMT in St. Ingbert, near Saarbrücken in southwest Germany.

In the EU-project d-LIVER, the IBMT is working with European partners to develop an IT- and cell-based system that will help people suffering from chronic liver failure to receive medical support in their homes (www.d-liver.eu). Its engineers are responsible for programming the IT platform and developing the sensor technology that will measure the condition of the liver cells in the cell-based system. Of the research being carried out at the IBMT, the patient management system is currently at the most advanced stage. For the first time, the scientists are combining classic components of telemedicine – such as remote monitoring for doctors – with a system that assists with decision-making. This system is called the Care Flow Engine, and Kiefer explains what exactly is behind it: "We've created IT systems that can take treatment plans drawn up by doctors and turn them into such user-friendly automated processes that chronic liver disease patients can receive quality long-term treatment at home."

Sensors measure vitality of cells

To this end, the scientists have developed an IT application called Personal Health Manager, which patients can access conveniently on tablet computers in the form of an app. It amalgamates all the data from devices that measure blood pressure, heart rate, weight, temperature and liver values along with the treatment plans from the Care Flow Engine. "Its main purpose is to ensure optimum treatment for the typical complications that tend to accompany liver diseases," says Kiefer. This can be achieved by means of tests, questioning, exercises, or instructions. For example, patients are regularly asked to weigh themselves, measure their liver values, and accomplish a cognitive test. This provides indications as to how much patients are suffering from conditions such as encephalopathy and ascites. The system automatically evaluates the results, suggests adjustments to medication doses, and recommends courses of action that are then discussed between the doctor and the patient.

"The technology is suitable in principle for the telemedical treatment of any chronic illness." says Kiefer.

The sensor technology for monitoring the liver cells was developed at the IBMT by physicist Dr. Thomas Velten: "Our sensors continuously measure the vitality of the cells in a bioreactor – and they do so by analyzing the cells directly. This is an important new tool to complement conventional biochemical analyses." Thanks to built-in sensors, operators do not have to open the bioreactor for every measurement, eliminating the danger of the cells becoming contaminated in this way. At the end of this year, the researchers want to confirm their results using bigger bioreactors that are equivalent to a human liver in terms of their volume. "Online measurement of cell vitality is an important part of our IT-based system to support liver treatment," concludes Velten. ■

Virtual tailoring

Contact: Martin Knuth, martin.knuth@igd.fraunhofer.de

Fashion designers, pattern makers and tailors use computer programs to produce new collections. The Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt is working with the company Assyst on connecting both worlds so the design process can be simulated virtually.

Until recently, it took days or even weeks to produce realistic-looking textiles on a computer screen. With the Vidya simulation program this process now takes just seconds. Alongside needle and thread, the computer mouse is increasingly becoming one of the most indispensable tools for designers and tailors. All it takes is a few clicks to make just the right adjustments to color, material and cut pattern. Shadowing, the optical and mechanical qualities of various materials, folds and pleats, diverse lighting and reflections can all be realistically represented in 360° panorama images.

The Future Fashion Design project sponsored by the European Union (www.future-fashion-design.eu) is helping to ensure new collections reach the market more quickly and customer preferences are realized with greater flexibility.

Simulating textiles: ideas can be implemented at the click of a button, and specific customer preferences quickly integrated into designs. © *Fraunhofer IGD*

A formula for bombproof concrete

Contact: Birgit Bindnagel, birgit.bindnagel@emi.fraunhofer.de

A new type of steel concrete protects One World Trade Center at Ground Zero – the concrete doesn't break, it merely deforms. © *Fraunhofer IAF*

Concrete that merely deforms in a blast rather than fracturing – this is made possible thanks to a special mixture of very hard, high-performance concrete and finely meshed reinforced steel. The new One World Trade Center in New York City uses this security concrete. Experts at the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI in Freiburg have been supporting DUCON Europe GmbH & CoKG for many years in optimizing this patented innovation.

EMI researchers conduct dynamic qualification tests of the material under extreme loads. This includes characterizing the material and calculating characteristic curve profiles. They have developed a mathematical formula that simply and quickly computes the required thickness of the innovative concrete for each specific application. With their new shock tube in Efringen-Kirchen, the researchers can simulate the force of detonations – without even using explosive effects. The high-performance concrete was also tested there.

Remote-controlled spiders to the rescue

Contact: Herrad Schmidt, herrad.schmidt@fkie.fraunhofer.de

From Fukushima to Haiti to Cologne, the German Federal Agency for Technical Relief (Bundesanstalt Technisches Hilfswerk THW) provides disaster relief and civil protection services all over the world. In areas with rough, difficult or ambiguous terrain, THW rescue workers use spider-like walking excavators as part of their operations.

Researchers at the Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE have equipped these special excavators with a sensor system. This enables operators to manage the heavy equipment safely in the field without putting themselves in danger. To allow inexperienced users to do the same, the scientists have also developed a modular user interface that provides a comprehensive overview of the operational environment.

Virtual underground lab helps in the search for permanent disposal sites

A deep geological repository has to be able to safely contain radioactive waste for a million years. But the sheer number of complex processes at work makes it impossible to calculate or even estimate if this is long enough. Researchers are currently studying these processes in virtual underground labs, for instance at Fraunhofer IFF in Magdeburg. Making decisions about nuclear waste repositories is simpler when everyone involved is thoroughly informed.

Photo: Dirk Mahler/Fraunhofer IFF

Efficient manufacturing processes

Factories of the future will conserve energy and resources, and barely pollute the environment with emissions. Fraunhofer scientists are working on solutions that companies can implement quickly.

Text: Marion Horn

© Fraunhofer IWU

At first glance, the 1600-square-meter interior of the brightly lit E3 research factory looks like an automotive manufacturing plant. Two assembly lines stand ready to manufacture car body and powertrain components. In fact, this is where scientists from the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz, Germany, are working with industrial partners to develop and optimize production processes, factory concepts and software systems in realistic industrial conditions. One of the topics they are looking into is how automotive manufacturers could use a single production line to flexibly produce car body components – doors, for example – that are tailored to individual customer requirements.

Down one side of the ten-meter-high hall, car doors are series produced just as they would be in a car factory. The facility is modeled on actual door assembly lines for midsized cars. "This allows us to work under conditions that are very close to those found in industry, which means we can quickly apply this knowledge directly to the real-life manufacturing processes our partner companies use," says Professor Matthias Putz, director of the IWU.

Ultra-short production processes

On the opposite side of the hall is a row of machine tools for making powertrain components. The facilities at the research factory have for the first time given engineers the opportunity to completely redesign plants and processes and to optimize individual solutions as well as entire process chains in a near-realistic manner. "Now we can offer our customer complete process chains, and not just pure technological research. Working with machine manufacturers, we find the best individually customized solution for the customer. Our work is about finding ways to produce components in a cost-effective, energy-efficient and resource-saving manner, and improving their material properties," explains Dr. Udo Hellfritzsch, a researcher at the IWU. In real life, reorganizing an entire process chain is very difficult. Doing so would involve interrupting series production – manufacturing would grind to a halt, machines would have to be replaced and processes changed. Such downtime can be dramatically reduced using industrial-scale test runs, which is why international industrial customers approach the IWU when looking for component manufacturing solutions.

One of the IWU's research areas concerns the manufacture of gear shafts and gears used in vehicles and wind turbines. Hellfritzsch goes on to describe the various manufacturing steps involved: "One of our aims is to replace conventional machining methods with forming processes as much as possible, for example with the gear-rolling process used here, or with spin extrusion. These processes displace and shape the material without generating any waste. Components made this way can be produced faster. They are more wear-resistant, more robust and make less noise once they are fitted in the vehicle."

But not every method is suitable for each kind of component. This is why the scientists have begun using computer-based simulations to calculate how technological adjustments will improve process speed and efficiency. After conducting test runs in their virtual production environment, they can then construct a new real production line. Hellfritzsch describes the steps involved: "To make hollow shafts using metal-forming technologies, we take the forged component and shape it using the BDM2000 spin extrusion machine developed here at the IWU. This produces powertrain components that are hollow – and thus lighter – but that are nevertheless very robust. This stage is then followed by swaging, gear-rolling, hardening and grinding."

"The process chain that we've developed is much shorter and uses around 30 percent less energy and material than established methods for producing hollow gear shafts. Depending on the geometry of the component, production speed can be increased by 30 to 40 percent. This method eliminates swarf disposal, which is damaging to the environment. Material strength can also be increased by 10 to 25 percent."

Conducting research during operations

Real and virtual production systems are increasingly becoming connected. Staff can use mobile monitors to access all digital data for all the plants. Information such as each machine's current energy consumption is provided in a user-friendly format that is tailored to the person calling up the data. There are 160 measuring points throughout the E³ research factory for gathering the necessary data. Up to 1500 readings taken at these points are then collected in the factory's own cloud, where the data is linked to information about orders, processes and resources. This provides a condensed real-time overview of the energy interactions both within the production systems and processes as well as between production and the factory environment. Having a reliable, secure IT infrastructure is an essential prerequisite for monitoring these complex data streams.

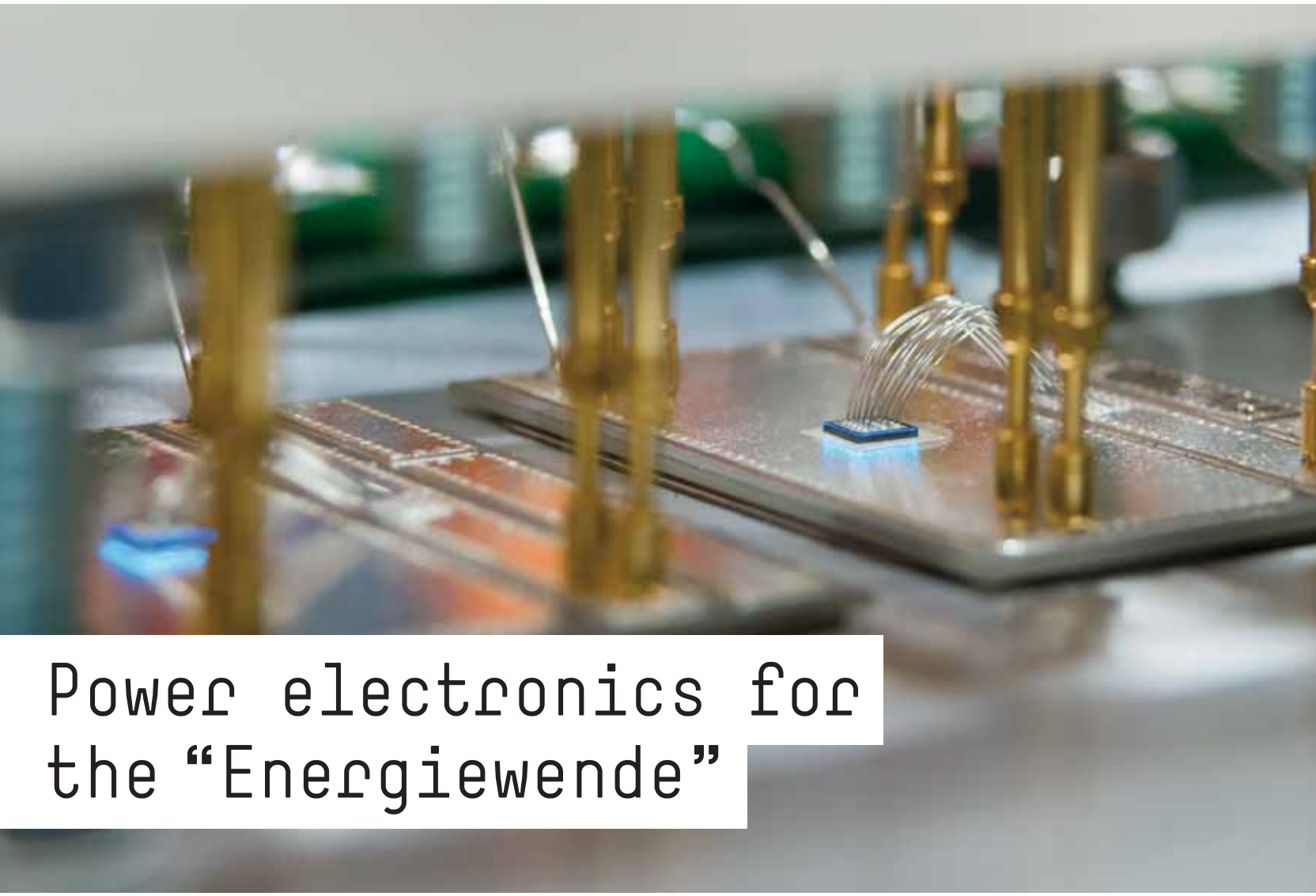
The monitors are also used to control energy supplies to the building, which is equipped with a combined heat and power plant, a photovoltaic system and trigeneration (combined cooling, heat and power). Depending on demand and capacity utilization, the idea is for the plants to run with minimum energy consumption.

www.e3-fabrik.de

Professor Putz explains the concept behind the E³ research factory as follows: "We take a holistic approach to production. Creating sustainable added value calls for the traditional economic target variables – time, cost and quality – to be complemented by new criteria such as energy, material efficiency, low CO_2 emissions and the human factor. We must consider the needs both of older employees and of the up-and-coming younger generation. The school children of today are the engineers of tomorrow; they communicate differently and use new kinds of media. Our work is about assimilating these developments and combining them with the requirements of a more energy- and material-efficient production setup in a bid to help shape the working and production environments of the future." A total of 20 million euros has been invested in the research factory by the Land of Saxony, the German Federal Ministry of Education and Research BMBF and the European Union. The industrial partners contributed to equipping the facility.

The three "E's" the in E³ concept stand for efficiency, emissions neutrality and ergonomics. "We superimpose these three levels onto one another, observe how they interact, and look for any innovations that may derive from the resulting synergies," Putz explains. The E³ research factory is experts' first attempt at implementing the approach developed at the IWU in a real-world setting. Since the end of 2013, the concept has also been expanded through Fraunhofer's E³ production lighthouse project. Twelve Fraunhofer Institutes are working across disciplines to develop concrete solutions for future production methods, with the aim of quickly translating new ideas for production technology into marketable solutions. By 2016, the project will see demonstrators and pilot applications for E³ production installed at three other German Fraunhofer locations – in Berlin, Stuttgart and Dortmund. The Chemnitz research factory, which was opened in May 2014, provides an open and flexible platform for all partners cooperating in the scheme. It allows new processes and technologies to be put to the test on a near-industrial scale. ■

Data on all required resources flows together in the glass-sided control center to form a factory-level picture. This includes compressed air, water and electrical power statistics as well as machine and process data.
© *Fraunhofer IWU*



Power electronics for the "Energiewende"

Over the coming years, Germany's power grids will have to go through considerable change in order to keep pace with the demands of the country's energiewende. A key part of this shift toward a new energy economy will be new kinds of electronic components and systems.

Text: Brigitte Röthlein

Germany's "Energiewende" – the transition to a new energy economy – calls for more than simply switching to renewables. To meet the country's goal of generating around 80 percent of its energy requirements from renewable sources by the year 2050, power grids must also be completely overhauled. It's not just a question of creating electricity highways to transmit power over long distances: the infrastructure also needs to be adapted.

The Fraunhofer Institute for Integrated Systems and Device Technology IISB in Erlangen is doing its part by developing components and systems based on high-performance power electronics.

In the past, the grid infrastructure consisted of a small number of large, centralized power plants, which generated electricity that was then distributed to all users. Now there are more and more small-scale generators connected to the grid, whose wind turbines, biogas plants and solar panels feed in varying amounts of power at different times. To assure that power supplies remain stable and reliable throughout the grid under these changed conditions, radical reengineering is called for to create a decentralized network. Such a network would improve the efficiency of today's power distribution with a view to making the most of available energy.

SiC diodes undergo endurance testing in the packaging and reliability lab. © *Fraunhofer IISB*

"Changes will have to be made on numerous levels, from the major European power grids and the distribution networks to factories, homes and electric vehicles," says Professor Lothar Frey, director of Fraunhofer IISB. The potential for change is particularly high in homes and offices. "When you think about it, the way we do things today is crazy. Electricity is supplied by the grid at 230 volts and used to power electronic devices such as computers, printers, TVs, hi-fi systems and fluorescent lighting. Almost all of these devices have their own internal power supply unit (PSU) that converts 230-volt alternating current (AC) into the direct-current (DC) voltage required by the device. Because these PSUs are usually made of cheap components to minimize costs, their conversion efficiency is relatively low – in other words they transform part of the electricity into unwanted heat. This is a huge waste of energy."

In certain cases, it would make more sense to convert the 230-volt AC grid supply into DC at a central point inside the building – by enlisting the help of high-quality, highly efficient power electronics. What is more, an increasing number of buildings are now equipped with solar modules, which natively generate DC. Rather than converting their output into AC, as it does now, it could be input directly to a DC network. The same applies to the DC output of solar storage batteries.

You could install an AC-to-DC convertor in the wiring circuit that serves your office or living room. Researchers at the IISB have already developed components to make this technically possible, including a converter the size of a pack of playing cards capable of serving all power outlets in a living room, and a DC network manager capable of serving an entire office building or several single-family homes. "With conventional technology, the switchgear needed to control a domestic power supply of 20 kilowatts would fill an entire cabinet," explains Professor Frey. "We can provide the same functions using efficient power electronics in a box no bigger than a telephone directory." The new technology is also of interest to industrial and commercial users, whose refrigerators and cooling systems, variable-speed motors and lighting systems can also be operated more efficiently, reliably and at lower cost using DC power.

High-voltage DC transmission

On a different scale, power electronics also plays an essential role in the German and European energy supply system. High-voltage DC transmission (HVDC) offers considerable advantages for long-distance power lines of the sort Germany needs to transport energy generated by offshore wind farms in the north of the country to electricity consumers in the south. The advantage of this method is that energy losses are 30 to 50 percent lower than in an AC transmission system. Modern DC transmission lines can be operated at voltages of up to several hundred thousand volts – and the higher the voltage, the lower the transmission losses. The cables can be installed as overhead power lines on overland routes, or buried underground, or laid as submarine cables. Each end of the DC transmission line terminates in a substation – where the AC-DC conversion takes place – containing up to several thousand inverter cells with semiconductor power switches.

Developing better cells

Each of these inverter cells weighs around 50 kilograms and stores a quantity of energy roughly equivalent to the explosive charge of a hand grenade. One of the Fraunhofer researchers' key achievements has been to design a fail-safe system that prevents the propagation of faults beyond a failed inverter cell, enabling the system as a whole to continue operating without interruption.

This multilevel converter concept offers another advantage, according to Professor Martin März, deputy director of the IISB and head of the power electronic systems department: "The passive filters used to limit the impact of electrical disturbances in conventional systems require a surface area the size of an entire soccer pitch. The new technology makes it possible to construct systems that fit into a standard industrial building or mobile container."

While Germany will certainly need its AC grids for a long time to come, in the future they will co-exist with DC grids. Power electronics will be essential as a means of linking the two types of grid. "In my view," says Professor Lothar Frey, "the way we send power through the grid will soon resemble the way we transmit data over the internet. There's electronics at every web interface, and in future the same will be true of power grids. The different elements, such as long-distance transmission lines, local substation networks, decentralized energy storage units, the many new generators, and of course the end consumers, will be linked via a multiplicity of electronic nodes. Together with intelligent control systems, this will have a stabilizing effect on the grid as a whole," affirms Frey.

Power electronics also plays a major role in electromobility. Here, the battery does more than just drive a car's electric motors – this also requires a centralized high-voltage, 400V elec-

Applying electrical contacts to power semiconductors using wire bonding.
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RC snubbers suppress voltage transients in semiconductor-based power modules. RC snubber in silicon technology, monolithic construction on a DCB substrate (DCB: Direct Copper Bonding).
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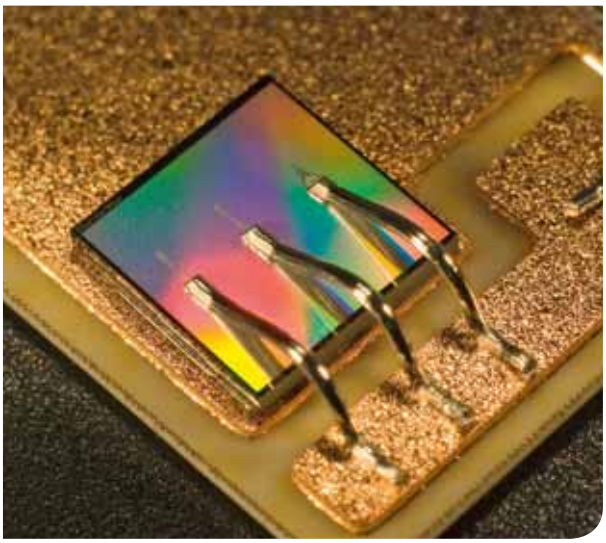

trical network. It also supplies the car's lower-voltage electrical system, which powers the lighting, air conditioning, power steering, radio, windshield wipers and other essential vehicle functions. In most cases, these electrical loads require different voltages and currents. The necessary interfaces are provided by electronic power converters. These have to comply with electromagnetic compatibility (EMC) requirements to ensure that they do not interfere with – or suffer interference from – other electronic components or vehicle systems by way of electromagnetic radiation.

To meet EMC requirements, and in order to save space and weight and also reduce the need for costly wiring, the researchers chose to place the power electronics components as close as possible to the functions they control, rather than grouping them in a central location. März refers to this approach as "point-of-action-focused system integration." He and his researchers were able to reduce the number of connectors by two thirds and eliminate many heavy, expensive, thick high-voltage cables. This means the electronic inverter, which converts DC power from the vehicle network into AC power to drive the electric motor, can be mounted directly on the motor or integrated into the drive system, as in hub-mounted electric motors. Meanwhile the power converter that generates the necessary low-voltage supply from the vehicle network is installed in the battery compartment, together with the charging device that allows the vehicle's battery to be recharged at any charging station. "We have developed an innovative rapid charging solution based on a DC system that does not require an external booster, which makes it particularly economical," says März.

To prove that these ideas also work in practice, the IISB researchers have already demonstrated their concept using a hybrid version of the Audi TT. To do so, they completely redeveloped all power-electronics systems along the energy chain, from the charging point to the wheels, including the charging device, the battery system, all monitoring functions, voltage transformers and the powertrain. The converters built by the researchers are extremely compact and yet do not require any cooling of their own.

World record in power density

To reduce the size and increase the reliability of power converters, it is frequently necessary to adopt an entirely new approach to choosing materials, designing components, packaging and systems, and manufacturing. The IISB conducts research in each of these fields. Important parameters when testing power electronics are efficiency and power density, and IISB researchers have already set a number of world records in these areas. Even today, the vast majority of electronic components are still made out of silicon. To arrive at power electronics that demonstrate the low power losses and fast switching speeds required, the IISB is collaborating with industrial partners to work up designs for new components that make increasing use of silicon carbide (SiC). This material is a wide-bandgap semiconductor and can be used to produce components with particularly low loss characteristics and high temperature resistance. With the exception of having to order in the SiC wafers, the institute has the means to perform all process steps in creating the finished components.

Using the thermal laser separation (TLS) method developed at the IISB, the fully processed SiC wafers can be separated into chips that can then be used to construct power modules.

New technologies are also available to increase the reliability of bonded, soldered and sintered joints, and for the polymer casting techniques frequently used to prevent flashover. Once they reach the prototype stage, the researchers integrate them in their demonstrators, where they are subjected to an exhaustive range of tests, including artificial ageing, to determine their load and wear resistance.

"This is an example of how we equip our customers for the "Energiewende" by providing them with expertise ranging from semiconductors to systems that can handle any amount of power," says Professor Lothar Frey. ■

The digital film reel

Instead of heavy rolls of film, digital film copies are sent to movie theaters these days. With the easyDCP software, these digital packages can be easily created in the required standard so that the digital film can run in any theater.

Text: Birgit Niesing

For more than a hundred years, analog technology dominated the cinema. Moving pictures were captured on film made from celluloid or polyester, and uniform standards applied worldwide. Each film strip was 35 millimeters wide and perforated along the outside edges. This way, it could be shown in any theater. Distribution of digital movies has changed all that: instead of sending analog reels of film, movie theaters receive DCPs (Digital Cinema Packages) via hard drive or satellite that include not only the encoded digital video and audio data but also subtitles in multiple languages.

Digital cinema needs universal standards too. Only then can digital films be shown in any cinema worldwide; In 2005, the six largest Hollywood studios defined the DCI standards, the technical specifications for digital cinema. At the studios' request, researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen have created international test procedures for compliance with the specifications of the DCI standards. In order to ensure that digital film copies meet these standards, the experts at Fraunhofer IIS have developed a software for creating DCPs suitable for all playback devices that work reliably on all cinema systems.

Simple and clear operation

"While developing easyDCP, we really concentrated on keeping operation simple and clear," says Dr. Siegfried Foessel, director of the Moving Picture Technologies department at Fraunhofer IIS. That's a concept that users found persuasive. In very little time easyDCP became the market leader; more than 1000 customers already use the software. Meanwhile large companies have started integrating easyDCP software into their products including Quantel, Drastic, and Blackmagic Design.

"We've tested easyDCP-created cinema packages on any number of playback devices and continuously improved the software," explains Heiko Sparenberg, head of the Digital Cinema group at Fraunhofer IIS. As for why the software has established itself so successfully on the market, "Feedback from our users has played an important role," he explains. The software enables not only the largest studios, but also smaller, independent producers and film makers to create their own digital cinema packages. Post-production companies, film producers, distributors and film festivals – all profit from the comprehensive software functions, such as the adding of subtitles and audio tracks in different languages or the support of 3D formats or 4K resolution. At the Berlin International Film Festival, the software is used to test the quality of digital film copies from around the world, so that flawed cinema packages can be quickly identified, prepared and validated for proper screening.

For their work on the topic "Digital cinema conquers the world – software for creating digital cinema packages enables digital cinema's breakthrough" Dipl.-Inf. Heiko Sparenberg and Dr.-Ing. Siegfried Foessel received last year's Joseph von Fraunhofer Prize. ■

Thanks to universal standards digital films can be shown in any cinema worldwide. Rresearchers in Erlangen have created a test procedures for compliance.
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Dr. Stefan Glunz, winner of the Becquerel Prize 2014.
© *Fraunhofer ISE*

High efficiency solar cells awarded

Since 1989 the European Commission has awarded the Becquerel Prize to distinguish outstanding merits in photovoltaics. This year the prize was awarded to Dr. Stefan Glunz, "Solar Cells – Development and Characterization" division director at the Fraunhofer Institute for Solar Energy Systems ISE. The prize committee honors Stefan Glunz for his excellent pioneering work in the area of high efficiency silicon solar cells and his contribution to the worldwide success of photovoltaic electricity generation. The prize was presented on September 22, 2014 at the European PV Solar Energy Conference (EU PV-SEC) in Amsterdam.

Glunz and his team have managed to increase the efficiency of wafer-based crystalline silicon solar cells and reduce production costs by a variety of methods. These range from investigations on electrically active defects in solar cells through reducing material use to numerous innovations in production technology. Among the highlights is the long-standing world record efficiency for multicrystalline silicon solar cells.

Institute Director Prof. Eicke R. Weber is pleased about this distinction for Stefan Glunz and thus for Fraunhofer ISE. "With this year's Becquerel Prize, the Committee honors one of the best researchers worldwide of next-generation high efficiency photovoltaics, which are now beginning to go into production."

German-Canadian team fights asthma

300 million people suffer from asthma, a further 600 million live with chronic pneumonia and up to 30 percent of the global population contend with allergies. Chronic inflammatory diseases can also affect other organs and parts of the body beyond the respiratory system; they can occur in the intestine, the joints, the skin, or the heart and blood vessels.

A new product made by the Canadian company Nuvo Research Inc. is designed to fight all these inflammatory diseases. And is used already in many countries around the world. Scientists at the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig are now working with a German subsidiary of the company, Nuvo Research GmbH, and the Translational Centre for Regenerative Medicine TRM at Leipzig University to develop a platform that will enable researchers to better understand the way the substance works. Their objective is to optimize the drug to make it more convenient to administer and better tolerated. Above all, the scientists are keen to develop derivatives of the drug with which it might be possible to alleviate an even broader range of chronic illnesses, and to prepare these drugs for approval on the European and Canadian markets.

The three cooperation partners have already conducted two studies and both proved the effectiveness and safety of the basic active ingredient. Currently they are hoping to set up another project that aims to improve the method of application of the drug. In Thailand it is currently administered as an infusion, which means patients have to visit the clinic five days in a row for several hours at a time. The trio is working on preparing the drug in such a way that it can also be injected by family doctors.

Applied research in space

After a decade-long journey chasing its target, Rosetta has become the first spacecraft to rendezvous with a comet, opening a new chapter in Solar System exploration. In November the European Space Agency' deployed its lander, to the surface of Comet 67P/ Churyumov–Gerasimenko.

On order to land the module safely, one of the challenges was the examination of the elastic and plastic properties of the comet.

The required transducers have been developed by the Fraunhofer Institute for Nondestructive Testing IZFP. The Comet Acoustic Surface Sounding Experiment CASSE is one of two instruments that were used to investigate the strength of the ground.

The four-year investment of Fraunhofer IZFP on this project led to a close collaboration with colleagues from the other participating European teams.

German-Thai center of excellence

The German-Thai center of excellence in Bangkok will transfer state-of-the-art digital engineering methods to academia and industry in Thailand. © *Bernd Müller/ Fraunhofer*

A new digital engineering center will now be established in the Science Park of the National Science and Technology Development Agency (NSTDA) in Bangkok. The joint center is set up by the Fraunhofer Institute for Factory Operation and Automation IFF, Otto von Guericke University Magdeburg and the NSTDA, the largest research organization in Thailand. The goal is the transfer of state-of-the-art digital engineering-methods to academia and industry in Thailand.

The center intends to enable students to earn degrees in digital technologies as well as to establish these in Thailand's industry, too. Partnerships with industry and the country's most important universities, including those in Bangkok, Chiang Mai and Khon Kaen, will assure the success of both goals.

Editorial notes

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Hansastrasse 27c
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Press & Public Relations
Phone + 49 89 1205 1301
Fax + 49 89 1205 77 1301
presse@zv.fraunhofer.de
www.fraunhofer.de/magazine
Subscription:
Phone + 49 89 1205 1366
publikationen@fraunhofer.de

Editors:
Klaudia Kunze (Head of Communications)
Beate Koch (Editor-in-chief),
Monika Weiner (Senior Editor),
Marion Horn, Birgit Niesing, Tobias Steinhäußer, Britta Widmann, Christa Schraivogel (Photography and production)

Editorial assistants:
Andreas Beuthner, Klaus Jacob, Bernd Müller, Brigitte Röthlein, Tim Schröder, Ulrike Zechbauer

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