



Fraunhofer

2/12 special issue

magazine

Green chemistry

International
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Fit for recovery



Prof. Dr. Hans-Jörg Bullinger. © Ansgar Pudenz

Good news! The German Bundesbank revised its growth forecast significantly upwards. It seems the German economy has recovered remarkably swiftly from the biggest crisis of the post-war era. There are two main reasons for this: Firstly, the federal government's stimulus programs have proved effective. And secondly, the German economy reacted to the financial crisis in a restrained and considered manner. Companies did not lay off swathes of employees as in previous recessions, but instead used the time to implement rationalization programs and continuing professional development. And now, in these times of economic recovery, they are reaping the benefit of experienced and highly-skilled workers. The added investment firms put into their employees during the crisis is now paying off in the form of added value.

Efficient and productive employees are without doubt the most important asset of any enterprise. Their knowledge and skills are the keys to success in global innovation competition. So how can businesses do more to help their employees become more efficient and productive? Performance is dependent on motivation, skills and fitness – both mental and physical. Currently, in all three of these areas, we are in the midst of a paradigm shift. We promote motivation within an enterprise when we establish a culture of trust, rather than mistrust. Motivated workers need more than just ideal working conditions. They also require development opportunities. And a management style that not only promotes autonomy and assumption of personal responsibility, thus giving them the freedom and encouragement to run with new ideas, but is capable, above all, of dealing with risks and mistakes.

Times have changed when it comes to skills, too. A good education is no longer enough to last a lifetime. On the contrary, continuing professional development is now de rigueur, and retraining has become the norm. Many companies are reacting to this sea change in the working world by laying on intensive training and development programs.

Finally, let us consider the last essential component of motivation: health. In the past, a great deal has been achieved

through programs to humanize the world of work. But here, too, we are facing a radical transition to a holistic approach that encompasses both physical and mental well-being. Just as in sport, fitness is also a prerequisite for excellent performance in the workplace. We must ensure that employees remain healthy – particularly if they are to continue working for longer in future. Many companies have already recognized this and are seeking to establish work practices that promote health, targeting their efforts not least at older workers, who suddenly find themselves back in high demand. Today, almost all branches of industry are desperately seeking new blood to help them take full advantage of the economic upturn.

The German Federal Ministry of Education and Research has also put the spotlight on health by proclaiming the Year of Science 2011 "Research for Our Health". Accordingly, in this issue, we have elected to focus our attention on the concept of regenerative medicine. In our lead article, you can read how it is possible to grow skin in a "factory", and how stem cells will help to cure serious diseases in the future.

After the difficult and turbulent times experienced by so many businesses and employees, it is now more important than ever that we remain fit and healthy. For only if we are in peak condition will we be able to meet the challenges of tomorrow.



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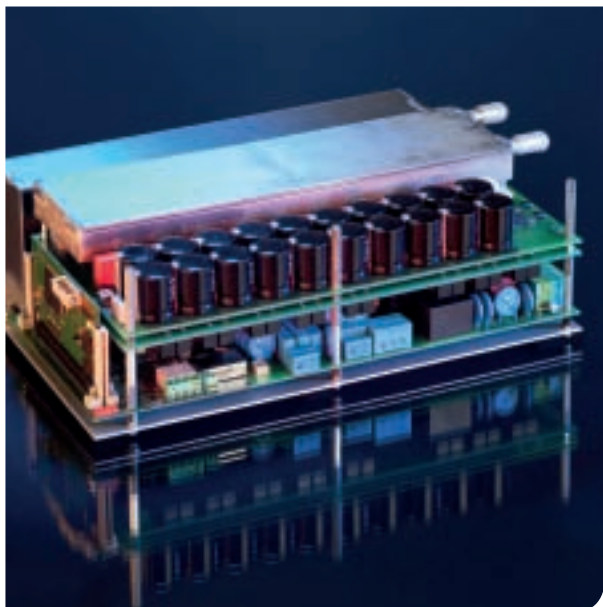
A team of researchers were honored for their achievements in organic electronics.

Plug-in automobiles

Electric cars are regarded as the motor vehicles of the future. They are quiet, clean and, as the need arises, can even help store or deliver energy. Researchers at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg have developed a high-capacity charger able to give the battery of an electric vehicle a charge of up to 80 percent within 45 minutes. In addition, this device achieves a 97 percent efficiency rate. The researchers applied innovative silicon carbide (SiC-JFET) transistors, which convert alternating current from the wall socket into direct current. Employing the SiC-JFET for this procedure means far less energy is wasted than with the transistors previously used.

The appliance is small, compact and suitable for installation in charging stations and in vehicles. As it also has bidirectional functionality: a car which is currently not being used can feed energy back into the network. This means vehicle batteries can provide a flexible storage system for renewable energy and help to balance network fluctuations.

Three-phase bidirectional charger for electric vehicles with a capacity of 22 kilowatts. © Fraunhofer ISE



Targeting cancer cells

Treating cancer with a vaccination made from the body's own cells (an 'autologous' therapy) has the potential to be a promising therapeutic method – but developing a new therapy is a costly and time-consuming process. The Fraunhofer Institute for Cell Therapy and Immunology IZI is supporting the German subsidiary of the Australian company Prima BioMed Ltd. in its efforts to test and gain approval for a novel therapeutic method of treating ovarian cancer. Together they have received some 4.1 million euros of development funding from the federal state of Saxony. The purpose of this collaborative project is to carry out a clinical study in order to gain approval to market the autologous immune therapy CVac™ in Europe, the USA and Australia.

The IZI is primarily responsible for the complex manufacture of the individual clinical trial batches. In CVac™ therapy, scientists isolate dendritic cells from the patient's blood and modify them to present specific tumor antigens. Back in the patient's body, the modification causes the dendritic cells to trigger a response from T cells, thanks to which these white blood cells are then able to recognize and specifically attack tumor cells. This method does not damage any of the body's other cells and is therefore less aggressive than radiotherapy or chemotherapy.

Manufacturing cell products in the cleanroom facilities. © Fraunhofer IZI



Virtual parking tickets

Parking in the city center quickly becomes a real test of nerves. Drivers first have to find a parking space, then later a pay station. Yet some parking garages in cities such as Munich, Essen, Duisburg or Freiburg now offer at least a quasi-automatic payment. The reason for this is a ten centimeter long, film-like RFID chip.

Researchers from the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund have developed the VIATAG RFID system for the Munich-based company motionID technologies. This enables cash-free, straightforward parking. Assisted by the chip on the windshield, a reader detects each vehicle using wireless transmission. Controlled from a central server, the system measures the parking time and debits the charges from the driver's online account. The car is identified using a twelve-digit code, but project manager Arnd Ciprina of the IML rules out any data protection problems: "No personal data are saved on the chip and the code is encrypted, so third parties are unable to attribute the identification numbers to any one user." The system allows more convenient parking for drivers, while making the calculation and billing of parking times more economical for parking garage operators.

The RFID chip is attached to the inside of the windshield. It measures a mere 1.5 by 10 centimeters. © motionID technologies



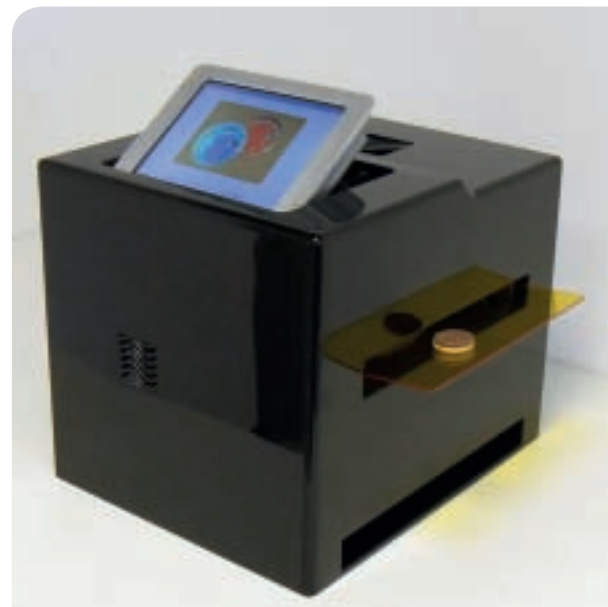
Inspecting food

Are there impurities in the packaged chocolate? Has the package been filled properly? Have the plastic seams been welded correctly? The millimeter-wave sensor SAMMI, short for Stand Alone MilliMeter wave Imager, answers these questions in no time. It sees through all optically non-transparent materials. And unlike x-ray scanners, its radiation does not pose a risk to humans.

The device, no larger than a compact laser printer, was developed by researchers from the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg. SAMMI can be used to scan any type of non-metallic material, whether it is used to inspect products on the production line or to analyze materials in the laboratory. It can detect dangerous substances such as explosives concealed in letters; it can spot cracks in bars of marzipan and even monitor the dehydration process in plants, to see how much they have been affected by periods of drought.

No special safety precautions or training are required to operate the sensor. And at only 20 kilograms, it is also very portable.

The sensor system SAMMI detects dangerous substances and impurities, and can be used to inspect packaging. © Fraunhofer FHR





Green chemistry

Algae can be used for the production of energy and chemicals. © Thomas Ernsting



Petroleum is a vital raw material for the chemical industry. Yet this finite fossil resource is steadily becoming scarcer and more expensive. Biomass, which includes wood, corn starch, sugar beets and vegetable oils, provides one alternative source of carbon. Plastics, paints and fine chemicals can also be produced from by-products of the food industry, such as whey and crab shells. The research community and industry are currently developing new processes for these alternative methods, many of which have already been successfully implemented on a laboratory or pilot scale. The task now is to transfer these methods to a demonstration and industrial scale.

Text: Birgit Niesing

Mobile phones, toys, computers, household devices – so many of the everyday objects around us are derived, at least in part, from petroleum. Oil contains significant amounts of carbon, making it one of the most important raw materials for the chemical industry. It is used in a wide range of products including plastics, carpets, curtains, wall paints, varnishes, soaps, perfumes and hairsprays. But petroleum is not the only source of carbon; it is also found in renewable resources. Yet exploitation of these alternative sources of carbon has so far been minimal, currently comprising little more than a small number of bioplastics made from cellulose, starch, sugar and lactic acid, and various petroleum-free detergents and cosmetics made from vegetable oils.

But is it realistic to think that biomass could replace petroleum? What chemical products can be extracted from plants and similar materials? The U.S. Department of Energy has investigated these and other questions and has concluded that renewable resources can be used to produce certain basic chemicals such as lactic acid and sorbitol. These basic building blocks can then be used to make complex chemical compounds such as those required for fuels, packaging, paints, varnishes, cosmetics and drugs – in other words for virtually any product in the consumer market. In addition, the International Energy Agency

(IEA) Bioenergy has identified a number of bio-based chemicals which can be obtained from biorefineries.

Yet “green” chemistry continues to be a niche topic. The management consulting firm Arthur D. Little estimated the global market for biochemicals at approximately 77 billion U.S. dollars in 2009, which only constitutes four percent of total sales. However, it predicted that this market share could rise to anything up to 17 percent by 2025. Governments have introduced policies to support and promote the switch to this sustainable form of chemistry. In late 2010, the German government approved a budget of 2.4 billion euros for its “National Research Strategy for BioEconomy 2030” which aims to tap into research and innovation to facilitate a structural shift from an oil-based to a bio-based chemical industry.

“We still need to learn to make better use of nature’s carbon reservoirs,” says Professor Thomas Hirth, director of the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart. That would enable renewable raw materials and white biotechnology to finally become a real alternative to petrochemicals. Over recent years, researchers have developed numerous methods of extracting key resources for the chemical industry from biomass. “But many

processes get stuck at the laboratory or pilot stage and never make it as far as industrial-scale development," Hirth explains. "We need new, scalable methods of turning renewable resources into viable materials efficiently and effectively – and those methods need to be tightly interlinked with the production structures that already exist."

To bridge the gap between laboratory development and industrial application, researchers from the IGB and the Fraunhofer Institute for Chemical Technology ICT are building a new facility to house the Fraunhofer Center for Chemical-Biotechnological Processes CBP in Leuna. The 2000-square-meter CBP building will provide space for technical equipment and facilities, laboratories, offices and storerooms. More than 20 industrial concerns and 15 universities and research institutes have expressed interest in participating in the project, which is jointly funded by the German federal government and the federal state of Saxony-Anhalt.

 www.cbp.fraunhofer.de

One of the goals of the Leuna-based researchers is to use materials such as wood chips as a source of carbon. To achieve this, they are building a pilot plant based on a modified Organosolv process, which is a technique used to solubilize the lignin contained in wood. The first step is to extract fermentable sugars and lignin from lignocellulose, a biopolymer that forms the cell walls of woody plants. Next, bacteria convert the sugar into basic chemicals which can be used for various applications – for example for producing plastics such as polyethylene. The researchers are hoping to use the phenols from the wood constituent lignin in the production of adhesives or for chemical syntheses. Any residual materials are used to generate energy in line with the objective of exploiting every possible aspect of wood as a renewable resource.

The CBP also focuses on the utilization of residual biomass, the acquisition of functional substances and energy carriers from microalgae, and the development of new technical enzymes. "The unique thing about the CBP is that, right from the very start, we have been working with industry partners who are making direct use of the products of our research," says Hirth. The chemical companies involved in the project are keen to verify the efficiency and sustainability of the biotech processes in the five available pilot plants – a process they feel should begin right from the pilot phase.

The CBP is involved as well in the "BioEconomy" Cluster of Excellence which is due to receive up to 40 million euros of funding from the German federal ministry of education and research (BMBF) over the next five years. More than 80 companies and research institutes have signed up to participate in the BioEconomy Cluster. "Our goal is to maximize sustainable added value from non-food biomass by using it to obtain novel materials, chemical products and energy," says

Professor Hirth, who coordinates the research projects in the BioEconomy Cluster.

 <http://bioeconomy.de>

One of the most pressing needs is for a natural replacement for the plastics that are currently produced from petroleum. Demand for plastics continues to be extraordinarily high: in Europe alone, each person uses, on average, considerably more than 100 kilograms a year. Some 265 million tons of plastic were produced worldwide in 2010 according to the European trade association PlasticsEurope. Yet bioplastics currently only account for a small fraction of this demand, with just 724,000 tons of "green" plastic coming off the production line in 2010. However, the demand for bioplastics is expected to increase substantially over the next few years. Experts from the industry group European Bioplastics estimate that some 1.7 million tons of green plastic will be produced in 2015.

The question of how to obtain, characterize, modify and process polymers from renewable resources is one of the topics currently being investigated by researchers at the Fraunhofer Institute for Applied Polymer Research IAP in Golm, where scientists are paying particular attention to the use of starch and cellulose as source materials. Starch is a key resource for technical applications such as paper, building materials, adhesives, bioplastics, detergents, cosmetics and pharmaceuticals. Cellulose obtained from lignocellulose is one of the most prevalent biopolymers. It is used in industry to manufacture products such as films, non-woven fibers, sponges, hygiene products and adhesives.

The IAP researchers have many years of experience in this field, particularly in the development of spin processes for a wide range of biopolymers. This experience is now proving invaluable in the development of a new spin process for making artificial high-performance fibers from AMSilk spider silk proteins, a joint project with the company AMSilk GmbH.

Plastic from cellulose

Cellulose is also the source material for Biograde®, a bioplastic developed by researchers from the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen in collaboration with the company FK uR Kunststoff GmbH. A chemical process is used to convert the cellulose into the plastic cellulose acetate. Softeners, fillers and other additives are then used to make the material processible and to adjust its mechanical properties. These additives also stem from renewable resources. After compounding, the bioplastic is ready for use and can be converted into a number of different products, such as ballpoint pen cases and computer keyboards. "As well as being environmentally friendly, Biograde® also offers a relatively high heat distortion temperature for biobased plastics," says Thomas Wodke from UMSICHT, outlining some of the material's key advantages.



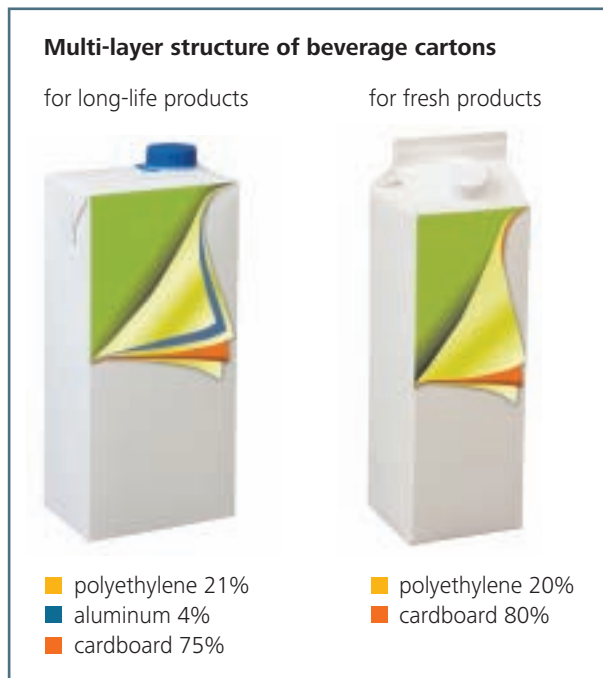
Researchers can obtain the biopolymer lignin from wood. © panthermedia



Oil from the jatropha plant can be used as a renewable resource to make a mineral-oil-free fluid for cooling lubricants. © Caesius



Chitin forms the exoskeleton of crabs and shrimps. Researchers hope to use it to produce basic resources for the chemical industry. © Helki



The coatings in beverage cartons are currently produced from petroleum.
Source: Fachverband Kartonverpackungen für flüssige Nahrungsmittel e.V., Berlin (German association of beverage carton manufacturers)
© nova-Institut

The family of products also includes two additional green polymers: Bio-Flex® is a material for blown or cast film, and the extremely stiff and rigid Fibrolon® is suitable for tableware and tool boxes.

Research conducted at the IAP has also demonstrated how raw plant matter and by-products from agriculture and forestry can be used to produce plastics. As part of the joint project LIGNOS, the IAP researchers are working with the University of Potsdam and aevotis GmbH to separate out the biopolymers contained in the plant materials with the help of newly developed biotech processes in order to significantly expand the range of raw materials available to the chemical industry. Their primary focus is on lignin, almost all of which is currently burned to generate energy.

Making films from whey

The IAP researchers have even managed to produce polyurethane from sugar beet pulp (SBP), a by-product of the sugar refining industry. The polyurethane can be used to make products such as mattresses, shoe soles, seals and flooring. The IAP researchers began by degrading the sugar beet pulp, which is predominantly comprised of pectin, cellulose and hemicellulose, into sugar monomers. They then synthesized polyols from these monomers and used the polyols instead of sorbitol in the production of polyurethane.

Meanwhile, researchers from the IGB have been using a by-product from the manufacture of dairy products as a source material for an integrated biotech process. The milk sugar (lactose) contained in whey can be converted into lactic acid (lactate) with the help of lactic acid bacteria. Lactate not only serves as a preservative and acidifier in the manufacture of foodstuffs, but can also be used as a feedstock in the chemical industry – for example in the production of polylactides, a biodegradable plastic.

Currently, bioplastics are primarily used as a bulk plastic for packaging, blister packs, bottles and disposable tableware. But could biological resources also be used to produce high-grade multilayer films? Companies typically use expensive, petrochemical-based polymers such as ethylene vinyl alcohol (EVOH) copolymers as a barrier material in multilayer films to minimize the amount of oxygen that penetrates the packaging. In the EU-funded project “Wheylayer”, researchers are working on the development of a sustainable packaging material. Their aim is to use whey protein as the barrier film layer. This type of film has many advantages: whey protein film offers excellent biodegradability, and the substances that occur naturally in whey also extend the shelf life of food products. “We have developed an economically viable process that can be used to produce the multifunctional films on an industrial scale,” says Markus Schmid from the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising, which is participating in the project. Coatings are an important component of beverage cartons. Researchers from UMSICHT and the IVV are working on producing carton coatings from renewable resources. Making the switch to bioplastics offers enormous potential: some 44,000 tons of coating polymers are required each year in Germany alone.

At least for the moment, however, biopolymers are not always able to fulfill all the specifications that are required for high-performance plastics. For example, plastics made from polylactic acid (PLA) are generally brittle and have low impact strength. In collaboration with their colleagues from the Fraunhofer Institutes for Chemical Technology ICT in Pfinztal and for Mechanics of Materials IWM in Halle, researchers from the IAP have developed a solution which involves reinforcing the natural plastics with staple fibers of cellulose (rayon). This combination creates a material that is completely bio-based and biodegradable, yet also stable.

Surfactants and lubricants made from biomass

Yet plastics are not the only thing that can be produced from biomass. Researchers are also hoping to manufacture resins, softeners, biosurfactants and solvents from renewable resources. Scientists working on the EU project “BioConSepT” are focusing on lignocellulose, vegetable fats and oils as carbon sources which are not used in the food industry. Using these second-generation resources, the goal is to improve the cost and sustainability of producing the chemicals by

some 30 percent as compared to the equivalent chemical methods and biotech processes based on first-generation raw materials such as glucose. The project involves 31 partners from research and industry as well as small and medium-sized enterprises, including the IGB.

Renewable resources such as ester from animal and vegetable fats already form the basis of technical lubricants, yet their manufacture continues to be very cost-intensive. But researchers from the IVV are hoping to change that. They are using jatropha oil as a basis for producing a cheap, mineral-oil-free, high-performance biogenic base fluid for lubricants in the industrial metalworking industry. To obtain the base fluid from the oil of the jatropha plant, the researchers make use of lipases. The result is a stable mixture of esters, glycerides and residual oil. The process gives an almost 100 percent yield and requires far fewer energy-intensive and cost-intensive cleaning steps.

Crab shells and algae for chemicals

Chitin, which forms the exoskeleton of crabs and shrimp, is a biopolymer that is seldom used. More than 750,000 tons of crustacean shells are disposed of each year in the EU alone. Researchers working on the EU-funded project "ChiBio" are investigating how what is commonly perceived as a waste product could be turned into a viable resource for the chemical industry. "Based on the concept of a biorefinery, we are developing a number of ways of utilizing the material and energy of crustacean shells with the goal of making the fullest and most efficient use of this residual material," says Professor Volker Sieber, the coordinator of ChiBio and head of the IGB's BioCat project group in Straubing.

Perhaps one of the most versatile renewable resources is algae, which can be converted into fuel, electricity, heat and fine chemicals. Researchers at the IGB use algae to produce fatty acids and carotenoids, for example. The algae are

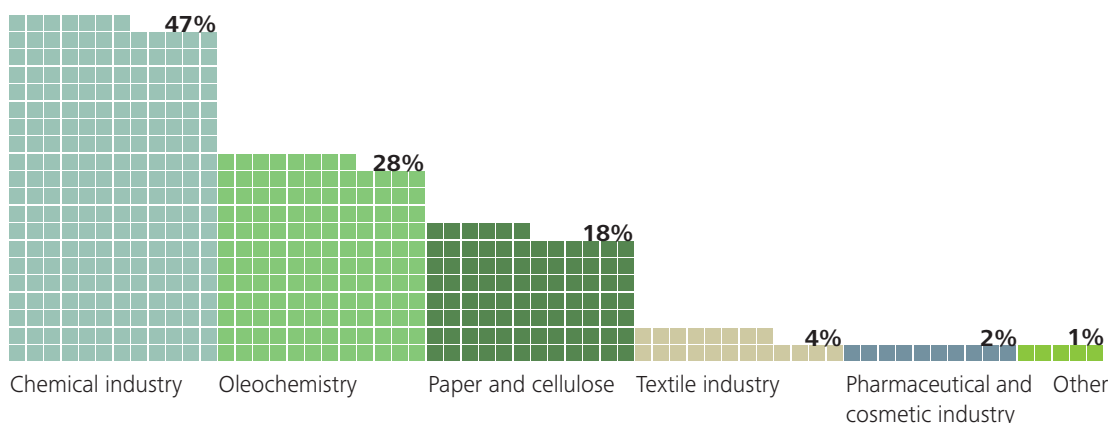
cultivated in a flat-panel airlift reactor in order to harvest the valuable resources they contain.

An EU project that began in 2011 has gone one step further. Researchers are cultivating microalgae in a wastewater treatment facility in southern Spain in order to produce biofuels such as methane and diesel on an industrial scale. The project offers an opportunity to investigate the entire process chain, including nutrient removal from waste water, algae cultivation, the extraction of useful substances, and the subsequent production of biofuel. Researchers from UMSI-CHT are also involved in the project. They are analyzing the chemical composition of the algae oil and identifying value-added products. The polyunsaturated oils in algae oil are of great interest to sectors such as the animal feed industry. The remainder of the algae oil is cleaned up by the researchers and converted into biodiesel.

"White biotechnology uses nature as a chemical factory. Traditional chemical production processes are replaced by microorganisms or enzymes," Thomas Hirth explains. That also helps to massively reduce carbon dioxide emissions, according to a study by the Danish branch of the environmental organization World Wide Fund for Nature (WWF) and the Danish biotech firm Novozymes. Their conclusions suggest that exploiting industrial biotechnology to its fullest extent between now and 2030 would reduce carbon dioxide emissions by somewhere between one and 2.5 billion tons a year.

Nature offers huge potential for the chemical industry – but very little of this potential is currently being exploited. In Germany, renewable resources make up just 13 percent of the raw materials used in the chemical industry. To reduce our dependence on petroleum, business and industry will need to place far more emphasis on renewable natural resources. But this will only happen if we can find more efficient ways of scaling up biomass-based methods from a laboratory to an industrial scale. ■

Use of renewable resources (excl. wood)



Acoustic perfection in the office

Disturbing background noise often makes working in an office environment much harder - particularly in the case of telephone conferences. Above all, this affects people who suffer from hearing impairment. A team of scientists is now tackling this very problem.

Text: Tim Schröder

For international corporations, daily conference calls have long since become an indispensable communication tool. Nowadays, every large corporation has its own call center. And what would business be like without a quick cell phone call here and there? As long as callers can hear each other clearly, everything is fine. But things get difficult when voices are lost in a sea of sound arising from echoes, reverberation and other background noises, which leaves callers at the receiving end hearing nothing but gibberish. During a telephone conference, participants may ask one another to repeat themselves once or twice, but then this repetitive inquiring becomes uncomfortable and they are left with having to strain themselves to listen in the hopes of being able to understand.

This is exactly what researchers from the Hearing, Speech and Audio Technology project group at the Fraunhofer Institute for Digital Media Technology IDMT in Oldenburg aim to change. Together with researchers from the Hörzentrum Oldenburg and the Akustikbüro Oldenburg within the "Auditory Valley" interdisciplinary research network, they are currently working on improving acoustics and communication technologies in office environments.

One goal is to attain perfect speech transmission in every situation. To achieve this, researchers are developing an acoustic filter that separates voices from background noise; only speech is then transmitted over the phone line. "We're contributing our expert knowledge in acoustic signal processing to the cooperation," states

Jan Rennies, IDMT project manager in Oldenburg. The Akustikbüro Oldenburg is responsible for planning and optimizing room acoustics, while the Hörzentrum Oldenburg is leveraging its expertise in the basic medical principles of hearing and the effects of sounds, and in particular its experience in hearing aid development. It is estimated that approximately 70 million adults in Europe suffer from hearing impairment that requires treatment, yet only 20 percent actually use a hearing aid. "So there's a lot of people out there who have a real problem with today's non-optimal telecommunications technologies," says Markus Meis, project manager at the Hörzentrum.

Disturbing noises lessen the ability to concentrate

Researchers are approaching this problem from two angles. Rennies is focusing on filtering out distracting noises from the acoustic signal itself. Christian Nocke from the Akustikbüro Oldenburg and Markus Meis are planning and assessing office space with optimal acoustic properties. Just what those are depends on the type of application. "The requirements for an open-plan call center differ from those for a telephone-conference room," says Nocke. As a result of the cooperation, several voice processing prototypes have now been developed that clearly separate speech from interfering background noise. The protocols are based on calculation specifications - algorithms that filter out speech from disruptive noises based on certain characteristics. The voice, for example, follows a typical four-hertz



rhythm with four syllables per second. In an office, this signal blends into a multitude of other noises. Telephone conference calls can prove to be particularly tricky because words resonate in the room. In addition, the caller's voice echoes from the loudspeaker, and bothersome background noises, such as the fan in the projector or the rustling of papers, can also be heard. But no matter what the noise, Rennies' software can handle it. An example is the "SI-Live Demo" program. This software shows conference participants how well their voice can currently be heard by displaying red-green bars on a screen, so speakers will know straight away if someone at the receiving end is having a problem following the conversation.

An additional component is the "HearingAssistance4Conferencing" program, which above all aims to facilitate communication for people with



Much of the noise in a call center is simply down to how loud open-plan offices are.
© FBloomberg/Kontributor

keeping any manual configurations to a minimum. Fortunately, the requirements for a phone are not quite as demanding as those for a hearing aid. Telephones generally only transmit sounds between 300 and 3,400 hertz, which quite accurately corresponds to the most important sounds in speech. Rennies is taking the first step toward tailored communication devices with the telephones that are currently being tested in a senior citizen center. Users can select specific hearing corrections using the phone's keypad. One option amplifies only higher tones, while another amplifies all frequencies. "That in itself leads to significant improvements in understanding what's being said," reports Rennies. "Many people with hearing aids still have difficulty using a telephone, because finding the right position for the receiver in relation to the hearing aid's microphone often takes so long that they miss the caller's name."

Although there is as yet no finished product, the tests conducted on the software prototypes have proven to be a success. And industry partners are already showing interest. Meis is convinced that "a telephone conference with perfect voice transmission would be a huge relief – especially when people are speaking a foreign language. In that case, it is particularly important to achieve excellent speech intelligibility while keeping listening effort to a minimum."

Researchers are also working on how best to improve "in-office acoustics". The Akustikbüro Oldenburg provides consultations and tailored solutions to companies for acoustic office planning. In a conference room, it is important for the presenter to be heard well and clearly. In open-plan offices, the opposite holds true. Employees who can clearly hear what is being said at neighboring desks can barely concentrate on their own work. Here the ideal is for individual voices to disappear into the background murmur. "In many cases, problems can be solved with architectural modifications," says Nocke, for instance walls that absorb or shield from echoes. Other situations would benefit more from an acoustic system such as the one designed by the Fraunhofer researchers. ■

hearing impairments. The software not only filters out speech from the surrounding noises, but also responds to the individual needs of the hearing impaired. Although this may sound simple, the technology is in fact really something special. The hearing of most sufferers is poor only across certain frequency ranges – usually higher-pitched tones – so the software must be intelligent enough to specifically amplify only those frequencies for each individual.

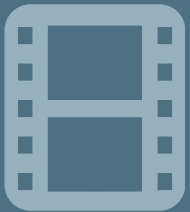
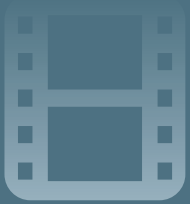
Hearing aid know-how combined with consumer electronics

Hearing aids have been able to do this for quite some time, but they require several adjustments by professional hearing aid acousticians before ideal results are achieved for each individual patient. Rennies is now venturing into everyday communication electronics. "We are merging

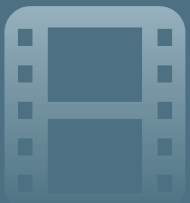
our hearing device know-how with consumer electronics," says the researcher. "This is something new." Of course, no one will be prepared to take their telephones or conference systems to a hearing-aid specialist in future to have them configured. "We have to find a simpler way to tailor devices to the needs of each user," explains Rennies. He is currently developing playful approaches, such as interactive slide controls that let users individually configure even televisions to their own hearing needs.

The challenge lies in automating this customization process as much as possible. "You have to individually adjust several dozen parameters to reach the optimal result. That's something only a hearing-aid specialist can do," emphasizes the expert. For this reason, Rennies' algorithms have to be clever enough to carry out the majority of adjustments to electronic devices themselves,

Pictures pick up the pace



H.264



Hundreds of programs, movies in the highest quality HD, and even in 3D – television viewers can select from an ever expanding range and ever greater quality. A refined compression mode called “H.264” ensures that the image stream gets channeled into their living rooms without any data congestion.

In 2012, a television era will come to an end in Germany: the last analog satellites, TV towers and antennas are being turned off. The future belongs to digital technologies: image and sound data reach the living room via satellite, broadband cable, fiber optics or DSL connections. Viewers can choose from hundreds of programs; some are already broadcast in highest resolution, and even in 3D.

This new flood of images generates a massive data stream that would typically clog the most up-to-date fiber optic networks in the blink of an eye – were it not for some ingenious engineering methods, designed to compress the moving images for transportation. The inter-national standard is the H.264 compression process. One of the masterminds behind this technology is Dr. Thomas Wiegand of the Fraunhofer Institute for Telecommunications,

Heinrich-Hertz-Institut HHI in Berlin. Thanks to processes such as H.264, customers of Telekom Entertain can watch movies in outstanding visual quality via DSL. Cable network providers are even able to offer their subscribers high-resolution, made-for-TV movies. The compression standard minimizes the data volume sent through the network to less than one one-hundredth. So, for instance, a once-unwieldy stream of 160 megabytes per second – roughly equivalent to the data volume needed for one HDTV program – is now turned into a much more manageable single megabyte that can be transmitted in real time.

Rapid transmission, thanks to compression

Even though this technology has revolutionized the transmission of moving pictures, it remains rather obscure. An average television viewer has not the slightest notion that behind the images he has just enjoyed viewing lies a myriad of data processing methods. The reason: H.264 is so good that to most people, the compression goes completely undetected. Similar to an mp3, the compression standard for audio files, the user does not notice that he is getting streamlined data, because he probably would not perceive what is missing in the first place.

A video consists of 25 or more individual images per second. When compressing video data, the software analyzes adjacent images and looks for the areas within them that have changed. Only these changes need to be transmitted. Everything else remains as it was, and is not sent again. For example, a decoder attached to the DSL network in the set-top box from Telekom Entertain combines the new information with the unchanged portions of the preceding images. "A unique aspect of H.264 is that for the forecast we not only use the one immediately preceding image, but rather several images. That way, the image content that was already visible before, and that appears again, can be predicted with extreme precision, and the consumer perceives no impairment to the image quality," explains Thomas Wiegand who, together with his team, devised several new compression and decompression algorithms in H.264.

From the very start, this process captivated Dr. Peter List of Telekom Innovation Laboratories. He

had already compiled his own test software ten years ago, which gave Telekom an idea of what was still left over after the original video data had been compressed and decompressed. "Most of all, we wanted to be in a position to independently assess how well coders and decoders really functioned as a whole, as well as the individual methods," the engineer recalls. "That was extremely important for us when it came to separating the wheat from the chaff among all the methods proposed." For more than a quarter century, the effort has been to lower the requisite bandwidth for digital video, and to increase bandwidth for networks. "But with the development of H.264, we successfully broke through that magical threshold that let us realize our original vision of television service to our customers only through our own networks," says List.

Virtual video library with downloadable movies

Telekom Entertain has well in excess of 1.4 million customers today who currently can select from up to 140 different TV channels via the Internet, or help themselves to their own favorite movies and series through the "Video Load" online video library. Telekom's videoconferencing services also use H.264: "The quality has become so impeccable that you can display your meeting counterparts in life-size dimension, which lets the conference participants get the feeling that they are really communicating in a face-to-face conference with each other," List explains with delight.

The pilot program developed by Peter List has also been further refined: it has been employed in several projects and prototypes at Telekom, such as video transmission in DAT channels (DAT=Digital Audio Broadcasting), for example, or the automatic measurement of subjective quality at Telekom Entertain. Telekom intends to use the technology in the future so that it can secure and further enhance quality at an early stage in the production and transmission of Entertain programs.

The involvement of Thomas Wiegand, Peter List and others at the outset was critical to the development of H.264. As a team, they worked collectively on the H.264 process. It has played a decisive role in a number of projects between Fraunhofer HHI and Deutsche Telekom. ■

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Testing solar panels in the American desert

In the U.S. state of New Mexico, researchers are testing solar modules under extreme weather conditions in a bid to improve their performance. The site was chosen because the sun shines here for longer and with greater intensity than most other places in North America. The test data from this location enable the modules' longterm output to be established.

Text: Monika Weiner

Nothing but bare rock, sand, dry grass: the only trees grow on the banks of the Rio Grande. Rain is rarely seen in Albuquerque, where the sun shines for 300 days each year. In summer the temperature rises to over 30 degrees Celsius in the shade, and the ground is often covered with frost in winter. Appropriate headgear is required all year round, be it a woolen hat or sunglasses. The largest city in the state of New Mexico lies 1,500 meters above sea level, and the sun shines with an intensity more than twice as high as that in Germany.

These extreme climatic conditions are a blessing for researchers aiming to perfect methods of converting solar energy into electricity, who have been flocking to Albuquerque in recent years. The local climate, with its intense solar radiation and extreme variations in temperature, offers the ideal conditions for testing and optimizing their designs. The region is also ideally suited for the construction of large-scale solar power plants capable of supplying consumers throughout the United States with clean energy. It is therefore not surprising that numerous well-known companies and research organizations have set up laboratories here.

The future begins a couple of miles behind the airport. The line of buildings on University Boulevard stretches up to Mesa del Sol, on the edge of a parched, pancake-flat plain that extends to the foothills of the Sandia mountain chain. There is plenty of space for everyone in the New Mexican desert. Residents include solar-module manufacturer Schott Solar, which has erected a huge production facility here, right next door to the Sandia National Labs, that are specialized in energy technologies with significant activities in photovoltaics. Since the spring of 2011, they have had a new neighbor at University Boule-

vard 5600 A – the CFV Solar Test Laboratory operated jointly by Germany's VDE test institute, the Canadian Standards Association CSA, the Fraunhofer-Gesellschaft and Fraunhofer USA. The technological expertise for this joint venture is provided by the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg.

Research on an XXL scale: the Solar Test Laboratory's indoor laboratories cover a surface area of 2,500 square meters, and the researchers have access to a further 25,000 square meters of outdoor testing facilities. The laboratories are so vast that the installed equipment – container-sized climate chambers and four-meter-high experimental setups for testing the breaking strength of the solar modules – seem dwarf-like by comparison. "At this site, we have been able to create the technical capabilities needed to certify all conventional types of solar module based on silicon, thin-film and concentrator technology, not only to American UL standards but also to International Energy Commission (IEC) standards," says Martin Plass, the test laboratory's general manager. "Certification is of enormous importance to manufacturers who want to commercialize photovoltaic products: the IEC certificate guarantees that the module will perform as promised, the UL certificate that it complies with U.S. safety requirements."

There is a huge demand for these certificates because numerous manufacturers are keen to capture a share of the rapidly growing North American market. The total electrical output of new photovoltaic systems installed in the United States has risen by 140 percent over the past year. Martin Plass and his team can conduct one hundred complete tests per year, each comprising extensive stress and safety tests, weather tests in the climate chamber and under

exposure to UV light, high-voltage resistance tests, output measurements, and several months of outdoor testing.

The tests are tough: only 60-70 percent of modules manage to pass them first time round. To meet IEC and UL safety standards, a photovoltaic module has to remain intact when bombarded with hailstones the size of golf balls, support the weight of 1000 kilos of sandbags without breaking, and never produce a short circuit, even when immersed in water. If, in addition, manufacturers want to obtain IEC design qualification and type approval, their modules have to pass a series of endurance and performance tests, including for example lengthy exposure to widely fluctuating temperatures ranging from minus 40 to plus 85 degrees Celsius in the climate chamber, or damp heat testing at a relative humidity of 85 percent and a temperature of 85 degrees Celsius for 1000 hours. The modules also undergo a so-called flash test, which is used to determine whether the power output corresponds to the manufacturer's specifications. To prove this the module is exposed to a short, bright flash of light generating an energy flux of 1,000 watts per square meter. Once the module has passed these tests, the engineers then take it outside to check whether the material continues to perform as well in real conditions. Depending on the material, outdoor testing can last anywhere between a few days and several months. "Thanks to the intense insolation in New Mexico, we can perform the same tests here nearly five times faster than at the ISE in Freiburg, which has been providing a certification test services since many years," says Plass.

Outdoor testing is an art unto itself. To measure the temperature of the cells under operating

At the outdoor testing facility in New Mexico researchers can measure the performance of the solar modules. Is it as good as promised? .

© Monika Weiner

conditions, the engineers bolt silicon modules onto an inclined scaffold to simulate the angle of exposure on a house roof. To find out how the technology responds to intense sunlight, the modules are mounted on moving platforms, called trackers – cleverly designed by a spinoff of ISE in Freiburg. Each tracker is equipped with two motorized axes linked to a sophisticated computerized control system that ensures that the modules remain oriented toward the sun as it moves through the sky from east to west each day. “This setup enables us to reach the required total insolation, measured in kilowatt-hours per square meter, a great deal faster, and thus considerably reduces the time needed to determine whether the module is capable of delivering a stable power output that matches the data supplied by the manufacturer,” explains Plass.

Future photovoltaic systems put to the test

As well as being a test site, Albuquerque is also a research center. The outdoor facilities of the Solar Test Laboratory are shared with engineers

Test facilities serving the global market

IEC certification is an internationally recognized sign of quality, not only in the United States. It is conferred by many approved institutions, including the VDE Institute in Offenbach. In order to offer designers and manufacturers the ability to test their products under the most realistic outdoor operating conditions, the VDE has entered into cooperation agreements with research institutions on three continents. As a general rule, the tests are carried out in the geographical region in which the solar modules are to be sold.

Products destined for the European market are tested by the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg. For the North American market, tests are carried out by the recently established CFV Solar Test Laboratory. Products for the Asian market are tested by the Solar Energy Research Center of Singapore SERIS.

The UL safety mark is required for products marketed in North America and is awarded by institutions including the Canadian Standards Association (CSA).



from the Fraunhofer Center for Sustainable Energy Systems CSE, based in Cambridge, Massachusetts – a region of the United States not exactly favored by high solar insolation but with a strong reputation for excellently trained engineers, innovative companies and people who strongly support ecological ideas. “New England is the ideal location for our activities: just a stone’s throw from the world-renowned Massachusetts Institute of Technology MIT and other world class universities like Harvard, as well as in close proximity to the many photovoltaic companies who have set up R&D and manufacturing operations in the region,” reports CSE director Dr. Christian Hoepfner. He and his team of researchers are developing advanced photovoltaic modules for tomorrow’s markets in collaboration with industrial partners.

The Fraunhofer researchers in Cambridge are delighted to be working together with the team in Albuquerque and the CFV Solar Test Laboratory. At long last, they can now test their new technologies in the region where future large-scale photovoltaic plants are to be built: in the south-western states of the USA. Hoepfner: “Our team in Albuquerque will be able to advise customers and work with them on site.”

David Meakin is one of the Fraunhofer engineers who began an assignment in Mesa del Sol six

months ago. “Out here we have all the facilities we need to test photovoltaic components and even complete systems that we have developed on behalf of our customers under real conditions. For instance, we can measure the amount of electricity fed into the grid at different levels of light intensity.” But this is just the beginning of a long-term program in New Mexico in which the Fraunhofer researchers not only intend to carry out tests but also predict future performance: for example the extent to which materials degrade and the output of a photovoltaic module changes after decades of use. “To help us make such lifetime predictions, we have launched the Fraunhofer Photovoltaic Module Durability Initiative PVDI in collaboration with Fraunhofer ISE and our industrial partners, which aims to develop new test procedures that deliver more accurate data than today’s standard methods,” reports David Meakin. This approach involves a more rigorous series of endurance tests in which the modules are required to operate reliably during repeated long-term damp heat testing while under electric load, withstand dynamic mechanical loads, and operate for up to one year in the open air without any loss of functional efficiency. The engineers intend to use the data collected during these tests to calculate the probability that a module will be able to achieve its defined service life. The first of these long-term test programs was started a few weeks ago. The ultimate aim of the Fraunhofer

researchers is to build up a database that they can use to assess the performance of new modules relative to existing ones as they are launched on the market.

While the solar energy experts are hard at work in their laboratory on University Boulevard, programming software and evaluating test data, a vision is being realized outside their door: at the end of the street, caterpillar trucks, earth moving equipment and cranes are laying the foundations for a model city incarnating ecological principles that might serve as an example for other development projects throughout the United States. In this new city, nobody will need to own a car: all stores, schools, churches and administrative offices will be within walking distance. There will be cycle paths and homes designed to minimize the consumption of energy and water. The electricity supply for this modern-day desert oasis will be derived from renewable sources – principally photovoltaic plants. This is nothing less than a revolution by American standards, given that most modern cities have been designed around the automobile. If everything works out as planned, Mesa del Sol will soon be the Eldorado not only for solar-energy researchers but also for families seeking a more environmentally compatible lifestyle. And they will quickly realize that it is possible to live the good life with renewable energy – especially in a region blessed with as many hours of sunshine as New Mexico. ■

Skyscrapers are rare in Albuquerque. The city expands largely into the desert. In the suburbs there is a lot of space – for solar panels and the testing facility. © *Sahmeditor*



Vegetarian cutlet

It looks like a cutlet, it's juicy and fibrous like a cutlet, and it even chews with the consistency of a real cutlet – but the ingredients are 100 per-cent vegetable. Researchers are using a new method to prepare a meat substitute that not only tastes good, but is also environmentally sustainable.

Text: Monika Weiner



Meat production is complicated, costly and not eco-friendly: fattened animals have to consume five to eight kilos of grain just to generate one kilogram of meat. It would be simpler and more sustainable if one were to make cutlets from seed – without the detour through the animal's body. Impossible? Not entirely: there are plants that are suitable for the production of meat substitute products. Researchers in the EU-project "LikeMeat" have studied what they are, and how they can be incorporated into a product that tastes and looks like meat. "Studies have shown that many Europeans are ready to give up meat, but there have only been a handful of alternatives until now," explains Florian Wild. The researcher at the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising is spearheading the project. "Our goal is to develop a vegetable surrogate for meat that is both juicy and fibrous, but that also has a pleasant flavor. The product should have a long shelf life, it should not be more expensive than meat, and we want it to be suitable for vegetarians and allergy sufferers."

In addition to the scientists at IVV, experts from the University of Natural Resources and Life Sciences, Vienna (BOKU) are also participating in the development, as are consumer researchers from the University of Wageningen, in the Netherlands, and eleven small to medium-sized corporations that manufacture or do business in food or food ingredients. The team roster also includes two Austrian and one Dutch company that have hitherto only processed meat, as well as an organic food producer from Spain. "As a group, we are seeking to engineer a simple production chain in which pure vegetable raw materials are used to produce a meat substitute that corresponds to consumer preferences," as Wild summarizes it. The ingredients originate from the land: wheat and peas, lupins and soya are all suited for production, explains Wild: "We are intentionally not tying ourselves down to one type of plant because many people get an

allergic reaction to one or the other substance. In the process, we have developed a variety of recipes. They are the basis for a product spectrum that offers a broad selection to people who suffer food intolerance or allergies."

But how do you turn a field crop into meat? "The processing technology was the biggest challenge," recalls the project manager. The previously conventional methods of mixing plant proteins with a little water, and heating them under high pressure, proved to be useless: with this hot extrusion process, the mass is heated up under high pressure. At the moment when it pushes through the die, the temperature drops dramatically, steam is released and the mass foams up. That is certainly the desired effect when making peanut puffs. But not in the production of meat substitutes. Wild and his colleagues use a new process specially developed for meat substitutes: the main ingredients – water and plant proteins – are brought to boil and slowly cooled down. Since no sudden release of pressure takes place, no steam blows out of the paste. As the temperature sinks, the protein molecules start to form chains. This gives rise to a fibrous structure that is quite similar to that of meat.

The prototype of the new vegetarian cutlet factory is currently located in the IVV laboratory. The system is no larger than two table tennis tables. On request, it can produce one endless piece of meat approximately one centimeter thick that can be shaped as desired, for example into little morsels for diced or thinly-sliced meats, or entire cutlets. The research team is currently able to produce 60 to 70 kilos of the meat substitute per hour – or 300 to 500 kilos per day. "Consistency and texture are already superb," Wild assures. There is still a little work to do on the flavor. By the end of the project term, in one year, the meat substitute from the land should be every bit as good as a genuine cutlet, and it should come directly from the machine, ready-to-eat. ■

The battle against AIDS

The first mobile safety laboratory to operate under biosafety level 3 conditions has been in operation in South Africa since May 2011. By cutting the time between diagnosis and the start of treatment to just one day, the mobile laboratory truck can mean the difference between life and death for AIDS patients in remote areas.

Text: Peter Hummel, Photos: Bernd Müller



Health authorities in the West Cape region send these gold-clad figures into the streets in rural areas to spread the message that people should take an HIV test.



Caledon is a small town located 160 kilometers from Cape Town in South Africa's Overberg district. The only jobs are in the malting plant and the casino. Those people who are out of work pass their time in the few stores still in business on the main street through town, or simply sit in front of their tin shacks hoping for better times. Caledon is not particularly attractive or well-known, and it offers very little in the way of opportunities. Caledon is simply a normal town in South Africa – where 60 percent of the inhabitants of townships are HIV positive.

But today there is a ray of hope heading down the rough track towards Caledon: a large white truck drives up to the square, turns the corner and comes to a halt. News of the arrival of this giant beast spreads like wildfire from shack to shack.

As he instructs the truck driver where to park, Uwe Schön is still struggling to believe that he is really here. "We've made it – finally!" he says. "Now it's time to see how our baby works in practice!" This particular baby – the world's first mobile biosafety laboratory – is 15 meters long, 2.5 meters wide and four meters tall. Uwe Schön is a physicist at the Sulzbach site of the Fraunhofer Institute for Biomedical Engineering IBMT in Germany's Saarland region, and he has spent the past five years working as the chief engineer on this truck project. Now the vehicle is operated by the local government of South Africa's Western Cape province – and Caledon is its first stop. 40-year-old Suzette Pheiffer hurries over to talk to the new arrivals. "Can you really test people's blood right here on the spot with this thing?" she asks. Uwe Schön nods. "That's great!" says Suzette, explaining that she works in a care home and that the blood samples they send off to distant Cape Town regularly get lost in transit. "It's really good that you are doing this. Welcome to the end of the world!"

Mobile laboratory improves medical care

Mobile labs can help fill a gap in patient care systems on continents such as Africa, where journeys tend to be long and arduous and extreme poverty means that people cannot afford to miss two days of work to take an HIV test. Up until now, the standard procedure was for patients to go to their nearest hospital to have a blood

sample taken. From there, the sample would be sent to a central laboratory. To get the results – some 14 days later – the patient would then have to return to the hospital. "For many people, the logistics of going through that whole process are almost impossible," says Professor Hagen von Briesen, research director of the Mobile Lab project. "And of course they are wasting valuable time in which treatment could have already started. If viral load is increasing, the need for treatment is acute."

This situation inspired researchers far from Africa in Germany's Saarland region to come up with the idea of a mobile laboratory in 2007 – a solution that would shift the entire process to people's home towns and reduce it to just a few hours. Scientists at the University of California, Los Angeles, had already determined that the biggest problem for people in rural areas of Africa was the lack of medical technology infrastructure. But numerous efforts around the world to design a mobile laboratory had always ended in failure because technicians were unable to find a way of getting the highly sensitive equipment on the road without it being damaged by vibrations and requiring constant recalibration due to changes in climatic conditions. Even the military had failed to make any headway in the face of these obstacles. "It took us a long time and a lot of innovative thinking," says Uwe Schön, "but by collaborating with a company that makes special-purpose vehicles we finally cracked it! For the first time, we have shown that it is possible to get approval for a mobile safety laboratory that can travel to where people need it most."

Inside the mobile laboratory, preparations are underway to test the first samples. Sim, the lab assistant, establishes an internet connection while his colleague Byron passes through the airlock to access the rear section of the truck, which contains all the essential technical equipment. The air that goes in and out of this rear compartment is filtered to protect technicians, patients and the environment; the temperature is kept constant, and a diesel generator is on hand to supply power as needed. The project team has also provided a sterilizer for contaminated items, as well as the equipment required to grow cell cultures – a process that can take up to three weeks. The liquid-filled containers for cell cultures are inserted into a contraption

secured to the laboratory ceiling which remains constantly in a horizontal position regardless of whether the truck is braking, accelerating, climbing a hill, or taking a bend. The lab even features an autoclave with its own dedicated water circulation system. "The conditions we have here are perfect – as good as those in a hospital," enthuses Byron.

What is still far from perfect is the knowledge and understanding of HIV and AIDS among Africa's population. 25-year-old Janine Ross is a counselor and social worker at a South African organization who works with hundreds of HIV patients in the area around Caledon. "This issue is still taboo in many segments of South Africa's population," she says. "People go to tremendous lengths to avoid being seen when they come to my office to pick up their next two-month supply of drugs."

AIDS has already claimed more than 25 million lives

Thirty years ago, two doctors – Michael Gottlieb and Wayne Sandera – published the first ever description of AIDS cases in a two-page report which appeared in an issue of "Morbidity and Mortality". Since then, 25 million people have died from the disease. It was not until the mid-1990s that drug companies released the first drugs capable of reinforcing people's immune systems and delaying the onset of the disease. Today, modified versions of these drugs have also reached Africa. After countless patent disputes, they have finally been made available at an affordable price. "Now that we have access to drugs that work, nobody should be dying from AIDS," says virologist Prof. Dr. Wolfgang Preiser from Frankfurt, who heads the Department of Medical Virology at Tygerberg Hospital in Cape Town. "The hope now is that we will one day find a vaccine." This is another area in which the mobile laboratory could prove to be a lifesaver. During the development process, Professors Preiser and von Briesen insisted that the mobile lab should include a cryobank using an electronic chip attached to each sample for a 100 percent identification during storage at minus 195 degrees Celsius to keep the samples in perfect condition.

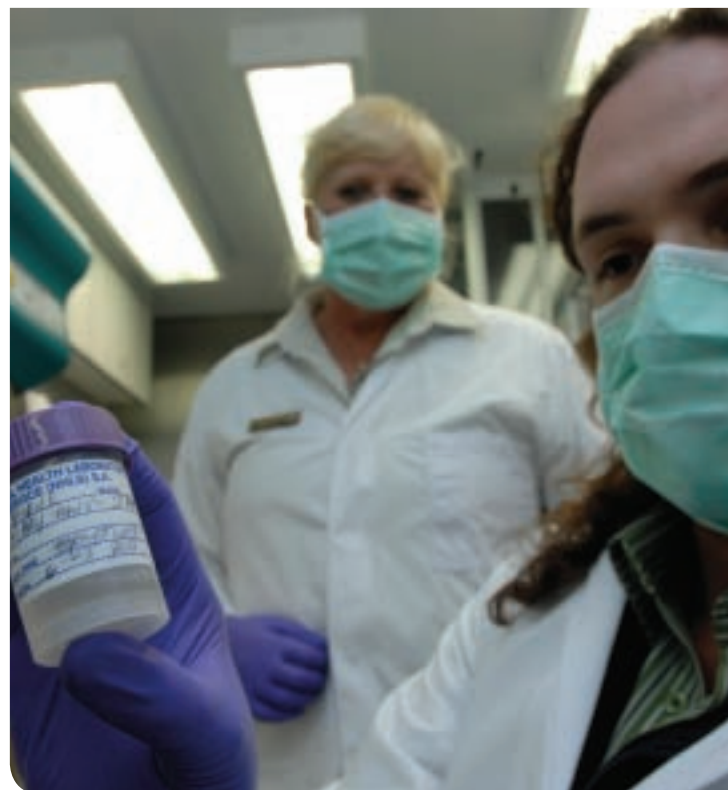
"This is an absolutely fantastic resource for vaccine researchers everywhere. We know what a struggle it can be to get hold of fresh,



The "lab on wheels" arrives in the South African town of Caledon.



Prof. Dr. Hagen von Briesen, Uwe Schön and Sam Khulela (from left to right) in the mobile lab.



Running the first test: South African lab assistants test an infectious sample.



Everyone who takes an HIV test receives a bracelet with the words "I know".



Many of those tested are HIV positive.



Mary-Ann (left) and Angeline are two sisters who have decided to take the test.



The truck looks huge in comparison to the local hospital.

high-quality samples," says Preiser. "This is the solution they have been looking for. And it is also a step forward for large-scale studies looking to maximize standardization." The development of this technology at the Fraunhofer institute in Sulzbach was extensively funded by the Bill & Melinda Gates Foundation. "A mobile cryobank gives us an opportunity to make major advances in HIV research," says the cell biologist von Briesen. "The fact is that immune cells are extremely sensitive: if you leave a sample at room temperature the cells change and you end up with distorted test results. That's why it is so important to freeze them within a defined period of time."

The mobile lab's patients can opt to be tested for TB as well as HIV. In this part of South Africa,

tuberculosis is at least as much of a chronic problem as HIV. Active tuberculosis generally develops in people who have a weakened immune system, so these two diseases often go hand in hand, as von Briesen explains: "Nowadays we can provide pretty good treatment for HIV – but things get a lot more difficult when we are faced with a combination of TB and an HIV infection. Diagnosis at an early stage is particularly important in these cases. That's where we will really start to see the benefits the mobile laboratory offers." Because tuberculosis is so infectious, the laboratory was required to obtain biosafety level 3 certification in accordance with the German biomaterial regulation BioStoffV.

Two hours ago, Mary-Ann and Angeline, two sisters in their early 20s, handed in their samples,

which Byron then tested for tuberculosis and HIV in the mobile lab. The social worker Janine Ross calls in the two young women to give them their results. "Well," she says, unfolding a piece of paper, "I have your results, and they show no active TB, and no HIV infection." The girls greet the good news with relief.

"We now know that the concept works. The laboratory of the future will be mobile and automated, and it will build people's confidence by being closer to patients than ever before," says Uwe Schön, who is delighted with the project's success. Now this engineer wants to build several more mobile laboratories, with the hope that people in other parts of Africa might also begin to benefit from the extended reach of this mobile solution developed in Germany. ■

Bobsled runs – fast and yet safe

They should prove a challenge for the athletes, but not put them in danger: bobsled runs have to be simulated before being built. This simulation is based on the friction levels of the runners on the ice. Now it has become possible to measure these levels accurately. These results will help build the run for the 2014 Olympic Winter Games.

Text:
Janine van Ackeren

The friction levels of runners can now be measured accurately: top right, the measuring setup with runner and sensor in the ice channel; below right, various types of runner: (left to right) bob, skeleton and luge. © Fraunhofer IWM

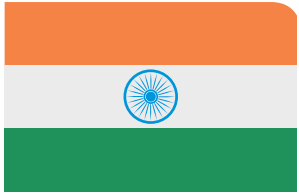


Lightning fast, the sled bolts down the icy run. Will the team make it to the finish faster than their competitors? The tension in the crowd depends partly on the run itself: the faster the sleds can travel on the run, the more thrilling the race. But the track mustn't be too fast: the crew still needs to be able to reach the bottom safely. So engineers have to calculate and simulate exactly how fast a sled can travel on specific sections of the track. The calculations are based on the friction levels between the runners and the ice. Up to now, the problem has been the difficulty of measuring these levels at such high speeds, and the data collected have been rather far from reality. This meant that the speed of the sleds was often estimated too high or too low, which could lead to accidents.

In future tracks are set to become safer. Researchers at the Fraunhofer Institute for Mechanics of Materials IWM at the Microtribology Center µTC in Pfingsttal have now developed a method of measuring the friction levels accurately. In so doing, they are able to provide their

colleagues from Gurgel+Partner, consulting engineers responsible for design and construction of the bobsled track for the 2014 Winter Olympics in Sochi, with a solid basis for their calculations. "This measuring device allows us to ascertain the precise level of friction between the sled and the ice at high speeds – from which we can calculate the maximum speed a team can reach," explains Prof. Dr. Matthias Scherge, business unit manager at the IWM. Our "bobsled track" is in fact a large drum, similar to that of a washing machine, which is 3.8 meters in diameter and open on one side, situated in a bunker that has been chilled to -4°C. On the inside of the drum is a layer of ice, on which the test runners slide. A hydraulic cylinder presses each runner to the ice, simulating the weight of the sled and the crew. Whenever the drum rotates, the ice moves out from under the runner, slightly displacing both it and the attached friction force sensor. So instead of remaining at the lowest point, the runner is carried along a little by the rotating drum. Just how far depends on the amount of friction between the runner and the ice.

In their experiments with this apparatus and with other test rigs, the researchers take into account numerous factors, such as the nature of the ice itself. Ice at Whistler ski resort in Canada, for example, has different friction qualities than ice in Krasnaya Polyana near Sochi. Atmospheric humidity is significantly higher at Whistler because of its proximity to the Pacific, so ice accumulates faster there. The scientists can adjust the climatic conditions in the lab accordingly. They are also looking into the effect on runners of having a good finish. To what degree does a professional finish affect the speed of a bobsled weighing up to 630 kilograms? Researchers also recreate the steering movements of the racing vehicle: the runners on the glide body can be set at an angle to simulate cornering. The minimal friction level – which is to say the fastest possible speed the sled can achieve on any particular track under various ice conditions, providing the team does everything right – is taken by Gurgel+Partner engineers as the basis for their calculations. In the meantime, construction is underway in Sochi. ■



Fit for vehicles

India is booming. The former agrarian state is well on its way to becoming an industrial nation. Gross National Product has been growing steadily for years and funds are increasingly pouring into research and development. Vehicle manufacturing is one of the most important industry sectors in India. Demand is huge: over one billion people live on the subcontinent. Simply supplying them with essential goods and meeting their mobility needs requires giant fleets of buses, automobiles, motorbikes and auto rickshaws. Fraunhofer and India's International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) have recently signed a cooperation agreement for the first of four planned joint ventures, which are to receive Indian financing.

To gear vehicle manufacture up for future environmental and economic demands, Fraunhofer researchers will from now on work very closely with engineers and scientists in India: together German and Indian researchers will develop a simulator for electric vehicles, off-the-shelf software for compact cars, new joining technologies to allow aluminum to be combined with plastic in bodywork and engine construction, and finally an automated 3D inspection system for manufacturing technology.



Perfect sound

Austria: land of music and festivals. Every year, crowds of tourists flock there for operas, musicals and plays. And yet a successful performance is no longer just a question of stage sets and music but also top-quality audio technology. Together with the organizers of the Bregenz Festival, the Fraunhofer Institute for Digital Media Technology IDMT in Ilmenau has developed a sound system which offers every spectator ideal acoustics.

The Fraunhofer software controls almost 800 loudspeakers on the stage and around the audience. These create dynamic space simulation as well as innovative sound effects. The acoustics of various types of space are reproduced in such a way that even with an open air stage, the music sounds exactly as it would inside an opera house. The directional sound mixer, the Fraunhofer SpatialSound Stage System, allows the audience to acoustically distinguish every flourish of the soloists.

"Our software is generating entirely new potential in sound design," says the IDMT's Rene Rodigast. On the lake stage at Mörbisch there were two Fraunhofer IDMT systems in simultaneous use, one for the stage and the second for space simulation in the auditorium.



Nano made in Russia

Today Russia's trade is based on natural resources. But in future it is looking to have a global market presence in research and high-tech, too. Nanotechnology is being heavily promoted by the Russian government, and there are plans to create a nationwide network of new technology centers. For a successful transition from the laboratory to the free market, Russian companies need partners with the necessary technology and expertise. During the "Petersburger Dialog" the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden and NEVZ-Soyuz AG signed a memorandum of understanding which aims at collaboration on research and development for the manufacture of ceramic materials and products. Adding nanoparticles makes for finer, more durable ceramics. These serve as a base material for electrical engineering products and also offer suitable wear protection for high-load systems in the oil and gas industry.

Together with the state-owned company Rusnano AG, NEVZ-Soyuz is building a new factory in Novosibirsk. The first ceramic components produced featuring nano enhancements are expected to roll off the assembly line there this coming year. Dr Bärbel Voigtsberger from the IKTS is confident: "We hope that this will provide us with a successful entry into the Russian R&D market and we are aiming for a longer-term cooperation."



Digital media

Tourism is booming right now in the emerging Asian countries. One of the growth markets is in interactive, electronic travel guides. An application developed in Singapore at the Nanyang Technological University NTU is able to bring to life the story of a historic building by bringing up pictures and information on a smartphone as soon as the phone's camera is focused on it. At the NTU, leading Asian scientists and German experts from the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt are working together on the further development of interactive digital media.

The newly opened Fraunhofer Project Centre for IDM@NTU is located on the university campus. It facilitates a close working relationship in the field of visual computing, including software solutions for mobile devices such as smartphones or tablets, as well as 3D learning programs or the design of virtual or augmented realities. "We are confident that the center will continue to achieve groundbreaking developments in the digital sector," states Professor Freddy Boey, provost of the NTU. "This area offers us a vast field of activity in the Asian market," confirms Prof. Wolfgang Müller-Wittig, manager of the Fraunhofer IDM@NTU. "This collaboration will promote our field of research on a global scale."



Antibodies under test

In theory, HIV-specific antibodies are very easy to obtain: plants just need to be encouraged to produce the required proteins. Molecular farming turns their leaves into mini antibody factories. Once fully grown, they can be harvested and the active ingredients extracted.

Researchers working on the EU Pharma-Planta project coordinated by the Fraunhofer Institute for Molecular Biology and Applied Ecology IME have now proved that molecular farming can be used to manufacture specific antibodies that protect people against dangerous diseases. A gel containing plant-produced antibodies against the HIV virus recently passed Phase I clinical trials at the University of Surrey in the United Kingdom. The gel, which is designed for external vaginal use, was shown to be effective in the trials, and was well tolerated by the test subjects.

Once all the clinical trials have been completed, the researchers want to use molecular farming to produce other medically important proteins – e.g. vaccines – which they then also intend to have clinically tested.



Façades in the desert

Masdar City, the world's first eco-city, is a burgeoning green urban development just a few miles from Abu Dhabi airport. Now, two Fraunhofer institutes have assumed shared responsibility for designing and monitoring an innovative façade test center in the city: researchers from the Institute for Building Physics IBP and the Institute for Solar Energy Systems ISE will use their know-how to help construct the new Competence Center for Building Materials and Façades.

Each room in the test center will be equipped with the ability to ascertain the energy values, the thermal and light transmission properties, and the overall performance profile of each façade to be tested. The research teams from Masdar City and the Fraunhofer institutes will use the data they collect to help the building industry identify high-performance construction materials and façades. The primary objective is to reduce the thermal conductivity of the materials. The better their insulation properties, the greater the amount of energy that can be saved on cooling the buildings – an absolute imperative in Abu Dhabi's scorching climate. The test center will also allow the energy-saving potential of innovative lighting solutions, novel cooling units and intelligent control systems to be demonstrated in a real-world environment.



Floating wind power

Wind energy is clean and sustainable. However, it cannot be used just anywhere. Until now, it has only been possible to establish offshore wind farms in flat coastal areas, because it has proved too difficult to build the necessary foundations if the water is more than 50 meters deep.

Under the EU project HiPRWind, aka Hyperwind, an international team of researchers is now seeking ways to generate electricity even far offshore. In the initial project phase, which began a year ago, the experts have been developing and comparing various concepts for floating wind turbines. Engineers at the Fraunhofer Institute for Wind Energy and Energy System Technology IWES used simulation technology to help them develop the most promising design so far: a triangular floating foundation supporting a conventional wind turbine, equipped with ballasts to provide the required stability during operation at sea. A prototype is due to be built this year.

Deploying wind farms on the high seas will place particular demands on the chosen technology: The turbine foundations and superstructure must be stable enough to withstand storms, and the individual components must be extremely reliable if costly maintenance and repair work is to be kept to a minimum. It is for this reason that scientists from research institutes and industry have joined forces to develop new concepts and solutions within the EU project.



Clean LEDs

Demand for light emitting diodes, or LEDs, is growing all over the world. These small lighting elements can be used practically anywhere, and are characterized by low energy consumption and long service life. However, LED manufacture is not a straightforward process, because it requires a totally clean and dust-free environment.

Achieving this kind of environment represents a particular challenge for Romanian manufacturer Microelectronica S.A.: the company is setting up an LED production facility in the basement of a disused semiconductor production plant – a confined and damp space. Experts from the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart are currently planning how to create optimal production conditions there, but the planning is just one of many stages to be completed. At present the team is devising strategies for building a research line that will be used to help optimize manufacturing processes; the know-how they glean from this line will then be integrated into production planning. The engineers are coordinating all the construction work and have guaranteed that the company will be able to commence operations at the facility by the end of the year.

Accessible browsing

The Fraunhofer Institute for Applied Information Technology FIT develops tools that can be used to verify compliance with Web standards. Companies are only gradually beginning to discover the benefits of web accessibility.

Text: Boris Hänbler



Web accessibility continues to be a long way down the list of priorities of companies in Germany, as confirmed by a series of tests carried out in 2011 by the Fraunhofer Institute for Applied Information Technology FIT in Birlinghoven. Researchers from the Web Compliance Centre used their analysis tools to check the compliance of German DAX-listed company websites with international web accessibility standards. Their results revealed serious deficiencies in 90 percent of the websites, including difficulties locating key information, lengthy loading times and poor usability on mobile devices. "Web compliance is not just about optimizing websites to make them accessible to older adults and people with disabilities," says Dr. Carlos Velasco from the Web Compliance Center at the FIT. "Poorly designed webpages also create a major headache for search engines such as Google. As a result, websites that fail to comply with accessibility guidelines may be ranked very low in search results – or may not appear at all. That's why you would expect this issue to be a top priority."

More and more companies are starting to understand the benefits of embracing web accessibility. For example, Hewlett Packard Italia, Public-I

Group and Polymedia have stepped forward to take part in the EU research project "Inclusive Future-Internet Web Services (I2Web)". The project, which is coordinated by the FIT, has a budget of 2.7 million euros spread over a two-year period. Project partners include the University of York (Great Britain) and the University of Ljubljana (Slovenia) as well as the National Council for the Blind of Ireland and the Foundation For Assistive Technology (FAST). The companies involved in the project offer Internet television, video on demand, online banking and content management systems – and they aim to make their services fully and easily accessible in the future.

There is no doubt this approach makes economic sense: people with disabilities and older adults are increasingly likely to resort to web-based services due to their limited mobility. The target group is already sizeable and is continuing to grow. According to the German Federal Statistical Office, the number of people in Germany aged 65 and over will increase by 54 percent by the year 2050, while the number of those aged 80 and above will increase even faster, rising by 174 percent. Almost one in three people will then be 65 or older. This is in addition to the

group of younger people who suffer from a disability or similar issue. The UN estimates that 40 percent of people in today's world would benefit from websites that comply with Web accessibility standards.

The guidelines on web accessibility that apply in Germany conform to the internationally agreed specifications and standards which are defined by the World Wide Web Consortium (W3C) and embedded in the German Federal Ordinance on Barrier-Free Information Technology (BITV). These guidelines include various recommendations, for example that images and videos on websites should always include a tag to supply a brief description and a title, that pop-up windows should generally be avoided, that site navigation should be straightforward and easy to understand, and that the entire website should be accessible with current technology. Disabled users often make use of assistive technologies such as text-to-speech software and keyboard navigation aids which only work properly on accessible, web-compliant sites.

"One of the most frequent problems we see in websites is actually the general design of the



site itself,” says Dr. Yehya Mohamad from the FIT. “Web designers often forget that users are generally searching for specific information – and they don’t want to click through 10 different pages of the site to find it.”

In 2004, IT experts at the FIT developed the “imergo Web Compliance Suite” to give website operators an efficient means of verifying the accessibility of their sites. Offering a range of tools that can be integrated in content management systems, the software actually checks website compliance with defined rules rather than solely focusing on web accessibility. For example, it offers the ability to search a social network such as Facebook for specific groups of words that could point to illegal activities, and it allows companies to verify whether every page of their website complies with their corporate design guidelines. “Large websites are often managed by multiple content managers,” says Velasco. “The software suite analyzes whether key items such as the logo are in the right place on every single page.”

In many senses, the EU project “I2Web” is the logical next step in the development of the

imergo Web Compliance Suite. For example, the prototype contains a development environment for an Accessibility Expert Viewer. Not all web accessibility guidelines can be automatically checked by a software program. Take the requirement that images on a website should have meaningful alternative text, for example. A test tool can certainly determine whether text exists – but not whether it provides a meaningful description of what the image shows. The Expert Viewer therefore provides a list of all the relevant image texts so that the editors can verify the content is correct. One key focus of the EU project is ensuring that interfaces conform to recognized standards, for example when users wish to enjoy video on demand or Internet TV on their television. I2Web ensures that the services run smoothly on as many devices as possible and that they offer full accessibility and usability.

The tremendous speed of Internet development means that the FIT researchers will have plenty to do in the future, too, as they strive to constantly adapt their tools to new browsers, cutting-edge mobile devices and additional interfaces. But their work is paying dividends:

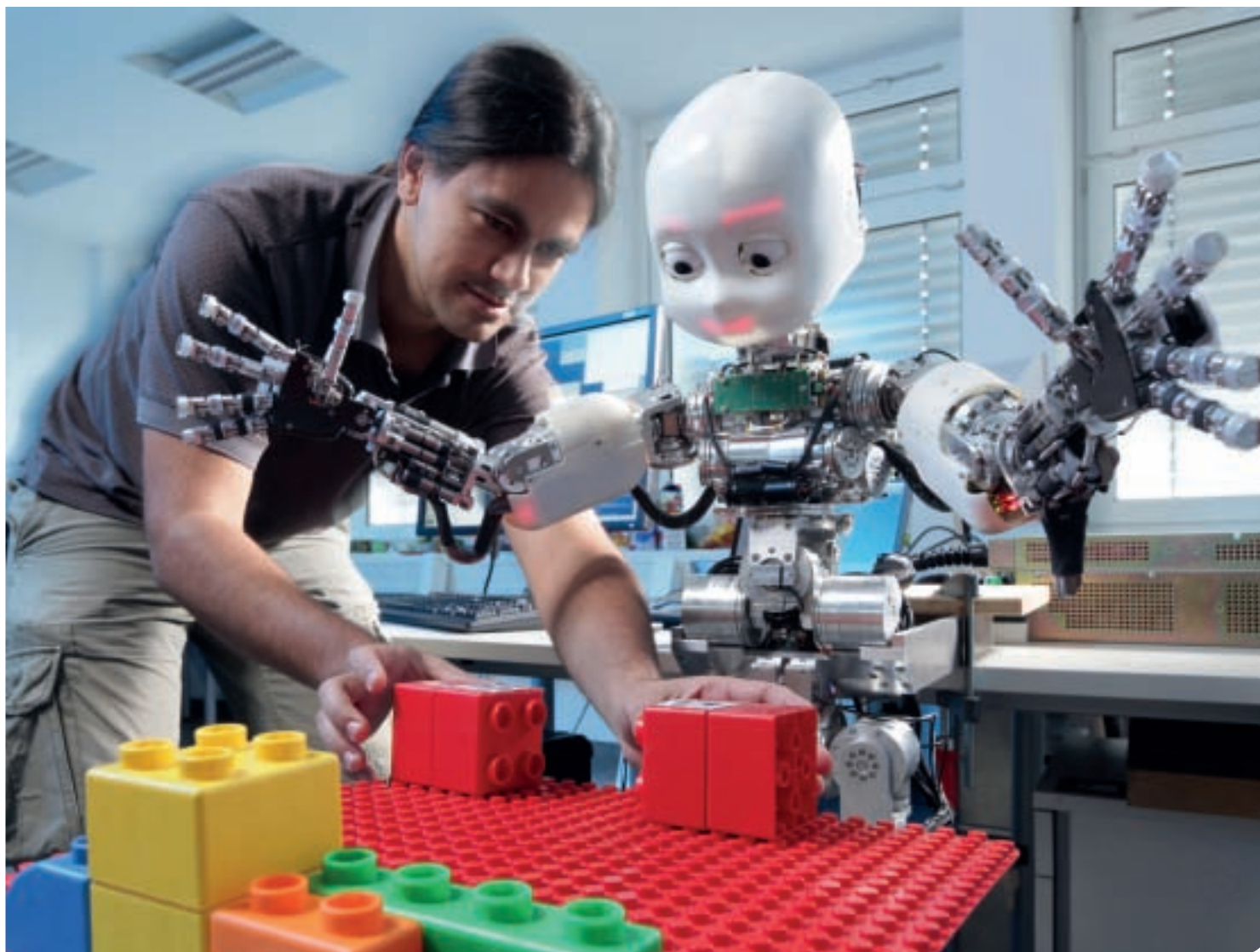
Open Text, one of the leading suppliers of content management systems, has successfully been offering the imergo tools as an optional add-on to its products for a number of years. Most of its users currently stem from the USA and Canada, where strict anti-discrimination policies are designed to ensure that disabled users and older adults can enjoy unrestricted access to services. Web accessibility is an important and heavily scrutinized criteria, particularly when companies tender for public sector contracts in those countries. In Germany, equivalent stipulations are only applied and evaluated in tenders for projects commissioned by German federal and regional administrations.

Ultimately, commercial considerations are probably the most powerful tool for encouraging compliance with web accessibility standards. If companies realize that it makes economic sense, then they are more likely to embrace the web accessibility concept. And it appears that realization is only a matter of time: British Telecom, which recently revised its websites to make them more accessible, recently announced a 6.5 percent increase in sales solely on the basis of compliance improvements. ■

Research in pictures

The 15th edition of the German science photo contest “deutscher preis für wissenschaftsfotografie” yielded first prizes in two categories (Best Single Photo and Best Reportage), a second prize in the Best Single Photo category, and a merit award in the Micro/Macrophotography category. The awards ceremony was held in Bremen.

Text: Christa Schraivogel



“All mine!”

Kurt Fuchs
First prize in Best Single
Picture category

iCub and the Lego bricks: Service robots are an example of technical systems with cognitive capabilities – but what matters most is how they respond to malfunctions and changes in their environment. Robots have to learn to cope with true-to-life situations.

"Appetite for photography"

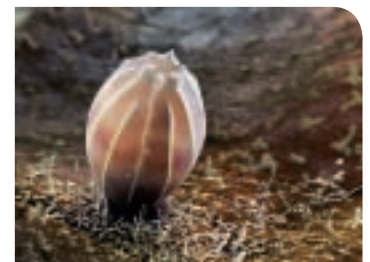
Florian Gloza-Rausch
Second prize in Best Single
Picture category

Bats feel most comfortable in the dark. They hunt at night and find a hiding place to sleep during the day – but they can still be coaxed out by tempting feasts such as pieces of apple and bananas!

**"Magnificent eggs"**

Martin Oeggerli
Micro/Macrophotography category

Fully-grown butterflies are extraordinarily delicate – and so are their eggs. It takes one week to transform a black and white SEM image into one of the richly colored pictures shown here.





“Survival of the smallest”

Zorana Musikic
Reportage category

Premature babies need warmth to survive. At first they get this from an incubator, but doctors try to make the switch to human warmth as soon as possible – even if the baby has to be bundled up or accessed through the incubator window.

2012 Photo Contest

When choosing your entry, please remember that the contest is only open to pictures that have never won a prize. For more details on the conditions of entry, please contact:

bild der wissenschaft
“deutscher preis für wissenschaftsfotografie”
Ernst-Mey-Strasse 8
70771 Leinfelden-Echterdingen, Germany
www.wissenschaft.de/fotopreis

**Entries must reach us no later than
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When might material defects mean that a power plant is no longer safe to operate? Simulation models help plant operators assess the risks. © MEV

Keeping a close eye on defects

Contact: Dieter Siegele,
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From safety valves to pressure regulators, technical systems rely on the trouble-free operation of each individual component. If an ultrasound inspection or other type of test reveals a defect in a component, the next step is to perform a comprehensive evaluation of the causes and effects this defect could have – for example by performing the safety and reliability analysis offered by the Fraunhofer Institute

for Mechanics of Materials IWM in Freiburg.

Using precise mathematical models of the material, the researchers simulate how the defect will evolve and progress within the component. Will a crack form? And when might that crack widen? This analysis enables the plant operator to localize and contain the risk and to define test intervals where necessary.

Feedback for electricity consumers

Contact: Dr. Marian Klobasa,
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German consumers receive an aggregated electricity bill just once a year – too infrequently for most people to identify where they could make energy savings in the future. Intelligent electricity meters – also known as smart meters – reveal how much electricity each individual appliance consumes. Funded by the German Federal Ministry of Education and Research (BMBF), the project “Intelliekon – Sustainable Energy Use in Households through Intelligent Meter, Communication and Tariff Systems” saw researchers install smart meters in more than 2,000 households in Germany and Austria.

The collected data was analyzed by researchers from the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe. The 18-month field trial confirmed that providing timely information to consumers helps them cut their electricity consumption by an average of 3.7 percent. Extrapolated to Germany as a whole, this equates to potential energy savings of some one billion euros. Colleagues at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg investigated how people responded to the web portal that was developed as part of the project. They concluded that succinct feedback on electricity consumption motivates consumers to take a more active role in achieving energy savings.

Robots inspect measuring devices

Contact: Bernd Winkler
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Vernier calipers are used in mechanical engineering and car manufacturing to measure whether components have been fabricated and fitted with precision. Calipers that are worn or out of calibration can therefore have serious consequences. Currently, most vernier calipers and similar measuring devices undergo regular manual testing by external contractors. These companies determine the measurement error of the calipers in their calibration laboratories. At the company MSB in Halberstadt, this job is now being performed by robots for the very first time. The advantage of this fully automated method is that it is both more accurate and more economical.

The robot design and the plans for their mechanical construction and control systems were developed by researchers at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart.

Robots test whether vernier calipers are out of calibration or worn. © Fraunhofer IPA



Boost in earnings

The Fraunhofer-Gesellschaft continued to grow in 2011. Financial resources rose 12 per cent to 1.85 billion euros. Especially pleasing: earnings from businesses increased by 15 percent to 531 million euros.

Text: Birgit Niesing

"The positive economic development in Germany is reflected in the respectable result for 2011," explains Professor Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft, presenting the figures for the previous year. "Financial resources rose from 1.66 billion euros to 1.85 billion euros. That's equivalent to growth of twelve percent."

The research organization's financial resources are made up of the budgets for contract and defense research plus the expansion investments. "Contract research – the key area of research and development services – grew eight percent to 1.515 billion euros. In terms of defense research, the current budget of 98 million euros was five percent up on 2010. The expansion investments rose substantially to 236 million euros," said Chief Financial Officer Prof. (Univ. Stellenbosch) Dr. Alfred Gossner, explaining the 2011 result.

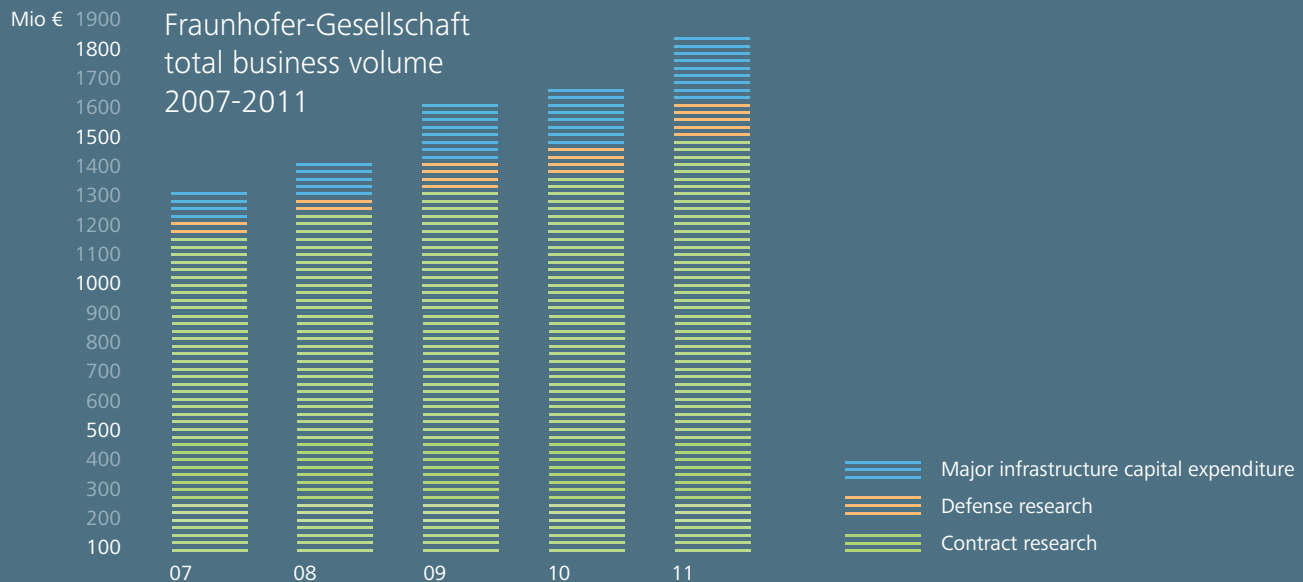
For contract research, project income rose to 1.1 billion euros – this is the income from orders with businesses, publicly funded projects and licenses. "Business income has developed especially well," emphasizes Gossner. "It is up 15 percent and reached a historic high of 531 million euros." Business income has increased dramatically twice in succession. Having risen by 15 percent, orders from industry in 2011 stood at 406 million euros. Fraunhofer took in 125 million euros from licenses. Income from public projects with the government and the states amounted to 405 million euros. And Fraunhofer earned 71 million euros from EU projects.

In addition to income from industrial orders and public projects, the financing model employed by the Fraunhofer-Gesellschaft has a third pillar, institutional funding. Institutional funding is provided by the German federal government and the states on a ratio of 90:10. Fraunhofer uses these funds for initial research, expanding the technology portfolio and for internal programs. This institutional funding grew by five percent in fiscal year 2011.

Three inventions per working day

In the fiscal year 2011, Fraunhofer researchers registered 673 new inventions. That's roughly three inventions every single working day. There are patents pending for 494 of these developments. The number of active industrial property rights and applications for such rights rose to over 6,131.

During the financial year 2011, Fraunhofer invested 236 million euros in the research infrastructure of its institutes (major infrastructure capital expenditure). That's a record level. "This high level of investment is mainly down to support from the European Regional Development Fund and the Recovery Plan 2," Gossner explains. The expansion has been largely supported by the government and the states, with 51 million euros in co-financing coming from EFRE funding. Some 59 million euros from Recovery Program 2 were also used. Last year, Fraunhofer accelerated the expansion of the application center "Polymer Nanotechnologies" of the Fraunhofer



Institute for Applied Polymer Research IAP, as well as two large-scale construction projects of the Fraunhofer Center for Silicon Photovoltaics CSP.

Pooled into defense research is the expertise from seven institutes engaged in the field of defense and security research. In the previous year, the budget for defense research grew by five percent to 98 million euros. Some 56 million euros were provided by Germany's Federal Ministry of Defense.

Last year, Fraunhofer hired 1,300 new employees. This pushed the headcount to over 20,000. "To be able to realize the growing number of research projects and process the rising order volume, we will continue to need new, qualified employees," emphasized Dr. Alexander Kurz, Head of Human Resources at the Fraunhofer-Gesellschaft.

To recruit highly educated employees, Fraunhofer employs an extensive talent management procedure. One example is the "Attract" program. It systematically approaches external scientists with innovative ideas from internationally renowned facilities or from industrial organizations. As group leaders with links to a Fraunhofer Institute, they have an opportunity to advance their activities in the direction of applied research.

During fiscal 2011, Fraunhofer had 200 million euros in sales (excluding license income) with its international partners. This represents growth of 14 percent compared to 2010. Income

from cooperation with European businesses and from EU-funded collaborative research rose by a full 17 percent to almost 145 million euros. Through orders with European partners, Fraunhofer generated more than 74 million euros, for an increase of 27 percent..

Success abroad

To date, Fraunhofer has been engaged mainly in Europe, the US and Asia. Now, the research organization wants to expand its international activities to the new growth region of South America. In September 2011, it opened the first Fraunhofer center in South America, the Fraunhofer Center for Systems Biotechnology CSB in Santiago de Chile.

A continually changing research landscape and ever-shorter innovation cycles require a research organization to have a flexible strategic planning process that is geared toward likely scenarios. That's why last year, Fraunhofer started the 2025 Strategy Process, which is based on a scenario analysis. In identifying new and innovative future fields, the Fraunhofer-Gesellschaft is taking into account short- and medium-term technological and social developments, as well as emerging long-term trends. Clearly urbanization and the associated growing importance of cities as a central living space are such global trend. Under the motto "City of tomorrow," Fraunhofer and other researchers are working toward the vision of a city that is not only sustainable and livable but also offers future viability. ■

Protecting goods during shipping

Whether by air, sea, truck or rail, goods have to be transported all over the world. There are many factors involved in ensuring they reach their destinations safely, one of which is choosing the right packaging. Specialist researchers are able to simulate real-life shipping conditions in the laboratory.

Text: Isolde Rötzer

In June 2011, 'Buste de Femme', a painting by Pablo Picasso, set off on a long journey which would take it from the Van Abbemuseum in the Dutch city of Eindhoven all the way to Palestine. To ensure the painting survived the journey unscathed, it was packed in a special crate. This packaging solution was developed by the Cologne-based forwarding company Hasenkamp, which specializes in transporting works of art, in collaboration with packaging experts from the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund. "You can't just put a work of art in a crate because there would be nothing to stop the vibrations reaching the painting and destroying it," says Gerrit Hasselmann, project manager of the packaging laboratory at the IML. "So a few years ago we developed a system for transporting art which actually involves hanging the painting inside a crate."

The packaging experts offer advice on all aspects of goods transportation – not only the actual time goods spend in transit by air, sea, road or rail, but also related issues such as terms and conditions for handling and distribution. So for a customer who wishes to send a shipment of ball bearings, for example, the experts can decide whether they are better off choosing boxes made from wood or cardboard. In their laboratory, the IML researchers can palletize, stack, jolt and shake, break and accelerate, load and unload the ball bearings under real-life conditions. And that's not all: the researchers can also help find the best way to assemble each unit load taking into account climatic conditions on the shipping route. The goal is to simulate real-life conditions as accurately as possible in a laboratory setting. From May 2012 onwards, the researchers will be getting additional assistance in meeting this goal from a one-of-a-kind test system that is able to realistically reproduce braking maneuvers and the stresses and loads imposed on goods when vehicles turn corners.

The Dortmund-based experts have many years of experience in this field. The packaging laboratory first opened its doors in 1986, and since then it has helped many companies to find the right packaging solution for their needs. "Some two thirds of our customers are packaging manufacturers. They are keen to use new materials, but want to be sure that these are suitable for goods transportation. They have their own customers who are looking for the same quality assurances and the peace of mind of knowing the packaging conforms to international quality standards," says Ralf Wunderlich, who has been part of the lab team since it was founded. The researchers begin by testing individual boxes or wrappings before moving on to examine how each unit load is assembled and checking whether the packaging is strong enough to cope with the bumps and jolts encountered during shipping.

"Section 22 of the German Road Traffic Regulations stipulates that every unit load should be like a concrete block. It must be capable of withstanding all the dynamic loads that occur when transporting things by truck, such as emergency braking, highway lane changes, and shunting impacts during rail transit," says Wunderlich. It also has to withstand all the climatic factors and structural loads that are imposed during storage, which is why the experts use special environmental chambers to simulate hot and cold conditions. They also test how much weight a crate can bear and determine the best ways of assembling an optimum unit load.

The remaining 40 percent of the laboratory's customers are companies that are having problems transporting their goods. One example might be a company that wants to find out why an increasing number of its products are being damaged in transit. In this case, the experts begin by examining the various components of the distribution network. They investigate which vehicles are used, how far the goods are transported,

whether the company has recently started using a new freight forwarder and whether the packaging has been changed. Then they simulate the transportation process in the laboratory. Generally, the cause of the damage can be pinpointed relatively quickly. "Sometimes we find out that vibrations on the truck are scraping off the surface of the films used to protect items such as LCD monitors, or that the goods are not being properly handled. We also often see problems in situations where the packaging also serves a marketing purpose – in other words where the products are going to be displayed on the shelves in the packaging they are transported in. Getting those products safely to their destination is a real logistical challenge. And sometimes the individual product packaging is fine but the unit load is poorly secured," says Gerrit Hasselmann, listing some of the issues the laboratory typically encounters. The IML experts often recommend using a new type of packaging, for example a wire box instead of a standard pallet.

Putting packaging to the test

The Dortmund-based researchers have recently acquired a new piece of equipment which enables them to simulate braking and cornering with a high degree of precision. The Horizontal Impact Test System (HITS) developed for this purpose cost more than half a million euros and has been specially tailored to the needs of the IML researchers: "Before HITS we could generally only simulate maximum loads – for example simulating how a box deforms at a maximum rate of acceleration of 20 m/s². But now we can reproduce the multiple small forces that act on the cardboard during shipping and simulate that over longer periods of time. That makes a big difference to the packaging units, because the impact of a load exerted over a longer duration is different to the effects of maximum force. For example, we can simulate a braking effect with acceleration of 8m/s² over one thousand millisec-



The Picasso is carefully packed in a special shipping crate. © Christian Kryl

onds and reproduce that over the entire braking distance. And we can simulate the same kinds of things for shunting impacts," says Hasselmann.

The new Horizontal Impact Test System is 17 meters long, 1.5 meters wide and 2.8 meters high, equivalent to the size of a truck bed. The system can incorporate two pallets at a time, weighing 1500 kilograms, and subject them to real-life transportation loads. The engineers can investigate the best methods of packaging each type of unit load for shipping by fastening the goods to pallets using straps, shrink hoods or stretch films and checking which solution best meets the requirements in each case. The aim is to use as little material as possible, in order to save money and conserve resources. The results obtained by the IML researchers provide real benefits to customers: "If a company is shipping 150 pallets a day, then the cost of packaging films and wraps has a very real impact on their bottom line," says Hasselmann.

In late 2011, Professor Ovis Wende was called in to transform the 1500-square-meter test facility into a showcase setting for the public. Wende, a professor of art in public spaces and scenography who works in the design department at Dortmund University of Applied Sciences and Arts, developed an artistic design concept for the test facility with the help of his graduate student Rafael Cichy. The goal was to create an attractive visual identity for the laboratory and its test systems which would appeal to company representatives who are considering using its services.

"We want visitors to get a visual feel for the technical expertise this facility offers. Our new layout creates a clear path through the facility while accentuating certain visual elements and revealing key details," Wende explains. The designers chose a clear, very light gray for the walls, ceilings and circulation routes which contrasts with the cool, dark gray of the cabinets, machines and working areas. To highlight and illustrate the contents of the facility, a red front wall at the entrance offers quotations and portraits of significant contemporary figures while a museum of selected test specimens is located on the opposite side. Weather charts and maps on the doors of the environmental and vibration chambers provide a visual reference to the respective test methods. The facility can quickly and easily switch from operating mode to presentation mode by activating a lighting system which richly enhances the overall visual effect without disturbing the experts' work. ■

Intelligent objects

Ever more industries are using radio-frequency identification tags. The latest examples were presented at a user conference held by the Center for Intelligent Objects under the motto "Using RFID and Friends for Success."

Text: Brigitte Röthlein

Europeans are passionate gardeners. They buy millions of flowers, vegetables and herbs to fill their front yards, balconies and vegetable beds. Customers also expect to find well-ordered, fresh and undamaged potted plants in their local garden centers. An enormous logistical effort is needed to make this all possible. This is why Container Centralen (CC), which is the market leader for standard trolleys used to transport potted plants, has been using RFID tags in all of its roughly four million containers since January 2011. Every trolley now sports a small red tag in the shape of a padlock that contains a radio chip and antenna. It identifies each cart with a

unique number, saving a huge amount of paperwork and administrative expense and helping to prevent fraud. For years the company had to contend with low-quality, counterfeit containers. This is no longer the case, which means CC can avoid the additional costs associated with repairing and servicing imitations.

Thanks to modern radio technology it is possible to locate objects, such as these plant containers, at any time. The technical term is radio-frequency identification, or RFID. The idea is actually simple: an object is equipped with a radio chip containing an identification number

and any other information that may be desired, such as data from certain sensors. A reader then receives the transmitted information from the chip contactlessly.

Intelligent objects register themselves

The simplest and cheapest are passive radio labels, also called transponders, smart labels or tags. These are composed of a small chip, which contains both the processor and the memory, and an antenna. They have no power source of their own; they receive the energy they need





When a marked component passes the warehouse's receivers (left and right above), its entry or exit is recorded in real time. © Lufthansa Technik AG

have the components lying around unused in a workshop. At the same time, every hour an airplane spends on the ground for maintenance is expensive. It thus made sense to equip each of the parts with a transponder so that they could be put to best use with a minimum of administrative expense. For this, the radio ID chips need to meet the airline industry's particular requirements: they need to function faultlessly on metal, be resistant to vibrations, pressure changes and moisture, and they must not be flammable – and all this for the duration of the spare part's lifecycle. Since no such transponders had yet been made, the IIS developed a prototype together with Harting Technology Group following a period of evaluation. The prototype has since been tested and certified by Lufthansa Technik Logistik. "This technology makes it possible to coordinate information and material flows," explains Tom Burian, head of the RFID project for Lufthansa Technik Logistik, "which allows us to organize our business more intelligently. For instance, higher priority parts can now draw attention to themselves and complain if they are left lying unused in a workshop for too long."

The market is growing 20 percent annually

When the Metro Group installed its first RFID chips in 2006, generating lots of hype, enthusiasts expected that every pot of yogurt would soon have one. The idea was to monitor the entire logistics process, from manufacturing to the supermarket shelf, electronically, and it was said that the chips would soon cost less than one cent a piece. However, this extremely optimistic prediction has yet to become reality. Even

to transmit data from the electromagnetic field the reader generates. The only drawback is that these transponders have a very limited range, so they generally need be placed very close to the reader to activate. The lower the transmission frequency, the shorter the range. Ultra-high frequency RFIDs can be read or written from a distance of up to 15 meters. Active RFID components that incorporate a battery so they are able to transmit of their own accord are more expensive but also more powerful. "Such intelligent objects include everything from radio ID chips to sensor networks that generate data, localize themselves and run certain programs," explained

Prof. Alexander Pflaum of the Fraunhofer Institute for Integrated Circuits IIS, who heads the institute's Center for Intelligent Objects ZIO.

Lufthansa Technik Logistik places particularly high demands on the tags. The company's goal is to permanently mark more than a million high-value replacement parts using RFIDs. A large number of parts, from flight recorders and pumps to oxygen bottles, fans and coffee machines, need to be removed, serviced and fitted again on a regular basis. "In the aviation industry, parts often cost tens of thousands of euros," says Pflaum, so it is important not to

today, an RFID chip still costs at least ten cents. Though not all the euphoric hopes have come to pass, Wolf-Rüdiger Hansen, managing director of the German branch of the Association for Automatic Identification and Mobility (AIM-D) still remains broadly optimistic: "Since the end of the nineties, business has been expanding steadily. Manufacturers of the relevant hardware and software are seeing annual sales growth of around 20 percent. Nowadays RFID technology has become essential to numerous industrial sectors, such as the automotive industry."

And yet this technology is still not being exploited to the full. That is why the ZIO and AIM-D have organized a user conference that uses specific examples to illustrate the potential value of this technology to companies. One example is Geis Global Logistics. This company puts RFID technology to good use in its logistics center in Erlangen-Frauenaurach, Germany. "The new facility is a big improvement on a standard logistics center," say Hans-Georg and Wolfgang Geis, managing directors of the Geis Group.

"It allows us to combine contract logistics, assembly tasks and packaging services for Siemens Enterprise Communications and other customers. That's why we call it a multi-user logistics and technology center." Geis employees there are responsible for the global distribution of end products, including incoming goods processing, warehousing, order picking, packaging and preparation for delivery. RFID technology gives the service provider and the customer absolute control over which goods leave the warehouse and when.

Deutsche Post DHL also relies on intelligent radio ID chips to locate its swap bodies. Swap bodies are freight containers on stilts that can be transported both on trucks and trains. Agheera – a spin-off of DHL Solutions & Innovations, the DHL innovation department – recently equipped 15,000 swap bodies with microelectronic tags. The transponder on the container roof has an internet connection and a GPS location system, and it is powered by a solar panel and a battery. "If the body is in transit, a built-in

motion sensor will indicate this and the chip will announce its location via the internet as often as the customer wants, generally every 15 minutes," says Frank Josefiak, Agheera's technology director. In the next phase, transport security will be improved. The chip will then also report whenever the container doors are opened and even record temperature changes or collisions during transport. This would allow haulers to prove that any damage was not caused by the transport itself. "However, it places great demands on the power supply, so we have installed very sturdy solar cells and there is passive cooling so that the system will work reliably over a lifecycle of six to eight years," says Josefiak.

RFID will continue to become ever more intelligent, predicts Wolf-Rüdiger Hansen: "We are seeing more and more radio labels being combined with smart cards and even credit cards. In passing data protection recommendations in 2009, the European Commission created a clear set of rules. Now the technology can move into ever more markets." ■



Before having its certification extended to permit its use outside the aircraft cabin, the RFID transponder had to prove its suitability in numerous tests, including for resistance to aggressive fluids.
© Lufthansa Technik AG

Safer runways

Parts often become detached from aircraft during take-off and landing – putting subsequent runway users at risk. Scientists are developing a new radar system which will make airports safer by detecting even the smallest objects on a runway.

Text: Britta Widmann

Ten years may have passed, but most people can still recall the Concorde crash: the TV pictures showing the supersonic jet with flames streaming from its tail were both shocking and unforgettable. The accident was caused by a piece of metal lying on the runway during take-off. The aircraft's tire burst as it rolled over the metal, sending chunks of rubber flying into the fuel tank, which then exploded – with the loss of 113 lives. To avoid these kinds of accidents, airport staff drive up and down runways at approximately six-hour intervals looking for any debris. But to monitor such huge areas without any kind of technical assistance is time-consuming and subject to error – especially in bad weather.

Not triggered by birds

In the future, a new weatherproof safety system will monitor runways continuously for debris and warn of any dangers. Research scientists at the Fraunhofer Institutes for High Frequency Physics and Radar Techniques FHR and for Communication, Information Processing and Ergonomics FKIE are developing the system in conjunction with the University of Siegen and the companies PMD Technologies GmbH and Wilhelm Winter GmbH in a project dubbed LaotSe – short for "Airport runway monitoring through multimodal networked sensor systems". "Our technology would have prevented the Concorde tragedy," says Dr. Helmut Essen, who heads the Millimeter-Wave Radar and High Frequency Sensors department at the FHR in Wachtberg. "Devices installed all along the runway continuously scan the surface. They can detect even the smallest of items, such as screws, but the system will only issue a warning if an object remains on the runway for a longer period of time. A windblown plastic bag or a

bird resting briefly will not set off the alarm."

The system comprises an infrared camera, optical 2D and 3D cameras and networked radar sensors. These sensors were developed by researchers at the FHR. The three different types of equipment complement each other: radar functions around the clock, whatever the weather. It can detect objects but not identify them. The cameras are better suited to classifying objects, but they are affected by the weather and the time of day.

Whenever a radar sensor detects something, it instructs the cameras to take a closer look. All the sensor data are then amalgamated using software developed at the FKIE to produce a situational overview. Experts refer to this as 'sensor data fusion'. If the overview reveals an abnormal situation, the air traffic control tower is informed. Air traffic controllers can check their screens to judge whether there is any real danger. "Our solution is merely an assistance system. The final decision on how to proceed lies with airport staff," emphasizes Dr. Wolfgang Koch, head of department at the FKIE.

Radar keeps watch

While similar radar systems have been developed, these are only capable of detecting metal objects, and often trigger false alarms. Dr. Essen outlines some of the new system's advantages: "Our radar sensor transmits at a frequency of 200 GHz, so it can even detect objects that are just one or two centimeters across. And using three different kinds of sensor means false alarms are almost out of the question. The device is miniaturized and scans up to 700 meters in all directions." Initial testing of a radar sensor and camera is scheduled to begin at Cologne-Bonn Airport in early 2012. ■



The radar sensor can detect objects that are just a few centimeters across on runways. © Fraunhofer FHR

Swarming and transporting

A single ant is not particularly intelligent. However, within a community the insects are able to solve complicated tasks. Now, scientists want to use this “swarm intelligence” in logistics. Many autonomous transport vehicles are set to replace the traditional conveyor technique.

Text: Birgit Niesing





The orange-colored vehicle stirs into motion with a soft whirr. Shortly afterwards, the next vehicles are launching. And in a little while, dozens of mini-transporters are moving about the warehouse. As if steered by magic, they are rolling over the light floor, turning sweeping bends, steering towards the high bay racking or rotating around their axis.

However, the Multishuttle Moves®, as these automated guided vehicles are called, aren't doing robot ballet dance. They are on scientific duty. At the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund scientists are working to improve the logistical flow of materials and goods in warehouses using "swarm intelligence". A Living Lab measuring 1,000 square meters was especially built for this purpose. Within the lab, the researchers recreated a miniature distribution center containing a rack system for 600 small-goods carriers and eight picking stations. The core of this test facility is a swarm of 50 autonomous vehicles.

"In the future, the transport system will carry out all tasks independently, from the removal from the shelf up to delivery to a picking station, and thus replace conventional conveyor technology solutions," explains Prof. Dr. Michael ten Hompel, executive director of the IML. "Automation will be made possible where current solutions have not been flexible enough yet."

Faster transport thanks to ant colony algorithms

But how do the vehicles know what to transport and where to, and which of the 50 vehicles takes on the respective assignment? How is the coordination accomplished among the vehicles? "Control of the automated guided vehicles is distributed. The 'intelligence' is in the transporters themselves," says Andreas Kamagaew, head of the department Automation and Embedded Systems. As soon as a new assignment comes in, the vehicles will be informed by a software agent.

Using Wi-Fi the vehicles exchange information to decide which vehicle can transport the load. Placing the order is done very much the same

way as in cab companies: the closest available and free transport system receives the order.

The shuttles can freely move about the floor area – with no guidelines whatsoever – thanks to sophisticated localization and navigation technology. They are equipped with sensors based on a newly developed hybrid sensor concept that includes a radio ranging system, distance and inertial sensors as well as laser range finders. Thus, the vehicles can calculate the shortest route to the target. The sensors also help to avoid collisions.

Shuttles move as if steered by magic

To demonstrate that this approach is reliable in practice IML researcher Andreas Kamagaew steps in the way of a shuttle. The transporter stops immediately, then curves around the researcher and continues its way towards the high bay racking. Kamagaew explains the safety concept: "Contact with people is not permitted." If a vehicle detects an obstacle, it will pass this information on to all shuttles of the swarm. Thus, the vehicles can include the information about the obstacle in their route planning and drive around it. "Furthermore, clear rules help to avoid collisions with other transporters: In the Living Lab, too, traffic from the right has priority. However, a shuttle that needs to recharge its battery is given right of way," says Kamagaew.

About one meter long and 70 centimeters wide, the vehicles are based on the components of the shelf-based Multishuttle that has successfully been in operation for many years. The Fraunhofer researchers developed the Multishuttle Move® with the assistance of Dematic. The distinctive feature of the Multishuttle Move® is its ability to move about both – within the shelving units and the warehouse. An additional floor landing gear enables the shuttles to do so. When driving on the floor steering is carried out by speed difference regulation of the two drives. For stability reasons a castor wheel serves as a third wheel. At the front and rear of the vehicle there is a laser range finder which is used in floor operation as a security feature to avoid



In the research project 'Cellular Transportation Systems,' IML scientists are exploring the application possibilities for the Multishuttle Move.
© Fraunhofer IML



collision as well as for localization. The power supply for the vehicles works with batteries being recharged during operation in the high bay racking.

How to reduce construction effort and the required space

Yet, what advantages do autonomous vehicles have over conventional roller conveyor technology? "The system is considerably more flexible and scalable," emphasizes Kamagaew. According to requirements, vehicles can be simply added to or removed from the system. This allows the system performance to be adjusted to seasonal and daily fluctuations.

Another benefit relates to considerably shorter transport routes. In conventional warehouses the space between the high bay racking and picking station is obstructed by conveyor sys-

tems. Roller conveyors tend to be arranged in circles. The bins cover a distance two to three times longer than the direct route. "What's more, our system makes storage and conveyor systems unnecessary," adds researcher Thomas Albrecht. "This reduces not only the overall space requirement but also the engineering and construction effort. The start-up procedure is very simple: plug & convey".

In the coming years, researchers plan to investigate the behavior of the autonomous vehicles in a swarm and how they can improve intralogistics. "We want to prove that cellular intralogistics is capable of replacing both classic conveyor technology and rack feeder in a technically and ecologically acceptable manner," says director ten Hompel. If the researchers are successful, very soon the orange-colored autonomous vehicles could be serving their purpose in real warehouses. ■

Multishuttle Move®

In the project 'Cellular Transportation Systems,' IML researchers are examining how autonomous transportation in the swarm works. The 5.5-million-euro project is mainly funded by the German state of North Rhine Westphalia. The company Dematic, Offenbach, also contributed to the development and manufactured 50 Multishuttle Moves®.

Transporter facts and figures

Length: 114cm

Width: 71cm

Height: 35 cm

Speed: 1 m/s on the floor,
2 m/s in the rack system

Payload: up to 40kg

Own weight: 134kg

Running time without recharging: 4.5 hours



Up to 60,000 people are stricken with Lyme borreliosis each year in Germany alone. © panthermedia

First aid after tick bites

They come out in the spring, and each year they spread further – ticks. Thirty percent of them transmit borrelia pathogens, the causative agent of Lyme borreliosis that can damage joints and organs. The disease often goes undetected. In the future, a new type of gel is intended to prevent an infection – if applied after a tick bite.

Text: Britta Widmann

For years, Mrs. S. suffered from joint pain and headaches. After an odyssey through doctors' waiting rooms, one doctor diagnosed Lyme borreliosis – an infectious disease transmitted by ticks. With its bite, the parasite introduced bacteria that then spread throughout her entire body. Mrs. S. is not alone – very often, the disease is recognized too late or not at all, or is not properly treated. Doctors are provided with no clues if the characteristic redness around the bite area is missing. Left untreated, Lyme borreliosis can cause symptoms that resemble rheumatism, damage joints, muscles and nerves, and affect the organs.

A gel that can prevent infection

If found in time, it can be successfully treated. If patients exhibit the disease-specific rash known as erythema migrans, doctors will prescribe antibiotics for several weeks. However, if, as in the case of Mrs. S., the disease has progressed far and is chronic, it is very difficult to treat. Currently, there is no prophylactic treatment and no vaccine against the infection. In the future, a new type of gel is set to nip the infection in the bud: the patient applies it locally immediately after the tick has bitten. Researchers of the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig developed the medication in close cooperation with the Swiss company Ixodes AG and the Institute for Infectious Diseases and Zoonoses of the Ludwig-Maximilian University in Munich (Institut für Infektionsmedizin und Zoonosen der LMU München). Ixodes AG is responsible for developing the formula, while IZI and LMU are carrying out the pre-clinical studies and the serological examinations.

"If the gel is applied immediately to the bite after the tick has been removed and one does not wait for any potential

symptoms to show, Lyme borreliosis could be prevented. This is because during the first few days, the bacteria stay right around the spot where the tick bite occurred and spread out only after that. The active ingredient of the gel is azithromycin, which is highly effective against borrelia bacteria and kills them locally in the skin," says Dr. Jens Knauer, project manager at IZI. Unlike other antibiotics, there is no known resistance of borrelia strains against azithromycin. Another advantage of the active ingredient: it has few side effects and as a result does not stress the body. It also distinguishes itself by its good depot action of up to five days in the tissue. The treatment is successful only if the medication is applied within the first few days after the tick's bite. "This gel, however, cannot be used to treat an established infection; it is suitable only for prophylaxis," emphasizes Dr. Knauer.

Patent for a new prophylaxis

The pre-clinical studies have already been completed successfully; in mice, the gel was effective even five days after a tick has bitten. The application has been patented. Starting this past summer, in a clinical phase III study (www.zeckenstudie.com), the researchers are testing the medication on people with proven tick bites. "Should the results of the pre-clinical studies be confirmed on humans, the gel will help to significantly lower the number of new infections," the expert adds. Annually, up to 60,000 are stricken with Lyme borreliosis in Germany alone, according to estimates by the Robert Koch Institute, with an upward trend – since, due to climate change, ticks are expanding their range ever further. "As soon as the gel can be purchased at the pharmacy, people who are particularly at risk, such as forest rangers, hunters, joggers or soccer players, should always carry it with them," Knauer recommends. ■



Migratory cancer cells

Many cancer patients do not die of their primary tumor, but rather from metastases. Current study findings indicate that cells actually begin to break away from the initial tumor and travel around the body in the very early stages of the disease.

Text: Monika Offenberger

Metastasis.
© Gschmeissner/
SPL/Agentur Focus

The lump in the woman's breast was discovered early. Surgeons removed all traces of the tumor, and her cancer seems to be gone. But she is not cured. Years down the line, life-threatening metastases appear somewhere else in her body, and the disease runs rampant once again. These secondary tumors can be traced back to disseminated cells which at some point quietly broke away from the original tumor in her breast. Known to migrate around the body, either in the bloodstream or through the lymph paths, these cells can settle anywhere, and, by and by, grow into new malignant tumors.

"We need to understand these cancer seeds better, so we can identify them in good time and render them harmless," says Professor Christoph Klein, Chair of Experimental Medicine and Therapy Research at the University of Regensburg. The medical scientist has already made an outstanding contribution to this end, having advanced a completely new hypothesis regarding the formation of metastases. Now, he wishes to put his acquired knowledge to practical use: he wants to develop meaningful diagnostic procedures and effective therapies to help people suffering from cancer. Early in 2011, in a joint initiative between the University of Regensburg and the Fraunhofer Institute for Toxicology and Experimental Medicine ITEM in Hannover, Professor Klein laid the foundations for the creation of a new Fraunhofer project group in Regensburg's BioPark. He describes the group's aim as follows: "We want to characterize disseminated tumor cells with a very high de-

gree of accuracy, and to look for suitable markers that will allow us to identify them as early as possible. If we can do this, we'll be able to help drug developers establish precisely which active ingredients really target the developing metastases and which groups of patients might benefit from their use."

Malignant tumors are one of the commonest causes of death in the industrial world. "Although we've recently seen a tremendous explosion of knowledge in the field of oncology, we still haven't won the battle to bring cancer under control. And that's really quite remarkable," muses Professor Klein. He believes this lack of resounding success to date is rooted in a widespread misconception of how cancer actually spreads within the body: "Until just a few years ago, cancer research concentrated predominantly on the primary tumor, asking why it occurred and how it could be eliminated. Secondary tumors were pretty much left out of the equation."

The current consensus is that normal somatic cells invariably degenerate into deadly cancer cells when specific genetic defects accumulate as a result of mutations in the cells' genetic make-up. This is how the primary tumor develops. Conventional thinking dictates that only later do the first, and then increasing numbers of cells break away from this original tumor and settle at some other location in the body of the cancer sufferer, forming the nuclei of the metastases which subsequently appear and generally

prove fatal. If this theory is correct, metastatic cells ought to exhibit the same genetic defects as the primary tumor, and ought to respond to the same medications. This whole idea significantly influences which active ingredients are used to treat specific types of cancer. Professor Klein quotes the concrete example of the drug Herceptin: Its active ingredient, trastuzumab, is known to keep tumor cells with a particular genetic defect in check. Breast cancer patients who exhibit the genetic defect in question initially have their primary tumor excised; then they are given Herceptin in the hope of preventing potential metastases.

Primary tumors and metastases are genetically different

"The underlying assumption is that the target cells in metastatic tumors have the same genetic defect as the nodes long since removed from the breast," explains Professor Klein. "But this is not always the case." He and his team have studied numerous types of tumor, including cancers of the breast, prostate, intestine, esophagus and pancreas, as well as melanomas, and compared the genetic similarities between the primary tumor and the disseminated tumor cells in the patients from whom they were removed. The results were consistent: the researchers found more – and also different – genetic defects in the primary tumor cells than they found in the disseminated cells in the bone marrow or lymph nodes. Professor Klein succinctly summarizes their findings: "The secondary tumors can-

not stem from those cells which made up the parent tumor at the time of surgical removal. We therefore conclude that the dissemination took place at a very early stage of the disease, when the original tumor had not yet fully matured. This contradicts the traditional model of metastasis formation." For this discovery, the professor was awarded Switzerland's prestigious Dr. Josef Steiner Prize for 2011. He shares the honor, which is endowed with one million Swiss francs (approximately 800,000 euros), with the cell biologist Dr. Eduardo Moreno from Bern, Switzerland.

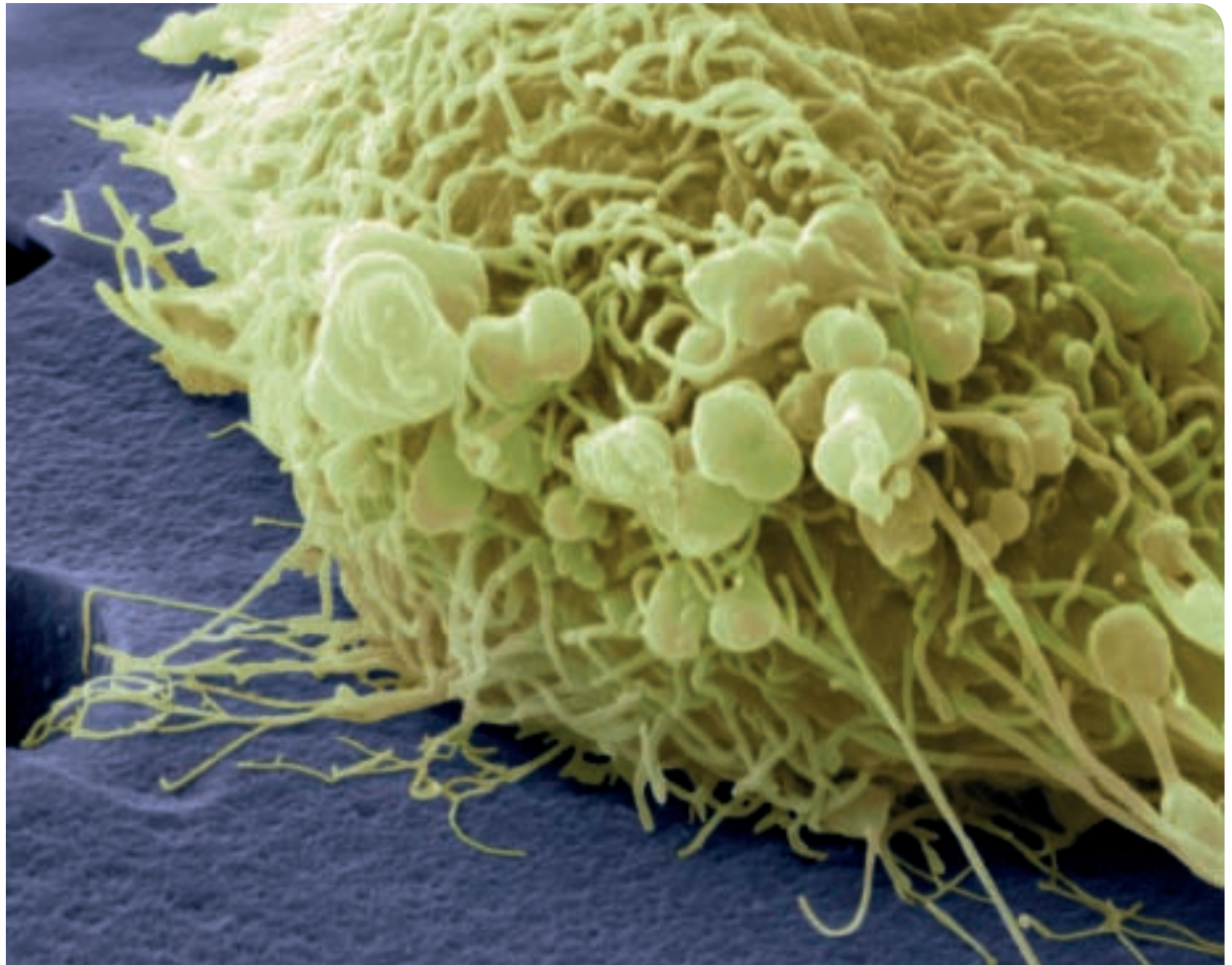
Professor Klein uses two new techniques in his work, both of which were developed in his working group, and is proud to report: "Not only are we able to amplify the entire genomic DNA of a single tumor cell and study it for genetic defects, we can also sequence its entire mRNA and identify exactly which genes were


actually transcribed in the particular tumor cell. We're now trying to use this information to establish the function of these genes." The medical researcher is currently working with the new Fraunhofer project group to devise suitable tests to detect disseminated tumor cells: "We're looking for specific surface structures that clearly differentiate these disseminated cells from both harmless cells and primary tumor cells, so it becomes possible to identify them before conventional imaging techniques would reveal any metastases." But that's not all. "When we obtain suitable specimens, naturally we want to use them for drug development purposes," says the professor. "They would help us make better predictions regarding which patients might respond to a new active ingredient, and which might not."

As head of the Fraunhofer project group, Professor Klein wants to put his newly-acquired

knowledge to practical use as quickly as possible. But in his capacity as Chair of Experimental Medicine and Therapy Research at the University of Regensburg, he is equally drawn to seek answers to those questions that remain unanswered. One problem, in particular, continues to gnaw at him: "We now know that the primary tumor releases cells at a very early stage, and that these cells can go on to form secondary tumors. However, there is no disputing the fact that patients whose original tumor is discovered and removed early have a much better chance of recovery than those who undergo surgery at a later point. Consequently, we believe that as it increases in size, the parent tumor encourages its disseminated daughter cells to transform into cells which then grow into metastases." The scientist wants to understand this line of communication between parent and daughter – perhaps so it can be cut in the future, or put to beneficial use. ■

Cancer cell in a colored scanning electron microscope (SEM) image.
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SPL/Agentur Focus






Electronics made of plastic

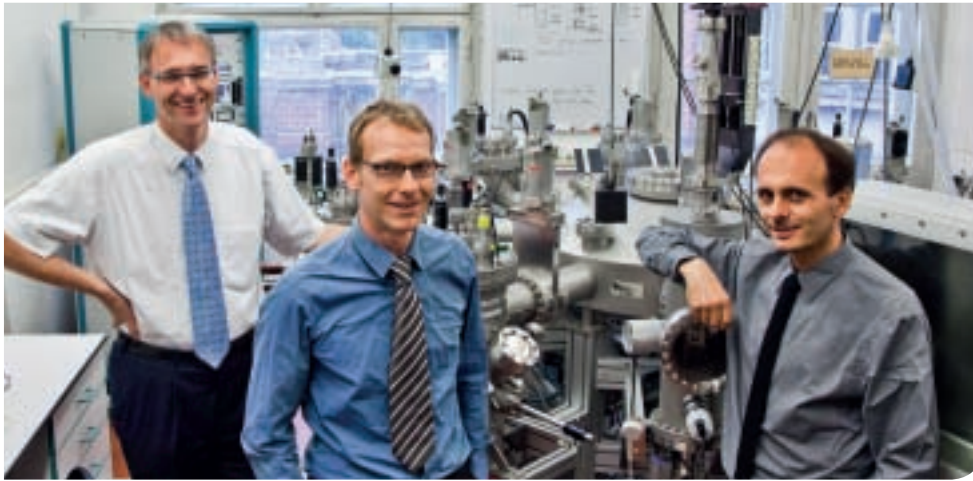
The German Future Prize 2011 was won by a team comprising existing and former Fraunhofer researchers. Professor Karl Leo, Dr. Jan Blochwitz-Nimoth and Dr. Martin Pfeiffer were honored for their pioneering achievements in the field of organic electronics.

Text: Klaus Jacob

Red, green and blue OLEDs with an active surface area of 2x2 millimeters, being tested for performance.
Photos © Deutscher Zukunftspreis/Ansgar Pudenz



Prof. Karl Leo, Dr. Jan Blochwitz-Nimoth,
Dr. Martin Pfeiffer (from left).



When the concept was first proposed, it was dismissed as being unrealizable: "It'll never work," commented one expert reviewer of an application for research funding. Today, 15 years later, the physicist Professor Karl Leo and two of his colleagues have been presented with the German Future Prize, one of Germany's most prestigious research awards, for what was once a highly controversial idea. Leo, director of the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden, has devoted most of his career to organic electronics. Until now, most electronic components have been made of inorganic silicon. The brittle material is a good semiconductor, but its manufacture requires a highly sophisticated process. It involves growing large crystals at high temperatures and then cutting them into thin slices known as wafers.

The more elegant solution is to use an organic material, a type of dye commonly used in the production of road signs. Such materials have the advantage that they can be applied as a coating on flexible films and other substrates. This gives rise to endless new possibilities, such as displays that can be rolled up and carried in a vest pocket or switchable window panes that light up at night to illuminate rooms while hardly consuming any electricity. On the other hand, organic dyes are poor electrical conductors. But this is where the once-mocked ingenious idea comes into play: their less-than-satisfactory conductivity can be increased by doping, i.e. adding a small amount of another chemical substance. After years of experiments, the researchers have succeeded in creating materials with an electrical conductivity a million and more times greater

than the original dyes, with a doping ratio of no more than one percent.

The German Future Prize, endowed with 250,000 euros, has been awarded by the President of the Federal Republic of Germany every year since 1997. It honors outstanding innovations that have made the transition from the research laboratory to industrial practice, thus helping to create jobs. Fraunhofer is a frequent winner of this prize, no doubt because it operates precisely at this interface between the world of research and the commercial market. This time, the jury chose to honor organic electronics, which Leo describes as a technology "that will revolutionize our lives".

The ultrathin semiconductor coatings have already made their way into mass production. They are equally versatile as the silicon chips that preceded them, for instance converting electrical energy into light just as easily as they convert sunlight into electricity. NovaLED AG has adopted the first approach, using the technology to produce materials for displays and lamps, while Heliatek GmbH has chosen to focus on photovoltaics. Both of these companies are spinoffs created by former members of Professor Leo's research team. By now they employ a total of nearly 200 people, and work closely together with other Dresden-based companies in a technology network. This year's Future Prize is shared by the founders of these two spinoffs, Jan Blochwitz-Nimoth (NovaLED) and Martin Pfeiffer (Heliatek), and their mentor Professor Leo. NovaLED AG is slightly further ahead in terms of marketing: the company is already mass-producing

materials for cellphone displays. In two or three years' time, it intends to start supplying materials for ultraflat TV screens that display true-to-life colors and consume a minimum of energy. "OLED displays combine the best qualities of LED and plasma screens, the two technologies currently available," says Blochwitz-Nimoth. They are more energy-efficient than plasma TVs and deliver sharper images than LED technology, because they don't need backlighting.

Solar cells made of organic materials have not yet reached the mass market. Heliatek GmbH expects to start production sometime next year. The company's latest prototypes have an efficiency of ten percent, which is not yet high enough to compete with conventional silicon cells. "But in the longer term we will reach efficiencies approaching 20 percent," Professor Leo states. Moreover, organic cells have other advantages compared with silicon technology, foremost among them a simpler – and therefore cheaper – manufacturing process.

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The method employed by Karl Leo and his prize-winning former colleagues involves depositing microscopically thin layers of the organic material on a substrate. These coatings have a thickness of no more than one fifth of a micrometer – one thousand times thinner than in conventional solar cells. Only about a gram of semiconductor material is needed to coat a surface area of one square meter – in a process that takes place at room temperature, not at the 1,000 or so degrees Celsius required to produce inorganic cells.

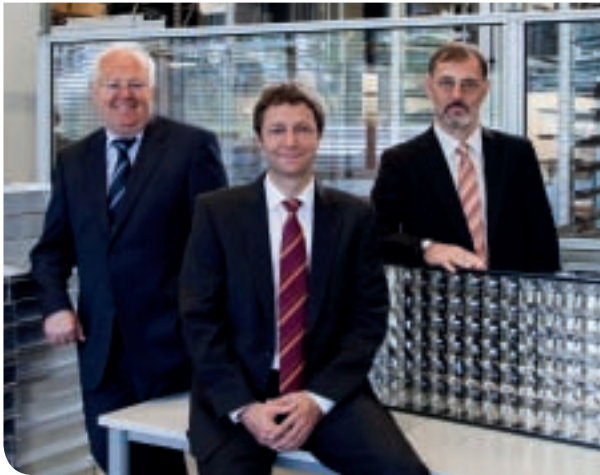
This not only saves energy but also allows PET films to be used as the substrate, instead of the heat-resistant glass that was previously the only option. PET is the same plastic used to make bottles for soft drinks. It is cheap, light and flexible. The prize-winners have developed a continuous process based on roll-to-roll technology that enables the solar cells to be manufactured cheaply in large numbers. The resulting lightweight modules can be installed on roofs too weak to support the weight of standard photovoltaic panels.

Before making its final choice, the jury had shortlisted three projects as potential winners

of the German Future Prize. A second project rooted in Fraunhofer research was among this year's finalists, competing alongside the organic electronics team. These researchers have developed an advanced photovoltaic technology, known as "concentrated photovoltaics (CPV)", which consists of very-high-efficiency solar cells and sun-tracking concentrator modules. The nominated team comprised Andreas W. Bett, deputy director of the Fraunhofer Institute for Solar Energy Systems ISE, Hansjörg Lerchenmüller from Soitec Solar and Klaus-Dieter Rasch from AZUR SPACE Solar Power. Their idea stemmed from the fact that conventional silicon

technologies. But back on Earth, other rules apply. Here, innovative products have to compete with established technologies such as conventional photovoltaic or solar thermal power generating systems. To obtain that decisive competitive edge, the researchers had another trick up their sleeves: they simply placed a lens in front of each cell to concentrate the sunlight, which increases the energy by a factor of 500. Because the beam of light is focused on one spot, the size of the semiconductor elements can be reduced to just three millimeters. The savings potential is evident: this concept enables 1,000 or more individual components to be produced from a single wafer.

sheep may safely graze on the land between the solar pillars. There is no need of water for cooling, an important consideration in arid climates. The energy consumed by the production process for these photovoltaic power plants has been amortized within six months – a record performance. Lerchenmüller reports that "these generation plants are twice as efficient as conventional silicon-based systems." He is pleased with the growing success of this new technology on the commercial market, and not least with the success of the spin-off company from the ISE that he and Andreas Bett founded six years ago.



Dr. rer. nat. Klaus-Dieter Rasch, Hansjörg Lerchenmüller,
Dr. rer. nat. Andreas W. Bett (from left)



Concentrator photovoltaics (CPV): Fresnel lenses
increase the energy yield by a factor of 500.

cells are unable to convert the entire spectrum of sunlight into electricity. They are notoriously inefficient when it comes to converting shorter wavelengths – those that contain the most energy – and totally incapable of converting long-wave infrared light. To overcome this problem, the scientists decided to pile up different semiconductor layers – gallium indium phosphide, gallium indium arsenide, and germanium – one on top of another so as to harvest the maximum amount of solar energy. Two years ago, they managed to achieve a conversion efficiency of 41.1 percent in the laboratory, beating the existing world record.

The process used to manufacture triple-layer solar cells is complicated and expensive. This isn't a problem if the cells are to be installed on satellites. In space applications, where the priority lies on low weight and high efficiency, the stacked-cell approach has almost entirely displaced silicon

Admittedly, CPV technology is not suitable for use at all latitudes, because it only works with direct sunlight. Its full potential cannot be realized in Germany, for example, where the sun is often obscured by clouds. The technology is best used in the Earth's equatorial sun belt – but even here, rooftop installations are impractical because the cells have to be constantly oriented toward the sun by means of a tracking system. The domain in which CPV technology can unfold its full potential is in the construction of large-scale solar generation plants. It was for this reason that Andreas Bett and his fellow researchers always kept an eye on integrated systems solutions when they were developing the solar cells. The modules are mounted on two-axis tracking platforms that automatically orient them toward the sun.

The individual platforms can be placed sufficiently widely apart to allow the installation site to be used for other purposes. Even

The German Future Prize not only honors past achievements but also and more importantly anticipates future technological developments. The shortlisted projects provide a foretaste of the ways in which our future lives will be transformed. The third project nominated by the jury meets this criterion, by presenting solutions for cars that provide a higher level of driver assistance. The Daimler team was nominated for an innovative system that detects road hazards and responds with the appropriate braking or avoidance maneuvers faster than even those demonstrated by experienced racing drivers like Sebastian Vettel.

It was thus against such strong competitors that the organic electronics team led by Professor Leo won the German Future Prize 2011. German President Christian Wulff presented the award to Professor Karl Leo, Dr. Jan Blochwitz-Nimoth and Dr. Martin Pfeiffer in mid-December. ■

Technical Oscar for ARRI and Fraunhofer

The Munich-based producer of professional motion picture equipment ARRI and the Freiburg Fraunhofer Institute for Physical Measurement Techniques have been awarded the "Academy Award of Merit" by the Academy of Motion Picture Arts and Sciences for their jointly developed ARRILASER film recorder. The Oscar statuettes were presented on February 11 in Beverly Hills.

Each year, the "Academy Award of Merit" honors personalities who are responsible for a technical achievement which "has demonstrably contributed to improving filmmaking processes in a significant way". Franz Kraus and Johannes Steurer from ARRI and Wolfgang Riedel from the Fraunhofer Institute for Physical Measurement Techniques IPM have each been awarded an Oscar for the design and development of the ARRILASER. The Jury of the Academy declared that this laser film recorder "demonstrates a high level of engineering resulting in a compact, user-friendly, low-maintenance device, while at the same time maintaining outstanding speed, exposure ratings and image quality". Extracts from the Scientific and Technical Awards Presentation should also be included in the broadcast of the Oscar Ceremony on February 26.

The basic concept of the ARRI LASER was developed by a research team led by Wolfgang Riedel, who had already developed a successful large-format recorder for the photography industry as project manager at Fraunhofer IPM. Riedel's idea to use the acquired know-how for the motion picture industry led to an extremely successful partnership with ARRI. The experience in imaging technology together with the specialist knowledge as regards the motion picture industry's needs allowed the Kraus, Steurer and Riedel team to define the requirements placed on a laser-based, high-quality, high-resolution film recorder. In 1998, after only two years of development, the first prototypes of such laser film recorders were delivered to the Digital Domain und Computer Film Company for testing. Today, ARRILASER is an industry standard. More than 280 devices are in use worldwide for the recording of digital film data onto film.

"The idea was to provide technology which met Hollywood requirements as regards quality, but which at the same time was also efficient



The "Award of Merit" is Hollywood's highest technology award. Franz Kraus, Wolfgang Riedel working with Fraunhofer IPM and Johannes Steurer of ARRI (from the left) were honored at the Oscar Ceremony. © ARRI

enough to be competitive for small-budget movies," explains ARRI CEO, Franz Kraus. ARRI Product Development Manager Johannes Steurer adds: "The ARRILASER made it possible to offer all features at a reasonable price – even for extremely short recording times. The motion picture industry was thus able to move from recording-based effects to complete digital production. The ARRILASER therefore allowed for digital movie editing on a large scale for the first time." "From a scientific point of view, the development of the ARRILASER was also an overwhelming success," remarks Wolfgang Riedel of Fraunhofer IPM. "There were many technological challenges which could only be met because scientists from extremely varying organizations were consulted. Several significant advancements in the specialist areas can be attributed to this joint project."

The Fraunhofer researchers used the knowledge acquired from developing the ARRILASER for further innovation: the ARCHE laser film recorder is, for the first time, able to print digital image data, e.g. historical documents, accurately and colorfast onto film which is stable in the long term. The color microfilm recorder has been used for many years by the Institute for the Preservation of Archival and Library Material at the "Landesarchiv" (State Archive) of Baden-Württemberg in Ludwigsburg. ■



The ancient column is the emblem of Tongji University.



Travelling China

Fraunhofer Gesellschaft and the Tongji University in Shanghai will continue to extend their close cooperation. On his visit to China Fraunhofer's President Prof. Hans-Jörg Bullinger met Tongji President Pei Gang and signed not only an Agreement of Strategic Cooperation but also a Memorandum of Understanding that implies the creation of "Tongji Academy E-Mobility", an institution that will focus on the development and marketing of electric engines. Another Agreement refers to the creation of a Joint Building Materials Field Test Base, where building efficiency can be improved.

The journey also took Prof. Bullinger to Guangdong, where he has been an international consultant of the governor since 2003. Guangdong is one of the most prosperous provinces in China, and around 400 German companies are located there. Frequently the governor invites chairmen, presidents and CEOs from multinational enterprises and organizations to exchange ideas. During this conference Prof. Bullinger and the governor Mr Zhu Xiaodan signed a Framework Agreement on Strategic Cooperation. Now Fraunhofer scientists and their Chinese colleagues look forward developing energy-efficient buildings in the City of Foshan.

Franco-German success

Fraunhofer researchers have teamed up with their French colleagues at the Carnot-Institut Laboratoire d'électronique des technologies de l'information CEA-LETI to develop reusable substrates for III-V multi-junction solar cells. On December 5, 2011 the scientists were honored with the Franco-German Business Award 2011.

The photovoltaics industry is booming – more and more solar modules are appearing on rooftops, and even large-scale solar power plants are increasingly feeding power into the grid. Multi-junction solar cells are particularly efficient in this regard: they can achieve efficiencies of up to 43 percent – twice the level of conventional solar cells made of crystalline silicon. The trick: they consist of several semiconductor layers that combine to transform the entire spectrum of sunlight into electrical energy. This technology is used in concentrator photovoltaics. There, lenses focus 500 times the light of the sun onto tiny solar cells. These concentrator systems produce solar electricity on a large scale, particularly in solar power plants located in areas rich in sunlight. Among the producers of these plants is SOITEC Solar GmbH, in Freiburg, Germany, a former spinoff of the Fraunhofer Institute of Solar Energy Systems ISE.

The multi-junction solar cells themselves consist of some 30 semiconductor layers built up, layer



for layer, on ultra-pure crystals of germanium or gallium arsenide. These materials are very costly, however. In a joint Franco-German project, researchers at Ithe SE in Freiburg and their colleagues from the Carnot-Institut Laboratoire d'électronique des technologies de l'information CEA-LETI in Grenoble, France, are working to develop new substrates for multi-junction solar cells.

The new technology replaces the expensive materials with reusable substrates. Whereas up until now the solar cells had to remain in place atop the germanium or gallium arsenide crystals, the solar cells are now removable from the new substrate, which is recycled several times. This way, the cost of producing solar cells can be reduced by up to 20 percent. „In the Solar Bond project, two high-tech institutes have

From left to right: Guy Maugis, Jos Lenferink, Bruno Bouygues, Frank Dimroth, Patrick Schnell.
© Robert Kluba

combined their skills,” according to Dr. Frank Dimroth, Head of Department III-V - Epitaxy and Solar Cells at Fraunhofer ISE. „CEA-LETI is a leader in the microelectronics field and Fraunhofer ISE in photovoltaics.” The French colleagues develop the substrate and adapt its properties to the requirements involved in growing multi-junction solar cells; the German scientists then apply the solar cells to these substrates and process them to create ready-to-use devices. The researchers are also working closely with SOITEC, a French company: in the future, the new solar cells will be used in their concentrator modules.

Bridge Building Award

Prof. Alexander Michaelis, director of the Fraunhofer Institute for Ceramic Technologies and Systems IKTS, was awarded the ACerS Bridge Building Award at the 36th International Conference and Exposition on Advanced Ceramics and Composites (ICACC) in Daytona Beach in the end of January. With more than 1,100 participants from more than 50 countries, this conference is one of the most important international events in the field of advanced ceramics.

The Bridge Building Award, which is annually awarded by the American Ceramic Society, recognizes individuals who have made outstanding contributions to engineering ceramics and thus significantly contributed to the visibility of the field and international advocacy. The work of Prof. Alexander

Michaelis and his teams covers all aspects of advanced ceramics from preliminary basic research to application. The focus is on the development and application of modern advanced ceramic materials, the development of industrial powder metallurgical technologies, and the manufacturing of prototypical components. Structural ceramics, functional ceramics and cermets are the main topics, with an emphasis on innovative complex systems which are applied in many industry sectors. The award, in particular, recognizes the Prof. Michaelis' contribution in the field of energy and environmental technology.



The German High Tech Champions

Four Fraunhofer researchers have won a prize in the Business Case Competition "German High Tech Champions". The program is sponsored by the German Federal Ministry of Education and Research and was launched in 2011. To date, a total of 12 German technology developers have been awarded 10 000 euros each plus a package that helps them bring their business cases to foreign markets.

In 2011, the German High Tech Champions presented their results to a predominantly US American audience: the inventions and commercialization concepts honored at the ceremonies in Boston and Chicago focused on photovoltaics and medical imaging. Among the winners, Dr. Andrés Lasagni from the Fraunhofer Institute for Material and Beam Technology IWS received an award for a contactless, rapid fabrication system of nanostructures for highly efficient photovoltaics. Furthermore, Dr. Uwe Lommatzsch from

the Fraunhofer Institute for Manufacturing Technology and Applied Materials Research IFAM demonstrated that his winning easy-to-integrate plasma deposition technology effectively improves reliability and lifetime of photovoltaic modules.

This March, the GHTC campaign reached out to India: in Delhi, three young German researchers presented their technological solutions for sustainable transportation needs in today's megacities. Once again, two Fraunhofer scientists were among the awardees: Andreas Küster and Dr. Jan Schubert, both from the Fraunhofer Institute for Transportation and Infrastructure Systems IVI. The researchers had developed not only the largest bus in the world, that can handle 256 passengers at one time, but also a navigation system for public transport that can be used via smartphone. The next award will take the winners to France.

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A man with dark, wavy hair and a light beard, wearing a red and white striped button-down shirt, stands on the left. A woman with short brown hair, wearing a dark purple cardigan over a dark patterned blouse, stands on the right. In the foreground, a clipboard with a silver clip at the top holds a white card with green text. The background is a blurred laboratory or office setting with shelves and equipment.

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