Fraunhofer magazine

# Fraunhofer magazine

1/12 special issue

# 3D movie thrill

# Renewable energy for enhanced efficiency

Prof. Dr. Hans-Jörg Bullinger. © *Bernhard Huber*

Managing the transition to sustainable energy supplies is one of the greatest challenges we face in the 21st century. With its study "Vision for a 100 percent renewable energy system" Fraunhofer has demonstrated how reliable, cost-effective and robust energy supplies can be achieved in Germany by the year 2050 using only renewable resources. But what will the changeover cost us? True, stepping up the supply of energy from renewables will initially incur additional costs, with a projected maximum of around 17 billion euros – roughly eight percent of Germany's total expenditure on energy – being reached in 2015. But, after that, the costs are set to fall dramatically. Over the period from 2010 to 2050, total cost savings of 730 euros billion could be achieved in the electricity and heat production sectors alone.

A decentralized system of energy production from renewable sources requires the power grid to be structured differently than the one already in place. In future it will be necessary to coordinate a large number of solar, wind and biomass power plants and to calibrate their yield and load estimates sensibly. Gaps in supply arising from fluctuations in the availability of sun and wind must be compensated for with fast-acting temporary storage and balancing power plants.

A radical shift in energy production toward renewables is possible only if we simultaneously launch a revolution in energy efficiency. The best way to lower energy costs is to conserve resources and consume less energy. Getting more light, more heat and more power out of one liter of oil or one kilowatt-hour of electricity makes economic sense not only for individual households or businesses but also for the national economy as a whole. More efficient electronics, for instance, can help to reduce power consumption significantly. Simply by switching over to LED lighting, which consumes 80 percent less power, Europe could save more than 56 terawatt-hours in electricity. That equates to the output of almost six nuclear power plants. The Fraunhofer study entitled „Energy efficiency in the production environment" has demonstrated the huge potential gains to be made from enhancing efficiency. The most important result of the study is this: In the medium term, energy consumption in the industrial production sector can be reduced by as much as 30 percent.

Existing housing stocks currently present one of the major opportunities for achieving more sustainability. Over one-third of Germany's energy consumption goes toward heating and cooling the country's buildings. It is well worth taking a look at the energy efficiency of older buildings as they consume three to five times more heating energy than their modern counterparts. Here, proper insulation or more efficient heating and cooling could help to achieve energy savings of up to 80 percent. In the Research Union Economy – Science, Fraunhofer has teamed up with the German Federal Ministry of Education and Research to develop the "City of Tomorrow," our vision of a metropolis that emits virtually no $CO_2$ and where no fossil fuels are burnt in the city's houses or its vehicles. Both electricity and heat are generated mainly from renewable energy sources, while transport and utilities are primarily electricity-based. Electric mobility has significantly reduced the burden of noise and exhaust emissions on the city's inhabitants. The quality of life is higher, and energy supplies are more secure than in other regions. Money previously spent abroad to purchase oil and gas remains within the country.

Germany continues to enjoy a sound reputation for technical innovation and the quality of its products. Going forward, energy and resource efficiency will be the country's new hallmark of quality. We need to build on the competitive advantage we already have in this field and translate it into economic success. In short, we need to become experts in efficiency.











# Content

# Attacking tumor cells

Treatment options for brain tumors are currently limited to surgery, radiotherapy and chemotherapy. Physicians are hoping that the autologous immunotherapy DCVax® Brain from the American company Northwest Biotherapeutics will increase survival rates and lead to fewer side-effects. The new treatment has already entered clinical trials in the USA, and the company is now cooperating with the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig to make it available to patients in Europe, too.

The first task facing the researchers is to adapt the drug manufacturing processes to meet European regulations and then apply for the necessary regulatory approval. Once approval is obtained, the scientists will move on to producing clinical trial batches. The new treatment method primes the patient's immune system to attack all the tumor cells that exhibit the corresponding tumor antigens on their surface. The researchers hope that it will also be possible to use this method to treat other forms of cancer in the future.

# Traces all over the world

Breathable textiles, food packaging, waterproofing agents, paints and cosmetics – the applications for perfluorinated compounds (PFC) are many and varied. The benefits they offer are manifold, including the ability to repel water and oil and to retard flames. But these outstanding characteristics come at a price: Scientists have detected concentrations of these substances in the soil, drinking water, crops and even in the livers of polar bears.

The toxicological properties of these tensides have so far not been thoroughly investigated. Now, Fraunhofer researchers are working together with nine other partners in the European Perfood project (www.perfood.eu) to track the path taken by these substances from the environment to our foodstuffs. Among other things, they are developing new analytical methods and testing different types of food packaging.

Researchers are using a special testing facility – a lysimeter – to investigate the effects that tensides have on the environment. © *Fraunhofer IME*

# Milling, grinding and polishing

Manufacturing turbine blades involves a large number of complex production steps. One example is manual finishing, which is currently still employed to remove the rough surface left by the milling process. Researchers at the Fraunhofer Institute for Production Technology IPT in Aachen have now succeeded in integrating precision finishing tools such as grinding and polishing tools within the milling machine itself, enabling components to be processed automatically. The engineers will soon be putting the manufacturing process into practice and testing their automated finishing system with industrial robots.

Automated finishing of a milled turbine blade. © *Fraunhofer IPT*

# A clear overview in emergencies

Natural disasters and environmental catastrophes do not stop at national borders. When it comes to the crunch, rescue workers need fast access to all relevant geographical data in order to plan their missions effectively. Under the auspices of the HUMBOLDT project, researchers have now created a basis for combining and publishing the spatial data that is already available in different formats. Led by the Fraunhofer Institute for Computer Graphics Research IGD, almost 70 developers from 13 countries cooperated in this project, which was sponsored by the European Commission. The software they have developed can also be used for environmental protection, urban planning or localization applications, and is freely available under an open source license.
www.esdi-humboldt.eu

# European space scout

Countless satellites, asteroids, comets and meteorites as well as the burnt-out remains of rocket stages and fragments of disintegrated spacecraft all make for heavy traffic in outer space. An estimated 20,000 pieces of junk of at least ten centimeters in size are locked in orbit around the Earth, reaching speeds of up to 28,000 km/h. The problem they pose is this: At such high velocities, fragments of just a few centimeters in size can damage and even completely destroy operational satellites.

This potential threat prompted the European Space Agency (ESA) to take urgent action. ESA commissioned Spanish company Indra Espacio to develop the demonstrator of a new European space surveillance system that will provide future protection against the dangers posed by space debris. Researchers at the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR are working on the receiver for the radar system, while their Spanish colleagues are taking care of the transmitter array. In addition to European governments and space research organizations, satellite operators, insurance companies, utilities and telecommunication companies will benefit from this high-precision space scout.

Disintegrated spacecraft can damage or even completely destroy satellites. © *ESA*

# Film music

Virtuoso guitarists employ a rich variety of masterful playing techniques. But how can the intricate process of playing the instrument be captured digitally? A special thin film on the tailpiece provides the answer. The film – known as DiaForce® – functions as a sensor, converting the tension on the string into digital control signals. Engineers at the Fraunhofer Institute for Surface Engineering and Thin Films IST in Braunschweig have been using this new method to capture playing techniques such as vibrato and bending with a high degree of precision. Developed in collaboration with the company M3i Technologies GmbH, the key technology is the thin film that coats the tailpiece, the part of the instrument that anchors the guitar strings to the body. The Fraunhofer researchers now aim to develop suitable mass production techniques for the coating. They are also hoping to extend its application to other musical instruments. In the future, coated tailpieces could replace the pickup devices on electric guitars. Pickups convert the string vibration into an electrical signal and are responsible for the bulk of the sound produced by an electric guitar.

The tailpiece is equipped with a thin-film sensor system which converts the tension on the string into digital control signals. © Fraunhofer IST

Pina – a full-length dance film in 3D with the Ensemble of Dance Theater Wuppertal Pina Bausch. © *NEUE ROAD MOVIES/Donata Wender*

# 3D movie thrill

Pirates of the Caribbean 4, The Three Musketeers, and Pina - these are just some of the more than 50 films that have debuted in movie theaters in 3D so far this year. The technology involved in delivering high quality in 3D is extremely complex, and this is where Fraunhofer researchers are at work on cornerstone developments and technologies.

Text: Birgit Niesing

Feature films, animated movies and documentaries in 3D are the top hits in cinemas everywhere, which means that moviegoers now more often need to remember the glasses that put them "in the picture". According to the consultancy firm Flying Eye, 12 of 2010's 20 most successful blockbusters worldwide were filmed in 3D. In Germany alone, one in six moviegoers (17.1 percent) attended a 3D film, despite the fact that film-lovers had to pay top dollar for the privilege – usually a fixed surcharge of two euros on the normal ticket price. The premium pricing strategy and large audience numbers make investments in 3D projection technology an interesting proposition for cinema operators. It therefore comes as no surprise that, by early 2011, some 22,000 projection rooms worldwide had already been equipped with the new 3D technology. In Europe, around 7,500 movie theaters – 900 of them in Germany – are already able to show 3D movies. Nowadays, virtually no movie theater switching to digital technology will forgo the installation of 3D projection equipment.

## Films you can almost feel

The ghost ship that suddenly sails through the middle of the movie theater, the sword that seems to slice through the person sitting next to you – 3D films thrust the audience into the center of the action. But how is this spatial impression created? How is it possible to project the film not only onto the screen, but also – seemingly – into the auditorium itself? The filmmakers' trick is to imitate nature. We are able to see objects in three dimensions because our left and right eyes view them from different perspectives. The human brain combines the two sets of information from our eyes to create a three-dimensional image.

To achieve the same effect in a movie theater, two cameras placed at roughly the same distance from each other as a person's eyes are used to record the same scene simultaneously. The pictures are then projected onto the screen separately for our right and left eyes – either simultaneously using two film projectors or in quick succession using a suitable digital cinema projector. Special 3D glasses ensure that the viewers' right eyes see only the "right" image, while their left eyes see only the "left" image. The brain brings this information together, creating an impression of being bang in the middle of the action on screen.

But a number of problems remain to be solved before 3D technology can become the standard in movie theaters and on television. For instance: how can the two images be recorded and projected in absolute synchronization and with exactly the right distance between them? This is a prerequisite to creating high-quality stereoscopic films. And how can

the recording and post-editing processes be optimized, also in terms of costs? In order to address these problems, film industry experts, university academics and scientists – among them researchers from two Fraunhofer institutes – joined forces to form "PRIME – Production and Projection Technologies for Immersive Media" (see box). Together, the participants developed business models and technologies for 3D cinema, television and games, presenting their results just a few weeks ago.

## STAN for high-quality stereoscopic images

Stereoscopic filming places great demands on filmmakers. Not only do the two image signals have to be perfectly synchronous, but the exact settings for the distance between the two cameras and the angle have to match as well. Even the slightest shift or tilt of the camera becomes visible on the screen, and can make viewers feel nauseous or even give them a headache. Researchers at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut HHI and their colleagues from KUK Filmproduktion have developed a camera assistance system for this purpose: the Stereoscopic Analyzer (STAN). The system allows stereoscopic images to be captured and analyzed even during recording; the settings of the two cameras can be adapted in real time to the scene being filmed, allowing any remaining distortions to be rectified electronically. The new technology is also integrated in two hardware platforms produced by the company DVS and in the workflow of ARRI's digital film camera Alexa.

Many challenges arose during shooting, as Frederik Zilly of the HHI in Berlin explains: "Many parameters – including the stereo basis, color adaptation, stereo geometry or the angle of the the two cameras – can vary from scene to scene depending on the motif, the content, the near and far points as well as on the convergence and the focal plane. STAN assists camera operators, stereographers and the entire production team in ascertaining the correct settings for these parameters, which are of such importance for the stereo quality." What is more, the system can create and store meta-data for the 3D post-production phase, and also allows live events to be transmitted in real time.

## World premiere: first live concert in 3D

STAN has already passed its first acid test with flying colors. In the fall of 2010, German hip hop group Die Fantastischen Vier (The Fantastic Four or Fanta4) gave a performance in a concert hall in Halle in eastern Germany that was broadcast live via satellite in 3D to more than 90 movie theaters in five countries. Running on the VENICE hardware platform of DVS, one of the PRIME project partners, STAN played a decisive part in the success of the premiere. "Even while it is recording, the system checks the stereo video images, automatically rectifying any incorrect settings. Without that, no live transmission would be possible," explains Dr. Ralf Schäfer, head of the image signal processing department at the HHI.

The concert was filmed using a total of five sets of 3D cameras. "The biggest challenge for us was to maintain our ability to respond at any time to what was happening live despite all our complex 3D technology, and at the same time ensure exact coordination of the stereographic images in real time," recalls Josef Kluger, general manager of KUK Filmproduktion and the director responsible for the 3D transmission. "With a normal film production, that process normally takes place during the many weeks of the port-production phase. Taking this into account, the quality of the live broadcast can only be regarded as spectacular."

## Two cameras create the spatial effect

Digital cameras are key components in making 3D films. As part of the PRIME project, scientists at the Fraunhofer Institute for Integrated Circuits IIS enhanced the MicroHD for three-dimensional filming. The camera is notable for its light weight and very compact dimensions, and can be used as a point-of-view camera – for instance in a racing driver's helmet. This gives the audience a view of the scene similar to that of the driver.

In the case of 3D films, the scene is recorded using two synchronized MicroHD cameras. A special camera configuration – stereo or side-by-side rig – simulates the distance between a pair of human eyes. "We use genlock technology to ensure that the cameras record the images in absolute synchronization. This means that one camera acts as the master, or digital leader, while the second uses identical settings to capture the calibration, color fidelity and geometry," explains Stephan Gick, who heads up the image sensor department of the IIS in Erlangen.

The BBC has already deployed the new technology, with animal film specialists using the compact cameras to make the 3D pilot film Peregrines, which tells the story of one such bird in London. Produced by KUK Filmproduktion, the film was awarded a special prize for visual effects at the "Dimension 3 Festival" in Paris. Spectacular shots can also be achieved using the 3D high-speed camera, which delivers up to 1000 images per second. This technology was used in the making of the short film Summer Feelings, where you can marvel at a water-skier's jumps in super slow motion and 3D. The camera can even distinguish individual water droplets in a plume of water.

MicroHD cameras can be used to record three-dimensional panoramic shots, in which up to 16 cameras (eight side-by-side stereo pairs) are arranged in a circle on a special rig. With a full complement of cameras, a rig like this can capture

This combination of hardware and software in the STAN camera assistance system tests whether the editing and 3D transmission are functioning correctly. © *Fraunhofer HHI*

In germany in the fall of 2010, a live concert was broadcast in 3D for the first time. The Fanta4 could be seen simultaneously in more than 90 movie theaters. © *Matthias Heyde*

## The history of 3D film

Moving pictures were still in their infancy when filmmakers began experimenting with spatial effects. In 1895, the Lumière brothers produced the 3D short film L'arrivée d'un train en gare de La Ciotat, which they also presented at the World Exhibition in Paris. But it was to take more than 20 years before the first 3D feature film reached movie theaters. In 1922, the silent film The Power of Love was shot using the red-green anaglyph method. The first 3D talkie was an Italian film entitled Nozze vagabonde, while the first three-dimensional color talkie in Germany – a promotional film entitled Zum Greifen nah (Within Reach) – made a real splash when it was shown in 1937.

3D cinema enjoyed its first heyday in the early 1950s. At that time, filmmakers began concentrating more and more on stereoscopic films in an attempt to lure audiences back into movie theaters and away from the new craze of television. Dozens of 3D films were launched, among them Bwana Devil, House of Wax and It Came from Outer Space. At the close of the 20th century, three-dimensional films were mainly confined to specialized IMAX-3D movie theaters, where they were shown on special screens with the aid of extra-wide 70 mm copies.

Now, digitalization makes it possible to show three-dimensional films in high technical quality in "conventional" movie theaters. The film "Avatar", in particular, aroused a wave of enthusiasm for 3D.

With compact dimensions of 6cm x 6cm x 8cm and an image format adjustable up to 1080p, the MicroHDTV lends itself to stereo, 3D, panorama or multiview applications. © *Fraunhofer IIS*

© Daniel Pilar/laif

## PRIME

Producing 3D content is a complex, time-consuming and expensive task. The objective of the PRIME (Production Techniques for Immersive Media) project sponsored by the German Federal Ministry of Economics and Technology was to develop new technical processes for recording, production and post-production as well as for displaying three-dimensional content on a range of terminals. With a budget of around €7.5 million, the project partners from industry and research worked together to develop technologies for the joint production of 3D films for movie theaters and television, to ascertain the market potential, and to gage public acceptance. The project, which commenced in April 2008 and came to an end in 2011, resulted, among other things, in a portable on-set tool for 3D filmmaking, the Stereoscopic Analyzer (STAN), a new generation of 3D-capable cameras, projectors with enhanced optical features, and a video workstation that supports the processing of stereoscopic content. The new technologies have already been put to the test in the production of several films, e.g. The Fanta4 Live in 3D, a Fraunhofer 3D image film, Summer Feelings – High Speed in 3D and Topper gibt nicht auf. Those interested in the results can view them in the Fraunhofer HHI's TiME-Lab.

**Partners in the PRIME project**

- The ARRI Group
- DVS Digital Video Systems AG
- Flying Eye Managementberatung für Medieninvestitionen GmbH
- Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI
- Fraunhofer Institute for Integrated Circuits IIS
- The Film and Television University (HHF) „Konrad Wolf"
- Kinoton GmbH
- KUK Filmproduktion
- Loewe AG
- Universität Duisburg-Essen, Institute of Multimedia Engineering – Entertainment Computing

www.prime3D.de

360° images in full. If only four pairs of cameras are used, the panorama is reduced to 180°.

3D-filmmaking also places new demands on data storage devices. As two cameras are used for filming, twice the amount of data needs to be stored, which is why Fraunhofer researchers have carried out further development on their Megacine field recorder. The enhanced device now makes it possible to record and play back the two parallel HD streams of a pair of stereo cameras simultaneously. When the data is downloaded to the PC, two separate image sequences are generated for the left and right camera. The newly developed Flashbox, which deploys flash-based cartridges as a storage medium, enables particularly fast work on set.

Up till now, post-processing of 3D films has been extremely time-consuming, as separate films have to be produced for the left and right eyes. During cutting and post-production the two streams must be processed and synchronized perfectly, which pushes up costs. The production of James Cameron's science fiction film Avatar, for instance, cost more than 250 million US dollars and took four years of computer processing to complete. The new "easyDCP Creator +" tool from the Fraunhofer IIS makes post-processing much easier, allowing filmmakers to create 3D digital cinema packages (DCP) for digital movie theaters more easily. The software even runs on standard PCs and Macs, helping to lower post-production costs.

Participants in the PRIME project were able to put their newly developed technologies into practice right away, testing them in several film productions. These included The Fanta4 Live in 3D, the Berlin Philharmonic in 3D, a performance by the pop group Marina & the Diamonds as well as in the short films 'Summer Feelings' and 'Topper gibt nicht auf'. In Dimensions of Research, an image film produced by Fraunhofer, 3D film techniques allow utterly new insights into the world of research at the Fraunhofer-Gesellschaft. These 3D films likewise impressed film specialists, with two of the productions receiving honors at the "Dimension 3 Festival" in Paris: the Fraunhofer 3D image film in the category "Best Corporate Film" and the live broadcast of the Fanta4 in the category "Best Live Acquisition."

"The partners in the PRIME consortium see the work done thus far as merely a start. The 3D recording technologies need to be made cheaper and easier to handle so that they can be used efficiently in normal TV operations," says Dr. Ralf Schäfer. That is why, just a few weeks ago, 30 companies and institutions came together to form the core of the new 3D Innovation Center Berlin, which aims to further advances in 3D-related technologies.

But not only the movie world is banking on 3D. A new age of television, too, is dawning, with TV sets that can reproduce films in living 3D quality. Even though only relatively few TV shows, sporting events, films or Blue-ray discs are available in 3D, the number of 3D-capable television sets sold broke the four-million barrier last year. According to Flying Eye, 178,000 3D-capable television sets were purchased in Germany alone.

## The third dimension in television

And yet, most of these devices still have a drawback: in order to view films, football games or concerts in 3D, you need to put on a special pair of glasses. While this is something that cinema audiences take for granted, it seems to bother people watching TV in their own homes, which is why Fraunhofer researchers are developing 3D devices that function without the need for glasses. With autostereoscopic presentation, a selected barrier on the screen ensures that the appropriate image content reaches only the left or the right eye. A camera integrated in the television monitors the viewer's head and face, recognizing the exact position of their eyes. Every movement is registered and the display adjusted accordingly. As a result, the viewer always sees an ideal 3D image.

3D television presents developers with even greater challenges because more than one person is usually sitting in front of a TV. Scientists at the HHI are thus working on displays on which not just one, but several, viewers can enjoy films in 3D. The objective is to combine multiview and tracking, but it will take a few years before we can enjoy 3D films with the whole family without having to put on special glasses.

## 3D-capable cell phones

In future, you will not have to forgo the pleasures of 3D when you are on the move. Researchers at Fraunhofer HHI have combined the new mobile communications standard LTE Advanced with a video coding process to enable 3D images to be displayed on cell phones. The secret is Multiview Video Coding (MVC). MVC enables the two images that are required to achieve the stereoscopic 3D effect to be compressed in such a way that the film's bit rate is substantially reduced. Thanks to this process, stereoscopic films can be reduced in size by up to 40 percent. In combination with the new mobile communications standard 3G LTE, it is possible to stream 3D films on cell phones quickly and in optimum quality.

Whether in a movie theater, on your TV at home, or on your cell phone or tablet PC while on the go – you will soon be able to enjoy high-quality 3D images anywhere you want. The pioneering work in this field is being done in movie theaters, where more and more well-crafted stereoscopic films are delighting audiences. ■

# Smart rooms and buildings

A bathroom mirror that reminds you to take your medicine, sensors that raise the alarm when someone collapses in their home, and a hotel room that can be converted into a conference room at the touch of a button: These are just some of the things developed by the Fraunhofer inHaus Center, an innovative workshop for intelligent room and building systems which recently celebrated its tenth anniversary.

Text: Janine von Ackeren

Whenever we get in a car we are immediately surrounded by technology: airbags designed to minimize impact in the event of a collision, electronic immobilizers to stop the car from being stolen, antilock braking systems to stop us losing control on icy streets – plus an ever-increasing array of systems for air conditioning, seat heating and navigation. Yet you would struggle to find anything like this degree of technological penetration in a typical house or apartment. In fact a lot of technology is availabe that could make our lifes easier. That's why researchers at the Fraunhofer inHaus Center in Duisburg are busy developing smart technologies that fit into our homes as neatly as they do in our cars.

"Our goal is to develop technological solutions that can assist people in rooms and buildings in ways we take for granted in our cars and to apply those solutions across multiple areas," says Klaus Scherer, managing director of the Fraunhofer inHaus Center. But how do 'smart technologies in the residential environment' actually work? One example is an intelligent network of sensors installed in the home of an elderly lady who lives alone, monitoring her situation day and night and ready to raise the alarm if she has an accident. The moment the 'pre-crash detection system' spots a problem, it alerts a care coordination unit, which then instructs the closest care service vehicle to provide assistance. More than ten years have passed since the Fraunhofer-Gesellschaft opened its inHaus1 research facility on April 3, 2001, and the facility has developed and tested a broad range of smart technologies for the residential environment during its first decade.

'Smarter Living' helps seniors to live independently in their own home.
© *Fraunhofer*

How can 'ambient assisted living' systems enhance quality of life for people of all ages? That question led to the creation of inHaus2 in 2008, which focuses on commercial and service facilities such as hospitals and care homes, hotels, conference centers, offices, and building operation and facility management systems. The research project started from the moment the construction of inHaus2 got underway: The building materials were fitted with RFID tags to help the researchers measure progress on the construction site against their virtual architect's plan and to optimize the site logistics during construction. All in all, a total of seven Fraunhofer institutes and more than 90 industry partners are involved in the inHaus Center.

One of the key areas researchers are working on is energy efficiency – for example how to heat buildings using minimal resources. One possibility is to use combined heat and power (CHP) plants which, as their name suggests, produce electricity, heat for heating systems and hot water all at the same time. At the moment, these small power plants only spring into action when residents need hot water or heating; power is generated essentially as a by-product. The micro-CHP plant installed in inHaus2 by the company RWE Effizienz GmbH in December last year takes this concept one step further by eliminating the need to generate heat at exactly the time it is required. It does this by using a highly insulated water tank with a capacity of 850 liters and an integrated electric heating element. Whenever electricity is cheap – i.e. when wind farms and solar panels are producing more power than the grid currently requires – the heating element converts electricity into heat and heats up the water. The building's residents can then use the hot water many hours later to take a shower or heat a room.

As well as cutting electricity bills, these new micro-CHP plants also offer benefits for the power grid by balancing out fluctuating demand. If the wind and sun are providing too much power, these small CHP plants can store energy in the form of heat – and when the sky clouds over and the wind drops, they can spring into action and help compensate for the drop in power. RWE Effizienz GmbH is aiming to link together multiple combined heat and power plants into a virtual power plant. "If we could link up multiple CHP plants into one intelligently managed system, it would give us additional flexibility. And that is crucial at a time when more and more power is being fed into the German grid from renewable energy sources," says Dr. Norbert Verweyen, Chief Technology Officer at RWE Effizienz GmbH.

The job of the inHaus Center researchers is to optimize how a facility of that kind should function in order to best meet customers' requirements – for example ensuring that the supply does not drop so low that residents cannot get hot water or turn on the heating. "We crunch real usage data and run the systems based on the results we get," says Hans-Jürgen Schliepkorte, who heads up the Energy Efficiency Solutions group at the inHaus Center, tackling questions such as how long the plant should run and how often the heating element is needed to take up power supply peaks. "The inHaus center allows us to simulate the sub-zero temperatures of a cold winter's day in the middle of summer," Schliepkorte says, explaining how they use computer simulations which were developed by colleagues at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg. Another inHaus energy-saving innovation is the 'decentralized heating pump system' developed in collaboration with the company WILO and other partners, which has already been brought to market. The system achieves average heating energy savings of some 20 percent.

## Innovative building materials and electronic assistance

One of the inHaus Center's new projects is 'Hospital Engineering'. The researchers hope to construct an exact model of the key areas of a standard hospital environment over an area of 400 square meters. The model will feature a reception and waiting area, an examination room, a patient's room with an integrated bathroom, a fitness and rehabilitation area and even an operating room with its own airlock. The construction phase will be finished soon. Then the researchers will be devoting most of their time to discovering how the various processes found in a hospital setting influence each other and how they can best be optimized. For example, the logistical decision to heat up patients' food in microwaves on the wards rather than in a central kitchen area has a clear impact on the power supply: Electricity consumption peaks at lunchtime when all the microwaves are running at full power.

The 25 partners participating in the project include the University of Duisburg-Essen, various hospitals and industry partners, and the Fraunhofer Institutes for Software and Systems Engineering ISST, for Material Flow and Logistics IML, for Environmental, Safety and Energy Technology UMSICHT, and for Microelectronic Circuits and Systems IMS.

"There is a clear trend towards holistic solutions that optimize all the applications and building management processes at the same time – an interdisciplinary challenge that requires a significant degree of integration and cooperation. The inHaus research facility is a unique tool that allows us to actively involve users right from the early development stages," enthuses Professor Viktor Grinewitschus, director of technology and innovation at the inHaus Center. ■

# Knowledge from the cloud

It is important for physicians to keep their knowledge up to date by periodically acquiring information on new methods of treatment and their patients' medical histories. Cloud services make it easier and quicker for them to find the information they need. Fraunhofer researchers are developing secure computing systems for cloud computing which are designed to locate, analyze and provide access to relevant correlations.

Text: Andreas Beuthner

© istockphoto

There is no shortage of praise for cloud computing. The new computing architectures based on virtualization software are acclaimed as being fast, flexible and resource-friendly. One organization that has embraced this new technology is the U.S. National Marrow Donor Program, which is hoping to use cloud-based environments to drastically cut the time required to match bone marrow donors with patients. Currently, finding a suitable donor typically takes around 96 days, but the hope is that cloud services could reduce this to approximately 45 days – the figure put forward by those who advocate structuring the healthcare sector service environment around networks.

In Germany, there is a reluctance to make such bold promises, especially when it comes to patients' personal data. People are still uneasy about the potential vulnerabilities of accessing storage, processing power and applications over the Internet: "What we need is a controlled environment that enables highly sensitive data to be securely processed in the cloud in line with statutory requirements," says Professor Martin Hofmann-Apitius, who heads up the Department of Bioinformatics at the Fraunhofer Institute for Algorithms and Scientific Computing SCAI in Sankt Augustin. "Cloud4Health" is a joint project that aims to pave the way to a secure cloud computing infrastructure for IT applications in the healthcare sector. The project initiator and coordinator is Philipp Daumke, co-founder of the Freiburg-based software company Averbis. Project partners include Fraunhofer SCAI as well as the non-profit organization TMF (Technology, Methods, and Infrastructure for Networked Medical Research), the University of Erlangen-Nuremberg (FAU) and representatives of the Rhön-Klinikum private hospital group.

## Cloud infrastructure tailored to the healthcare sector

Specialist information, patient records, treatment processes and administrative tasks can all be described in software models. This information can then be accessed by authorized physicians, medical technicians and hospital managers as a cloud service. This eliminates the burden of maintaining sophisticated and expensive computing resources, developing complex data models, and running elaborate searches across multiple databases – because someone else does it for them: "The Fraunhofer institute has a powerful computer center that hosts the cloud services and makes them available over the Internet," says Hofmann-Apitius. The researchers at the SCAI have long specialized in the mathematical and computer science algorithms required for the reliable analysis of very large data sets and the software applications based on these algorithms.

Hofmann-Apitius cites the example of ProMiner, a software tool developed by SCAI researchers. This application runs targeted searches for gene and protein names in scientific literature, using dictionaries it generates automatically to significantly boost the efficiency of the search process. This 'intelligent' text mining can also be applied to medical papers and articles, physicians' reports and medical products to identify their contents and make the results accessible in databases. "Our primary task is to pick out scientifically robust correlations from the huge streams of data in the healthcare sector and to generate the right workflows," Hofmann-Apitius emphasizes. One potential application lies in the field of prostheses for hip and joint replacements. According to a survey by the German Society for Orthopedics and Trauma Surgery (DGOT), some 400,000 joint and hip implants are performed in Germany each year, a higher figure than in any other European country. What is not clear, however, is how many of these surgical interventions can actually be classed as successful, what complications arose, and what typically causes replacement surgery to be carried out at short notice.

In May this year, an endoprosthesis register was launched. Run by the German Association of Orthopedics and Orthopedic Surgery (DGOOC), the register draws on data provided by implant manufacturers, health insurance funds and hospitals. "Automated extraction methods would make it easier to develop an implant database," says Hofmann-Apitius, "and it would then be fairly simple to make the results accessible through a cloud computing infrastructure." Other possible applications include automated feasibility and cost-effectiveness studies for medical treatments and early detection of the unwanted side-effects of recently launched drugs.

## Building trust with cutting-edge firewall technologies

One of the key concerns is data security. As well as running a test bed for the overall cloud infrastructure and for the automatic retrieval of relevant correlations, SCAI researchers are also testing out a range of tools designed to make cloud computing more secure. Connections to the host servers and access to individual documents and applications are subject to special security measures which are designed to rule out any possibility of improper use. The fact is that personal data in public networks continues to be one of the favorite targets of hackers and data thieves. To help build trust in cloud computing, the SCAI experts and their partners utilize cutting-edge firewall technologies and a network monitoring system trained to recognize suspicious activities. The security specialists also envisage drawing on further measures such as recoding or encrypting users' plain text input.

Despite all the hype surrounding pioneering cloud solutions, the practical implementation of cloud services in the healthcare sector is still very much in its infancy. "We are breaking new ground in the field of medicine," says Hofmann-Apitius. Based on his experience in bioinformatics, he acknowledges that many issues are still very much up in the air, particularly the move towards an industry-wide cloud portal. Nuremberg University Hospital has limited its first tentative steps towards cloud computing to its own environment, which is easier to control and monitor. The Rhön-Klinikum hospital group is also restricting its trials of service-based computing structures to its own hospitals, at least for the time being. But the ultimate aim of the technology and infrastructure is cross-company implementation, as Professor Hofmann-Apitius emphasizes: "Reliable cloud services would benefit the entire healthcare industry." ■

# Lasers take the lead


The welding of aluminum and copper battery lugs with a disk laser for the production of battery systems used in electric vehicles. © *Fraunhofer ILT*

Conserving energy is a top priority for auto manufacturers today. Laser technology can help. Lasers can be used to process thin light-weight components made of fiber-composite materials, as well as to manufacture more efficient engines and more powerful batteries.

Text: Monika Weiner

The era of gas guzzlers that clatter through streets and pollute the air is over. Cars rolling off the assembly line today are cleaner, quieter and – in terms of their performance weight – more efficient than ever before. Nevertheless, development continues. Ever-stricter environmental regulations and steadily rising fuel costs are increasing the demand for cars that further reduce their impact on the environment.

But customer demands are often tough for manufacturers to meet: car bodies should be safe yet light-weight and engines durable yet efficient. Year after year, new models must be developed and built that can claim to be better, more efficient, and more intelligent than the last. The race against time and competitors places high demands on manufacturers and their suppliers. Lasers can help them win the race. Resistant to wear and universally applicable, laser light is an ideal tool in the manufacture of vehicles. Lasers can be used to join, drill, structure, cut or shape any kind of material. Surfaces can be engineered for motors and drivetrains that create less friction and use less fuel. Lasers are not only a decisive key towards faster, more efficient and economical production, but also towards energy-saving vehicles.

## A weight-loss program in automotive manufacturing

Extra pounds cost energy. They have to be accelerated and slowed down every time you drive – over the entire lifespan of the car. To reduce weight, manufacturers are increasingly turning to the use of fiber-reinforced plastics, which are 30 to 50 percent lighter than metal. The disadvantage, however, is that these new materials are difficult to process. Fiber-reinforced plastics are brittle, meaning cutting and drilling tools are quickly worn out and the conventional assembly techniques used for metal components are often not appropriate. “Lasers represent an ideal alternative here,” explains Dr. Arnold Gillner of the Fraunhofer Institute for Laser Technology ILT

in Aachen. "Lasers can cut fiber-reinforced plastics without wear and can join them too. With the appropriate lasers, we can cut and ablate components with minimal thermal side-effects. Lasers can also be used for welding light-weight components – a viable alternative to conventional bonding technology. We can even join fiber-reinforced plastics to metals with laser welding. The laser roughens the metal surface, while the plastic, briefly-heated, penetrates the pores of the metal and hardens. The results are very stable."

Weight reduction can also be achieved with high-strength metallic materials. These, however, are difficult to process. "Joining combinations of various materials allows us to make optimal use of the individual materials' specific properties. But this proves to be difficult in many cases," explains Dr. Anja Techel, Deputy Director of the Fraunhofer Institute for Material and Beam Technology IWS in Dresden. Her team believes in lasers: "With our newly-developed integrated laser tools, we can now even weld together combinations of materials, free of fissures or cracks." In 2011, Fraunhofer scientists presented, for the first time, a new welding head capable not only of focusing with extreme precision but of moving back and forth across the seam with high frequency to mix the molten materials. When they harden, they create a stable bond.

Lasers also save time and money in tool design. The molds used in the production of plastic fixtures and steering wheels, for example, have to be structured to give the finished component a visually and tactilely appealing surface. Most car manufacturers order a design from their suppliers, whose surface typically has the appearance of leather. Until now, the negative pattern used to create the design has been etched out of the steel tools used in injection molding – a tedious and time-consuming process. "With lasers, the steel surface can not only be patterned more quickly, but also with greater scope for variety," explains Kristian Arntz of the Fraunhofer Institute for Production Technology IPT. "We can transfer any possible design directly from the CAD model to the tool surface: What will later become a groove in the plastic is preserved as a ridge, while the surrounding material is vaporized. The process is efficient, fully automatic, and highly variable."

## How to save energy with lowfriction motors

Laser technology is also in demand in engine optimization. Engineers strive to keep friction as low as possible in order to improve efficiency. "That is true not only for the electric engines currently being developed, but also for classic internal combustion engines and diesel motors, as well as transmissions and bearings," says Arnold Gillner of the ILT. Ceramic, high-performance coatings are especially desirable, because they are not only resistant to wear but also smooth, which generates less friction.

Until now coated metal components have been prohibitively expensive, being produced in plasma chambers in which the ceramic was vaporized and applied to the surface of the components. Fraunhofer scientists have now developed a less expensive and faster method in which workpieces are coated with ceramic nano-particles, then treated with a laser. This finishing process has already been applied to gear wheels and bearings.

Lasers can even be used to make specific modifications to the properties of engine parts. "Friction between the cylinder wall and piston is responsible for a big part of a motor's energy consumption. That is why we try to minimize it. This is especially important for engines featuring modern, automatic start-stop functions that are stressed by frequent ignition," says Gillner. "To protect them, we have to ensure that the cylinder is always coated with a film of oil. Laser technology can help reduce friction with special structuring processes that improve oil adhesion." Fraunhofer researchers aim to increase the engine's life-span and reduce energy consumption in this way.

## An fitness program for electric cars

Lasers can even increase the efficiency and life-span of electric batteries. That is good news for manufacturers and owners of electric cars, since batteries continue to be extremely expensive. The engineers and scientists at Fraunhofer are currently working on various solutions to make batteries more durable and less expensive. One approach is to increase the surface area of the electrodes with appropriate coating in order to increase their efficiency. Another approach involves analyzing and optimizing production processes. Manufacturers produce batteries using one anode and one cathode cell, which they then connect. In theory that sounds pretty simple, but in practice the fusing of copper anodes with aluminum cathodes creates brittle connections that break easily.

That presents a problem for application in cars that sometimes drive on cobblestone or dirt roads. With the help of lasers, researchers at the ILT have succeeded in forming durable connections between electrodes without creating the culprit brittle alloys. Researchers at the IWS in Dresden have developed an alternative solution in which a laser warms the surfaces and rollers press them together. "Using roll plating with lasers and inductive pre-heating, we were able to create very stable connections with high electrical conductivity, with only a minimal loss of power," reports Anja Techel. "The finished batteries are very efficient. And since only small amounts of electrical energy are transformed into heat, these batteries do not require as much cooling." ■

# End of the film reel

Charlie Chaplin performs on screen today just as he did 80 years ago. If films are properly stored, they will remain in good condition for centuries. In the cinema of the 21st century, however, film reels have all but disappeared. Movies are stored, distributed and projected digitally. Preserving digital media for the future is a challenge for research scientists.

By Monika Weiner

At the Berlin Filmarchiv the film reels are stored at a temperature of minus six degrees Celsius. Here the German film heritage is archived. But how do you store the new documents that is recorded on videos or hard discs?
© *Hubert Link/dpa*

## New lease of life for videotapes

The archives of broadcasters, research institutes and public authorities hold treasures which are threatened by technical progress. "Millions of video cassettes on which TV programs, research expeditions and historic events are documented will no longer be able to be watched in a few years' time," warns Arne Nowak from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen.

For years videotapes were the documentation medium of choice. Professionals recorded TV programs on Betacam, researchers preferred U-matic, the general public used VHS. Now all such recordings are in danger. Magnetic tapes have a limited life of just a few decades and are already showing signs of age. What's more, the equipment for playing them back is now thin on the ground. The only option is to digitize them, but this is often difficult to do and comes with a loss of quality.

In cooperation with the Bremen-based company Cube-Tec, Nowak's team is now developing a software program which reads, digitizes and archives information from videotapes. "We are aiming to develop a system which functions automatically and at the same time achieves a very high level of quality." The software will enable users working at TV companies and in archives to quickly digitize and archive their data in high resolution. The development is based on the Curator Suite software from the EU project EDCine.

Rolls of film as far as the eye can see. Shelf after shelf, from the floor to the ceiling, filled with round, metallic cans in which cinematic treasures are stored: Fritz Lang, Friedrich Willhelm Murnau, Wim Wenders, Rainer Werner Fassbinder share the shelves with Luc and Jean-Pierre Dardenne, Chantal Ackermann or Jaco Van Dormael. 65,000 documents of movie history are kept in the Belgian Film Archive, the Cinémathèque Royale de Belgique. The collection fills three warehouses near Brussels. Altogether it covers an area of 15,000 square meters. If you want to take a look into the huge halls you need to wear warm clothing. The temperature is kept at a constant five degrees, the relative humidity at 30 percent – under these conditions analogue film can be preserved for centuries.

Archiving is an art in itself. Every film must be viewed, described and catalogued, all films kept in proper conditions and handled under strict rules. "The method has proved itself over the years," reports Nicola Mazzanti, deputy director, curator and head of digitization at the Cinémathèque Royal. "Most European archives even brought their films safely through the Second World War."

But a new era has dawned for the archivists. Movies made in the 21st century do not arrive in film cans but on hard disks. Film has had its day, and most movies are produced, sent to movie theaters and projected digitally. New methods are needed for archiving these movies, along with huge data storage capacity – one to four terabytes for every hour of action, and this doubles for 3D movies. The information has to be archived in such a way that the name of the movie is immediately indicated and whether it is an original, shortened or foreign-language version. Another crucial task is to ensure that retrieval will be possible in ten, fifty or even a hundred years. "Long-term archiving is the biggest problem. Nobody knows how long the digital storage media available to us today will remain stable and whether software to play the films will be available in a few decades' time," explains Mazzanti. This uncertainty is a nightmare, not just for him but for archivists all over the world.

## Saving without losses and easy access to the data

The end of the nightmare is in sight. Working in collaboration with an international team of computer scientists and engineers from universities, research institutes like Fraunhofer and companies, Mazzanti has developed a new concept for digital archiving in the EU project EDCINE: "Our aim was to develop a system for losslessly storing movies and viewing them in high resolution which would also provide comprehensive information about quality, image resolution, any processing, and data compression as well as permitting easy access to the data. This lastpoint is important as it enables archives to supply their customers – movie houses, TV stations and website designers – with movies quickly, in the desired file and compression format." The experts have been at work for three years. At the Fraunhofer Institute for Integrated Circuits IIS in Erlangen a special software program was developed which compresses digital film data without losing any information. The computer scientists were able to draw on their experience with digital movie data: "We had previously developed 'easyDCP', a digital cinema package software system," explains project manager Heiko Sparenberg. "The program processes image and sound data so that it can be recognized by professional playback devices. This enables semiprofessional productions to be shown in digitally equipped movie theaters, for example at film festivals. Digital technology therefore opens up access to the big screen to a much larger target group so it is no longer the exclusive preserve of professional productions."

The research scientists in Fraunhofer's Digital Cinema Group refined in the project EDCine the software and adapted it to the needs of archivists, producing the Curator Suite. This program stores data in such a way that little disk space is required, but the data can be retrieved at any time and reproduced in original quality. Information about any subsequent processing is retained. "The system is based on the international JPEG2000 standard, which can be accessed and used free of charge throughout the world," explains Sparenberg. "Several standards exist worldwide but JPEG2000 is the most suitable for archivists because it supports both lossy and lossless compression, delivers very high quality and is independent of computer and software manufacturers. If at some time in the future a manufacturer disappears from the market or a manufacturer-specific format is no longer supported, the archivists would have to switch to new formats. JPEG2000 guarantees that the data will still be readable." The new software also offers a playback function with which movies can be viewed, quality controlled and analyzed at any time – regardless of what hardware and software the archivist is using. A further component encrypts the data packets, protecting them from unauthorized access.

Mazzanti's team tested the prototype of the Curator Suite at the Cinémathèque Royale and improved it in collaboration with the research scientists. The archiving software has been on the market since April 2011 and half a dozen licenses have already been sold. The license includes six months' technical support. In Brussels too the archivists are now viewing, processing and storing digital movies using the new system. ■

# Solar electricity is a benefit for all

The future is green, with more and more countries making the switch to renewable energy. The affluent and industrialized West is currently at the forefront of investment in solar power stations – but a recent study by the World Bank has highlighted how less developed countries can benefit from this change, too.

Text: Monika Weiner

The harder the sun beats down, the better. Countries where the sunlight is intense offer the perfect locations for solar thermal power stations. These consist of giant mirrors that reflect the sunlight onto receiver tubes containing oil, steam or a molten salt. The heat transfer medium absorbs the energy and transports it to the turbines where it is used to produce electricity. Dozens of solar thermal power stations have already been built in the USA and Spain. In Europe parabolic trough power plants are favored in which the liquid-filled absorber tubes are positioned directly above the parabolic mirrors. In the US there are plans to construct numerous solar power tower plants: these feature an array of mirrors which focus the sun's rays onto the top of a high solar tower in the center of the array.

## Up to 80,000 jobs

"The clearer and more cloudless the sky, the better it is for generating electricity," says Christoph Kost from the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg. "So countries in North Africa and the Middle East would be ideal places to operate solar thermal power stations – but the technology is still largely unknown in those regions." That could soon change: in collaboration with a group of researchers from the Fraunhofer Institute for Systems and Innovation Research ISI, Kost and his team have been investigating whether less industrialized countries could benefit from solar-generated electricity and, if so, how they could put this into practice. As part of a study initiated by the World Bank, researchers and industry partners analyzed the situation in Algeria, Egypt, Jordan, Morocco and Tunisia.

The enterprise was financed by the World Bank's Clean Technology Fund. The Fund's financial experts wanted to find out whether investing in solar thermal power stations in the Middle East and North Africa would benefit the local economies of the countries concerned – and the researchers' results were encouraging: "The construction of solar thermal power stations would indeed yield a win-win situation," says Kost. And Dr. Mario Ragwitz from Fraunhofer ISI adds: "The power plant technology and specialist components could be supplied by European companies, which would open up new markets for them. The countries in the Middle East and North Africa could produce and supply numerous components themselves and take on the task of building and operating the plants."

Ultimately, these countries would benefit not only from the green electricity produced by the new solar power plants, but also from the positive economic side-effects: the ISE researchers estimate that rolling out solar thermal power plant technology in the region could create between 60,000 and 80,000 jobs. This would, however, require local companies to commit to investing in the new technology, building production facilities and giving their employees the necessary training.

The study was recently submitted to the World Bank, which will support the new power stations with low-interest loans. Morocco currently has one solar thermal power station at the planning stage, and there is already a great deal of contact between the European and Moroccan companies who are working together to set up a supply chain for the required components. ■

Solar thermal power stations: a single square kilometer of desert is all that is needed to supply some 100,000 households with 250 million kilowatt-hours of electricity a year. *© DLR*

# Sun quenches thirst

Two thirds of our blue planet are covered by water. Yet there is still not enough clean drinking water to go around, especially in many poor countries. To help improve this situation in the future, scientists have developed a new method that uses solar energy to desalinate seawater.

Text: Monika Weiner

Theoretically, there is more than enough water on the Earth to meet everyone's needs. Yet only a small portion of it is actually fit for drinking; the remainder is either too salty or too polluted. In many parts of the world, clean drinking water is a precious commodity: people will walk miles to fetch what they need or pay large sums for it to be shipped and trucked to its destination. In the future, this situation looks set to get even worse: climate change is leading to droughts in many regions and causing deserts to grow. At the same time, steady increases in the global population require us to produce ever more food and to cultivate and irrigate ever more land. In dry, arid regions, rivers are running dry – making conflicts between neighboring countries inevitable. Experts are already warning of water wars and mass migrations when the poorest of the poor are forced to abandon their drought-desiccated homelands. In many places people have already been reduced to fighting for their very survival. "Contaminated water kills more people than AIDS, malaria and measles combined," said Bolivia's former UN ambassador Pablo Solón in a speech to the United Nations General Assembly last year. He added that most of the victims are children under five years old, noting that diarrhea is the second most common cause of death in this age group. The UN General Assembly passed a resolution in July 2010 affirming that everyone has the right to safe and clean drinking water. This right is an internationally recognized fundamental human right on a par with the right to food and the right to freedom from torture and racial discrimination.

## Water shortages cost lives

But where will this clean water come from? New, deep wells only offer temporary respite in areas where rainfall is scarce, because groundwater reserves dwindle rapidly if they are not replenished. The only truly abundant source of water on the Earth is seawater. Desalination is perfectly feasible from

Many remote areas that lack clean water typically have abundant quantities of three things: sun, wind and sea. Construction of a solar-powered water desalination plant in Gran Canaria. © *Fraunhofer ISE*

a technical standpoint, but it requires copious amounts of energy, and most existing plants run on oil or natural gas.

"There are a number of tried-and-tested methods of converting seawater and brackish water into drinking water," explains Marcel Wieghaus from the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg. "The second most common method – after distillation or 'thermal desalination' – is reverse osmosis, where water is forced through a membrane to filter out the salt." Worldwide, some 50 million cubic meters of seawater per day are already desalinated using this method, and this figure is constantly rising: in four years' time, plant operators expect to be producing some 100 million cubic meters of desalinated water a day. Most of this water is used in agriculture, major conurbations and tourist resorts, where per capita consumption is especially high.

Ultimately, large-scale desalination is not sustainable because it consumes fossil fuels, but it is certainly cheap, with the biggest plants producing drinking water for 50 U.S. cents per cubic meter. "Industrial-scale desalination is an economically acceptable solution for cities and holiday destinations which have a network of pipes into which the desalinated water can be fed," says Wieghaus. Together with an international team of researchers, industry representatives and potential investors, he worked as an engineer on the EU project ProDes, which investigated the extent to which alternative energy could also potentially be used to desalinate seawater. The abbreviation ProDes stands for Promotion of Renewable Energy for Water Production through Desalination. The team of researchers spent two years comparing technologies, preparing market analyses, examining financing models and developing strategies to implement desalination plants powered by renewable energy sources.

## Sustainability is feasible

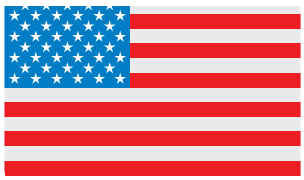
Now their results are out, and the figures show that desalination plants can, in principle, be powered by alternative energy sources – though not at prices that can compete with water produced by industrial-scale desalination plants. Nevertheless, the ProDes researchers say that systems based on renewable energy have a good chance of succeeding in the market for a very simple reason: even though experience with seawater desalination has shown that the larger a plant's capacity, the cheaper it can produce water, the fact remains that many parts of the world, especially isolated regions, do not require water in industrial quantities. The challenge here is to supply water to farms and villages that are not connected to the power grid or the mains water supply. A system capable of producing between 100 and 1,000 liters of drinking water a day is often all that is required – and on this scale renewables-based systems are already capable of competing with conventional technologies: "For places such as villages or settlements in North Africa and the Middle East or on small islands, which are hundreds of miles from the nearest big town, seawater desalination plants powered by renewable energy are already an excellent choice," says Wieghaus.

## Membrane technology: perfect for remote areas

The researcher and his team at the ISE have developed a 'solar thermal membrane distillation system' tailored to the concept of a decentralized water supply. The energy required for desalination is supplied by the sun, which heats the salty or brackish water in the collectors to 80 degrees. The hot water and steam are then guided into a module containing a hydrophobic membrane which is permeable to steam, but not to liquid water. The steam condenses on the other side of the membrane to produce clean water, which can be collected in a container. "Basically, the desalination process works in a similar way to the breathable membranes in outdoor clothing which keep rain out while allowing moist air to escape from the inside," explains Wieghaus, who teamed up with two of his colleagues from the ISE in 2009 to set up the spin-off company SolarSpring GmbH, which develops and markets the membrane distillation systems.

The technology claims to offer advantages over conventional methods of reverse osmosis. It is robust and less complex, and the fact that the membrane is hydrophobic means that water immediately drips off before any dirt can accumulate, so there is no need to pretreat the water. Industrial-scale plants that work on the principle of reverse osmosis have to perform membrane cleaning on a regular basis, while solar thermal membrane distillation systems require virtually no maintenance at all. The first successful prototypes are already up and running on Gran Canaria and Tenerife, in Italy, Tunisia, Mexico and Namibia.

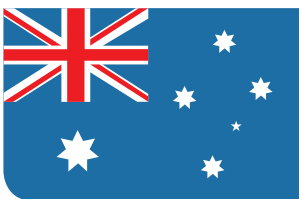
And solar thermal membrane distillation is not the only technology capable of drawing on renewable energy. Studies carried out by the ProDes researchers have also shown that reverse osmosis can be powered by solar energy, wind energy or hydropower, so it is certainly feasible to achieve sustainability in theory. In practice, however, Wieghaus acknowledges that this comes at a price: "Environmentally-friendly desalination technologies are still the preserve of those who can afford them. The places that need them most, such as remote villages, generally don't have the necessary financial resources, so they are dependent on aid from governments and NGOs." The question of how long it will take for renewables-based water treatment to become properly established therefore depends on how seriously governments take the UN General Assembly's resolution and, crucially, on whether they are willing to stump up the cash to provide everyone with something to which they theoretically have a right – namely clean drinking water. ■



## Earthquake-proof

Earthquake-proof construction is a matter of life and death in many countries of the world. "The disaster in Japan really brought home the importance of research and development in this field," says Prof. Bohumil Kasal, Director of the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut, WKI in Braunschweig. Since 2008, he has been in charge of an EU research project to develop new timber buildings reinforced with fiber composites. In addition to researchers from the Czech Republic, Poland and Great Britain, the project also includes the participation of numerous industry partners who have agreed to provide the materials to be tested.

Simulations have shown that wood is a good material for constructing buildings in areas that are prone to earthquakes. The key is the strength-to-mass ratio, which is relatively low in concrete and steel, but high in wood: in order to construct buildings which are stable, you need to cut the amount of mass that could be accelerated and cause damage in the event of an earthquake. But the stability of a timber building depends on the joints between the structural elements. The EU project included a comparison between different forms of construction – steel and wood joints and joints reinforced with a cement epoxy matrix – as well as the testing of various frame structures.



## Logistics lab down under

Australia poses great challenges on the logistics front. It is a huge country, and the distances between towns are enormous. At the same time, traffic is constantly increasing here, too. So anyone looking to carry out just-in-time deliveries there needs cleverly devised concepts and reliable planning tools. These are currently being developed by an international and interdisciplinary team of scientists in the new Future Logistics Living Lab. The laboratory was opened at the Sydney Technology Park in February. A dozen universities, research institutes and IT and logistics companies are involved – including the Australian research organization NICTA, the Fraunhofer Institute for Experimental Software Engineering IESE and the German software group SAP.

The Future Logistics Living Lab's research scientists are seeking to identify the challenges of the future and work out solutions with the aid of information technologies. For example, they aim to develop concepts which will enable transport and logistics companies to increase safety, reduce carbon dioxide emissions and deliver on time despite traffic jams, and all without incurring high additional costs.

## Communication of the future

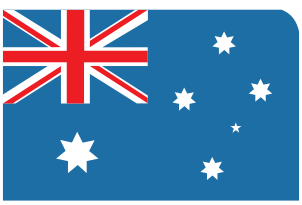
Companies looking to provide telecommunications services in Indonesia are faced with a daunting prospect: the country stretches over thousands of kilometers, with 239.9 million inhabitants spread over 6,044 islands. "Just like all network operators in emerging countries, Telkom Indonesia has to perform a balancing act: many regions don't even have the infrastructure for fixed-line connections, yet users in the regions that are already hooked up are clamoring to use the innovative multimedia communication services offered by cutting-edge communication technologies, such as IP-based Next Generation Network (NGN) technologies," says Prof. Thomas Magedanz from the Fraunhofer Institute for Open Communication Systems FOKUS.

To help providers tailor the services they offer to their customers' needs, Magedanz and his team have developed a high-tech solution: "Universities and companies such as Telkom Indonesia can use our 'Open NGN Service Platform' to train their employees, develop innovative services and test out business models before taking the decision to buy an expensive, fully-fledged commercial platform." The new pilot platform has the advantage of being manufacturer-independent and compatible with all commercial systems.

Telkom Indonesia has now gathered enough experience to tackle the next step, which is to implement a commercial NGN system with support from the Fraunhofer researchers.

## Innovations on tour

China is building, and demand for new housing and office space continues to grow particularly in urban areas. This presents a unique opportunity to employ state-of-the-art energy-saving construction techniques. Fraunhofer research scientists recently demonstrated how urban development can be planned with sustainable and resource-saving effect and how buildings can be constructed and air-conditioned using innovative insulating materials and solar technology to save energy at the Traveling Conference on Building Innovation. During a week-long tour of the cities of Shenyang, Qingdao and Hangzhou, five experts from the Fraunhofer Institutes for Building Physics IBP and for Solar Energy Systems ISE as well as the Fraunhofer Building Innovation Alliance BAU gathered information about local construction projects, presented new technologies and answered questions about town and building planning.



## Giant pump

Weighing in at a colossal 35 tons and capable of shifting 10,000 liters of water a second, the biggest pump in Asia posed a huge engineering challenge for its Indian manufacturer. Despite its huge dimensions, there was a real risk that the structure would vibrate like a guitar string during operation – and those kinds of vibrations could easily have fatigued and cracked the pump's welded and screwed joints.

The engineers were keen to predict and prevent vibrations right from the design phase by using prototypes, so they turned to researchers from the Fraunhofer Institute for Structural Durability and System Reliability LBF in Darmstadt for help. To obtain the data their Indian colleagues needed to optimize their simulations, the team from the LBF used an extremely sensitive measuring system designed to document tiny accelerations and rotations. The 17-meter-high pump is now up and running and supplying water to a power plant in New Delhi.

## On the right track

Finding the right way to a destination is no longer a problem, as long as the navigation system can receive GPS signals – but this can be problematic in narrow streets, buildings and tunnels. In the future, motion sensors incorporated in satellite navigation devices will supplement the measurements taken by the GPS receivers. The idea is simple: from a known starting point, the motion sensors are able to determine the route taken. They do this by measuring how long the device has been traveling and in what direction. A software system can then calculate the exact position from the data. Up to now the cost of the solution has been prohibitive, because motion sensors are too expensive.

In the EU project Milepost research scientists at the Fraunhofer Institute for Silicon Technology ISIT in Itzehoe are working with Italian colleagues at Consorzio Pisa Ricerche and with various companies. Together they are developing new types of motion sensor which are cheaper and more precise than the technology previously available. These inertial sensors are produced using techniques from silicon microsystem technology.

## Virtually underwater

Leisure pool complexes have traditionally offered water slides, warm pools and wave machines, with some of the more exclusive water parks throwing in palm-fringed beaches and exotic cocktails for good measure. But a German-Korean consortium led by the Fraunhofer Institute for Applied Information Technology FIT in Sankt Augustin has set a considerably more ambitious goal for its AREEF project: it aims to provide a virtual underwater world for people to explore. Visitors to the pool, in particular children, will get the chance to learn more about underwater fauna and flora.

This new entertainment technology is based around mobile devices such as tablets and smart phones. The virtual underwater world will be superimposed on the camera image of the real pool environment displayed on the device's screen – a technique known as augmented reality, or AR. This will enable users of the application to experience forests of underwater plants, colorful coral reefs and fish. The AREEF project marks the continuation of the FIT's work in the field of underwater augmented reality which began in 2009 with the development of the world's first prototype of a mobile underwater AR system. The focus now is on developing a fully-fledged system that is economically viable. The project is funded by the Korea Institute for Advancement of Technology KIAT. Fraunhofer FIT is the first European research institute to lead a project of this kind.

## Working with Western Cape

For many years the South African province of Western Cape has been focusing on research and education. Four major Universities – Cape Peninsula University of Technology, University of Cape Town, Stellenbosch University and University of Western Cape – are attracting scientists from all over the world. When Helen Zille, the President of the Provincial Government, visited Bavaria recently she signed a Memorandum of Understanding with Fraunhofer.

The goal of the agreement between the universities in the Western Cape region and Fraunhofer is an intensified cooperation in the fields of environment and climate protection. Teams of specialists intend to join their efforts to improve the way we consume our natural resources like raw materials, water and energy.

The cooperation seeks the support of the program "International partnerships for sustainable Technologies and Services for Climate Protection and Environment ", CLIENT, of the German Federal Ministry of Education and Research BMBF.

# TVs with intuition

In the future you will not need to press any buttons to operate your TV or multimedia device. All you will need to do is point a finger. Research scientists are developing the necessary control technology in an EU project.

Text: Monika Weiner

You want to watch some TV? No problem, just tell the TV set. If you say "TV please" it will turn itself on. If you want to change the channel just wave your hand. Is the sound down too low? Point at the volume control and move it upwards to make it louder. Going online is easy too. Say "Internet" and the start page appears. From here the whole world can be reached by voice control – friends on Facebook, interesting holiday destinations or the latest offers on eBay. The TV allows means of control that users prefer and are always suited to the situation users are currently in.

Compared to how we control our TVs nowadays, this sounds like magic, but it's actually not far from reality. An international team of research scientists is working together in the European project GUIDE to develop the fundamentals for the new media world of the future. "Internet on TV is already a reality in the market, although not every user has capable devices or is able to use the new services." explains project coordinator Christoph Jung from the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt. "Modern TV panels and set-top boxes allow users to access program information from internet sources, like in HbbTV, or to watch selected web content in a TV app store."

In collaboration with seven research partners from five countries Jung's team is now developing novel software for TV manufacturers and service providers which can easily integrate different controls such as speech, gestures, smart remote controls, etc. and configure them according to the individual's needs. This will make it possible to efficiently create personalized TV experiences for different groups of users, including people with specific impairments or disabilities.

## Technology for everyday use

It is no easy task to create a device that can be operated intuitively by everybody, because people are different. They differ in the way they look and in the gestures and facial expressions they make, and they do not all speak the same language. Elderly people in particular often suffer from various age-related impairments

(e.g. in hearing, vision, cognition and motor functions), which makes it harder for them to deal with complex TV menus and input controls. If a machine is to better understand users, and recognize their wishes, it must be equipped with some intelligence. "The control system has high expectations to live up to. It needs to robustly recognize the capabilities and preferences of a user, it must adapt to the individual user, and of course has to learn and change while the user gets better at using the system," explains Jung.

To show that these ambitious goals can be achieved, the research scientists in the GUIDE project are developing a control system for the elderly – the acronym stands for "Gentle User Interfaces for Elderly People". The industry still regards senior citizens as a difficult target group. Although they have a lot of time available for media consumption, which makes them potential customers for producers of TV sets and multimedia devices, they also require simple operating concepts – which up to now have not been available off the shelf. As a result: "Elderly citizens still haven't been fully recognized as potential customers with specific needs, mostly due to the fact that providing appropriate products and services would be time consuming and costly" says Jung. "With GUIDE we aim to make a step forward in that respect, by providing design knowledge and software support to the European TV industry."

## Remotes are on the way out

But what type of system do the elderly need? What developments do they favor? To answer these questions researchers working on the GUIDE project surveyed senior citizens and conducted tests with them. The scientists invited the residents of nursing homes to take part in the studies. Participants were given different device control methods to try out. Using the gesture-recognition system, they were able to change the volume and channels using hand movements. For entering multi-touch gestures they were provided with an iPad. The researchers recorded the interactions and any problems that occurred. At the end of the tests the participants were asked to complete a questionnaire to indicate what type of system they would like and where they experienced difficulties. Although more studies and long-term observations will have to be carried out, the researchers were able to gain some indication that elderly people can successfully cope with different control devices and combinations, and that many of them can imagine using such technology one day in their homes.

Scientists at the University of Lisbon are currently developing new user models, which represent the information on user preferences and impairments. On the basis of this information they are able to adapt the devices to individual needs. Specifically, elderly people with poor vision are provided with enlarged text or different colour scheme. For those with hearing problems audio rendering can be adapted, or subtitles can also be brought up. Dementia patients could be given contextual help at any step in an application.

But how does the device know what particular problems its user has? The answer is by getting to know the user personally. As part of the GUIDE project the researchers are developing an initialization procedure which guides the user once through a sequence of tests where the software can learn about its new master. "It's important to design the initialization in a motivating way" says Jung. "By improving our user models – and focusing on the important parameters of a user –, we can make this initialization shorter and require less tests."

## Smart control for all

At the end of the project in 2013 the researchers intend to make part of the results available to TV application developers as an open source platform. "This will provide the basis for a new generation of devices that can be intuitively operated using the GUIDE technologies," explains Jung. In his view everybody will benefit from this development: the manufacturers, who will gain a market advantage when they introduce the new control technology; the elderly, who will be able to remain in touch with the quickly evolving multimedia world; and all users who prefer personalized experiences across various devices. ■

# How to create complex software

Getting complex software systems ready for market can take a long time - but a new Fraunhofer solution aims to speed things up significantly. Soon companies will be able to launch high-quality software at a diminishing cost thanks to semi-automated tests and development processes.

Text: Chris Löwer

Last year 53 million passengers and around 2.2 million metric tons of freight passed through Frankfurt airport, Germany's biggest air transport hub, with aircraft taking off or landing some 460,000 times. Each flight must be carefully coordinated, safely guided in or out and efficiently slotted into the overall schedule, while the passengers and freight on the ground must be speedily and efficiently guided to their destinations. This is a tremendously challenging logistical task which would be impossible without closely interlinked networks of computers working away in the background.

Safety is the number one priority – but it can only be guaranteed if the software systems are perfectly coordinated and utterly reliable. For the developers, the extreme complexity of this task makes managing all the intricacies of the physical airport environment look like child's play in comparison. As if that were not enough, many of the tools the software developers need are incompatible with each other. Endless programming code and escalating software architectures form the ideal breeding ground for errors. These have to be picked up during lengthy manual testing – a process that takes a lot of time and never produces 100 percent perfect results.

Yet there is a better, faster and more reliable way of doing things: a team led by Dr. Tom Ritter at the Fraunhofer Institute for Open Communication Systems FOKUS in Berlin has developed an open platform based on the ModelBus technology which enables the automated development, integration and error-checking of complex software systems. The new platform links up tools that could previously only be used separately – for example UML tools, editors for domain-specific languages and Office programs such as Excel – thereby saving time and creating a more coordinated work process. "Depending on the stage you are starting from, this platform could cut your development costs by up to 45 percent," says Ritter.

## Open platform supports all standard protocols

The trick is to ensure that all the programs can continuously access the same database and that any changes are automatically forwarded to all the different tools. This automatically synchronizes the developers' work and eliminates the need for time-consuming manual coordination. The open development platform is easy to customize and supports all commonly used industry standards and protocols – and ModelBus also creates independence from software manufacturers, whose tools tend to be incompatible. The advantage of an open and universal standard is that everything speaks the same language. And that's not all: the specifications of the software under development can be linked as standard Excel lists to the evolving systems and their components, which can then be optimized and checked against those specifications before making the finishing touches.

But how can you test something as complex as an airport software system in a way that covers all eventualities? This new platform once again provides the necessary framework: "We developed special algorithms to help developers derive test cases," says Ritter. ModelBus-based test solutions run a defined number of passes to check whether the software can cope with tricky applications – or whether it needs more fine-tuning. "Our systematic algorithms even enable us to find test cases that would otherwise have slipped through our fingers due to time

Smooth-running airport operations based on a fluid exchange of data and information between a broad spectrum of programs. © *MEV*

and budgetary constraints. And that significantly reduces the number of errors," Ritter enthuses.

Thales is all too familiar with the difficulties that can arise when you have distributed development teams comprising more than 100 computer scientists working on one software solution. A specialist manufacturer of information systems for security and mobility, Thales worked with FOKUS on the development of the airport application as part of the EU project Modelplex. "Establishing a seamlessly intermeshed transfer of information between different media and coordinating all the various IT systems involved requires a huge effort in today's world," says Ivo Bettens, the Program Manager at Thales Information Systems Belgium. "The ModelBus technology developed by FOKUS has enabled us to significantly reduce development times." The EU project clearly demonstrated that this new tool for programming complex systems works in the real world, not just in the lab.

The ModelBus technology allows developers to automatically carry out quality assurance measures in the background during the entire development process – even if changes are made further down the line. And changes are an inevitable part of the job of business software programmers, who are required to precisely tailor their solutions to each customer's requirements. Clients sometimes come up with additional Customer Relationship Management functions at the very last minute – functions they insist they cannot live without. This can often lead to unexpected system errors at a later date. Ongoing, automated testing cuts the risk of quality problems emerging in subsequent development phases or after delivery to the customer.

## Tough times for bugs

This functionality has already been put to the test in a practical setting. In collaboration with the software company SAP, the Berlin-based Fraunhofer research team led by Prof. Dr. Ina Schieferdecker developed an automated test system based on ModelBus known as FOKUS!MBT and applied it to the example of a commercial sales management system, as Schieferdecker explains: "FOKUS!MBT enables us to automatically derive the required tests and carry them out with far less effort than existing test methods." It is still the norm in software development to create test cases manually – even though this is a time-consuming approach that often fails to produce the best results.

Together with the airport solution, FOKUS!MBT is another concrete application of the ModelBus technology, which has significant market potential. In the future, it is likely to become increasingly important to merge design and development tools into a single entity in order to cope with the growing complexity of software architectures.

After six years in the development pipeline, ModelBus is now ready for market – and Tom Ritter is seeing keen interest from industry. "This solution offers major cross-industry applicability," he reports. "It works whether you're dealing with software for automotive, logistics or telecommunications applications." The key factor in deciding whether ModelBus is a good choice is really the type and scale of the project in question. For small teams of developers it may require too much adaptation, but the bigger the development project, the more the technology can flex its muscles and the more likely it is to be a good buy. Whatever the case, it looks like bugs have some tough times ahead. ■

# Replacing plastic with whey

Researchers working on the EU project „Wheylayer“ have not only developed a biomaterial from whey protein – they have also come up with a commercially viable method of producing multifunctional films on an industrial scale.

Text: Katja Lüers

From pre-packed Camembert to shrink-wrapped meat loaf – choosing the right packaging is a key issue in the food industry. Companies need to protect food products from oxygen, moisture and chemical and biological contamination while keeping them fresh for as long as possible. Transparent multilayer films, in which each layer offers specific benefits, are frequently used to protect food from contamination, with the best combination of layers being chosen for each specific product.

To minimize the amount of oxygen that permeates into the packaging, companies typically use expensive, petrochemical-based polymers such as ethylene vinyl alcohol (EVOH) copolymers. The German Society for Packaging Market Research (Gesellschaft für Verpackungsmarktforschung mbH) estimates that more than 640 square kilometers of composite materials employing EVOH as an oxygen barrier layer will be produced and used in Germany in 2014 – enough to completely cover Lake Constance. There is therefore a strong impetus to develop a sustainable packaging material which is both economical to produce and environmentally friendly. Researchers working on the “Whey-layer” project have been using whey protein instead of petrochemical-based polymers (see box) – and the results so far are extremely promising. “We’ve managed to develop a whey protein formulation that can be used as the raw material for a film barrier layer. And we have also developed an economically viable process which 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.

First, some background: whey is a by-product of the cheese-making process and is produced in abundant quantities, with 90 percent of the milk used to produce cheese in Europe ending up as whey. Some 40 percent of this whey is disposed of, and Schmid adds that “the disposal of this whey represents a major challenge for the milk industry, especially with waste water regulations becoming more stringent”. But how is it even possible to make a barrier film from whey? The researchers from the IVV began by purifying sweet whey and sour whey and producing high purity whey protein isolates. They evaluated a range of different modification methods in order to obtain suitable proteins with outstanding film-forming properties. To enable these proteins to withstand the mechanical loads involved, they were subsequently mixed with differing concentrations of various softeners and other additives, which were also biobased. “All these additives are approved substances which are used in the foods we eat, for example glycerin and sorbitol,” says Schmid.

The search for the perfect formula was a tricky process for the Freising-based researchers. For

Films coated with whey protein improve the barrier effect and sustainability of packaging.
© *Fraunhofer IVV*

## Wheylayer

To a layperson, the idea of replacing plastic with whey sounds like a joke – but the science behind it is very real. It is already possible to produce heat-sealed sachets, flow wrap and lidding films with barrier layers based on whey protein. The antimicrobial substances that occur naturally in whey also extend the shelf life of food products, and the whey protein film offers excellent biodegradability.

Researchers working on the joint EU-funded research project "Wheylayer" are aiming to develop new, sustainable packaging materials. They intend to use the outstanding barrier properties of whey protein films to keep out oxygen and moisture and aim to replace polymer layers in packaging materials with this natural product. Since 2008, packaging manufacturers, industrial associations, process engineers, recycling specialists, research institutes and producers of milk products have been working together to find a solution that fulfils the project's objectives.

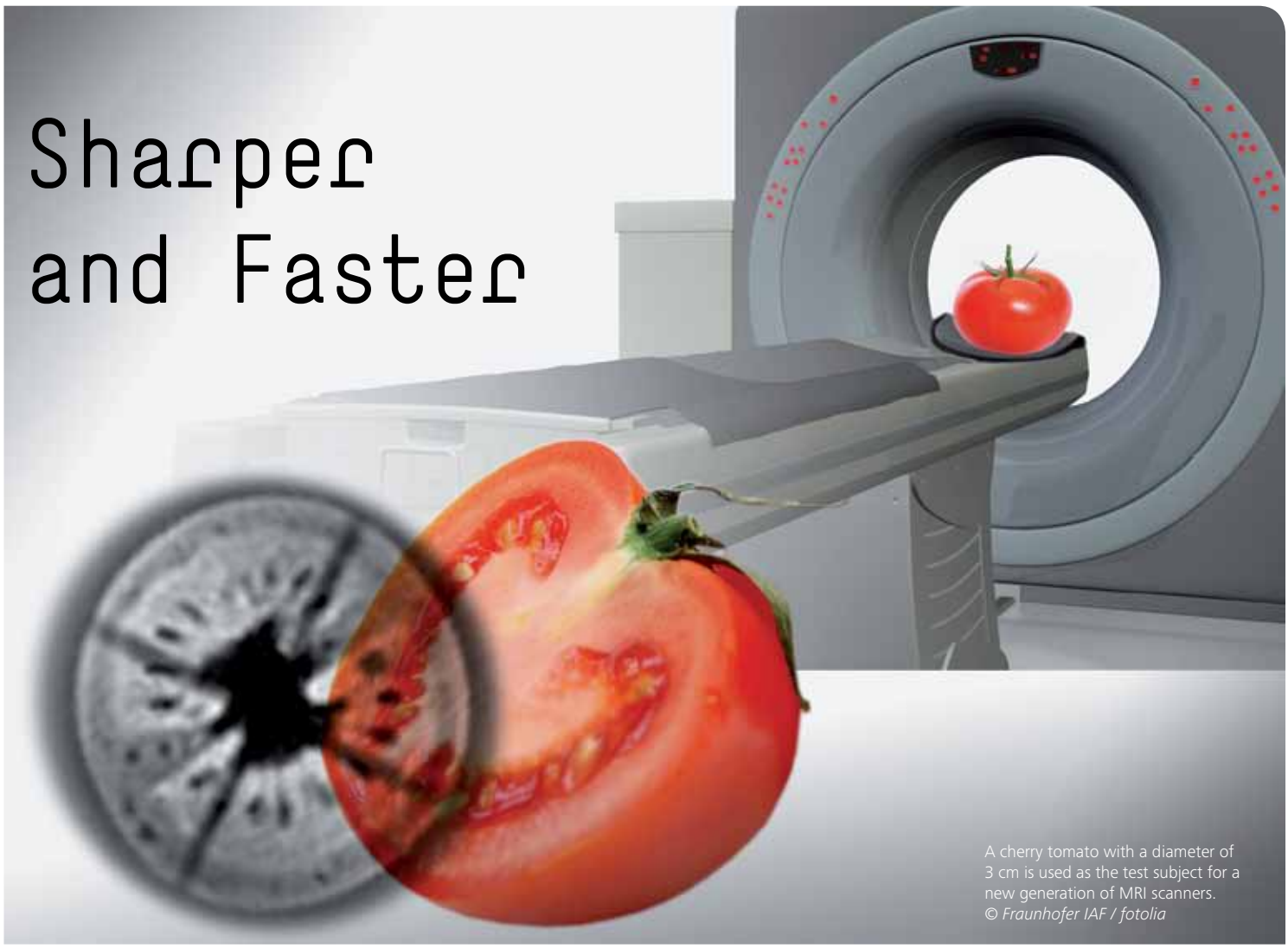
www.wheylayer.eu

example, use too many softeners and the film becomes soft and flexible but its barrier effect against water vapor and oxygen decreases – in other words, permeation increases, which means that the food is no longer adequately protected. In the end, the researchers not only found the optimum formula, but also came up with a suitable, economically viable and industrial-scale method of applying whey protein coatings to plastic films and combining these with other films using different technologies. The overall process produces multilayer structures with barrier functions which can be used to produce flexible, transparent food packaging materials. "Our work at the IVV to manufacture a multilayer film of this kind using a roll-to-roll method is a world's first," Schmid notes. Companies that choose to make the switch to whey proteins in the future will only need to make minor modifications to their plants. The researchers have already applied for a patent on their new technology.

As well as being a renewable resource, whey also improves the recyclability of the composite materials. The polymers of EVOH-based multilayer packaging films cannot be separated into their constituent parts and recycled; once they are combined with other synthetic materials they can only be disposed of by incineration. But the situation is very different if a whey protein film is used instead of EVOH. "We developed the recycling method in collaboration with the University of Pisa," says Schmid. The films are shredded and the whey protein coating is enzymatically hydrolyzed. The whey proteins, which are insoluble in water during their use as a packaging material, can be enzymatically split and washed away from the other composite materials. This separation process allows the various reclaimed constituents of the film to be sorted by type and recycled.

The IVV researchers are so convinced of whey proteins' future potential as an alternative packaging material that they have initiated their own project in Freising which goes one step further. According to a survey carried out by the German Society for Packaging Market Research, there is not only an increasing demand for composite films, but also an increasing need for thermoformable composites. Growing demand for prepared products in trays is expected to increase the volume of these composites from 76,497 tons in 2009 to 93,158 tons in 2014. Currently, EVOH or films coated with silicon oxide are seen as the barrier materials of the future. "But completely replacing EVOH with silicon oxide coatings is virtually impossible. You can't thermoform the material, so it can't be processed as required," says Schmid. The researchers are now working hard to replace EVOH in thermoform composites with a barrier film based on whey protein. This additional application for whey protein would likewise conserve resources and reduce the emission of carbon dioxide into the atmosphere. ■

# Sharper and Faster



A cherry tomato with a diameter of 3 cm is used as the test subject for a new generation of MRI scanners.
*© Fraunhofer IAF / fotolia*

New low-noise, energy-efficient amplifiers for MRI scanners raise experts' hopes of capturing images from inside the human body with more detail than was ever thought possible.

Text: Bernd Müller

## A trick of layers

Electrons are given a rough ride in traditional silicon amplifiers. These negatively charged particles are constantly being pulled off course by positively charged holes, so they jolt through the semiconductor like a car rolling over potholes. Things are very different inside the IAF's high electron mobility transistor. Here, areas with a negative and positive charge are separated by an intermediate layer, which enables the electrons to move much more freely. The benefits of this design are low noise and reduced heat generation. The trick up the IAF researchers' sleeves was to grow the semiconductor layers in such a way that minimal mechanical stresses arise. Because in fact the gallium arsenide crystal lattices and the indium-rich intermediary layers are something of a mismatch: the layer technology was originally developed for substrates made from indium phosphide, but this material is very expensive.

The term "by-product" hardly conjures up images of high-tech equipment. On the contrary, it sounds like something people have no use for. However, when Dr. Michael Schlechtweg from the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg uses this expression, it goes without saying that he means something else entirely: state-of-the-art technology that was developed for a specific purpose, but which has found a new application in another scientific field. This is the case for the IAF's metamorphic high electron mobility transistor. "This is a high-tech component that we actually developed for high-frequency amplifiers in satellite receiver systems and radio astronomy," explains Schlechtweg, head of the High Frequency Devices and Circuits department, "but its performance is equally impressive when used as an amplifier for magnetic resonance imaging."

Back in 2006, the ministers for research and technology in Germany and France agreed to launch a joint project called INUMAC (Imaging of Neuro disease Using high-field MR and Contrastophores). Conceived to consolidate the leading position of both countries in medical technology, the project received funding to the tune of EUR 200 million. When it came to an end in 2011, the results were impressive. Companies such as Siemens and Bruker BioSpin worked alongside the IAF, the Department of Microsystems Engineering (IMTEK) at the University of Freiburg and the University Medical Center Freiburg to develop key technology for MRI scanners with exceptionally high field strengths for medical applications. The higher the field strength, the finer the details that can be detected when the body is being scanned. Current clinical devices typically work with a magnetic field strength of up to 3 tesla. In contrast, the INUMAC project aimed to achieve a field strength of a mighty 9.4 tesla.

## Noisy, blurred features made visible in unprecedented detail

Anyone who has ever been in an MRI tunnel at a clinic may be familiar with the heavy coils that staff place over the patient's legs or stomach. These are used to pick up weak magnetic resonance signals from hydrogen atoms moving around inside the body, which in turn provide information about tissue structure and composition. The latest MRI scanners feature several dozen receiver channels of this kind. Signals from inside the body are collected from a number of angles, supplying the raw data for three-dimensional images that doctors can rotate and enlarge on the computer screen when making their diagnosis. To obtain even higher resolutions, it would be better to use more coils, preferably smaller ones, and to have them pressed tight against the body. Flexible coils of this design have now been developed by IMTEK in Freiburg, using a special printer to apply electrically conductive ink onto flexible circuit boards.

However, these miniature coils can only supply weak measurement signals. The signals picked up by traditional coils usually travel along meters of shielded cable before being amplified. At this stage, they are already subject to a fair amount of noise, which blurs details in the image. Ideally, the signals would be amplified at the coil itself, but this has not been possible to date because of the high build-up of heat in the amplifiers.

This is where the IAF's technology comes into play. Amplifier chips with metamorphic high electron mobility transistors are made using gallium arsenide technology. Thanks to an especially high indium content, the charge carriers are extremely free to move, which minimizes noise and heat development. Yet until now, people had only thought to use these expensive components in telecommunications engineering with high frequencies into the terahertz range or in radio astronomy, where extremely faint signals are picked up from the depths of space. A 9.4 tesla MRI scanner produces signals at a comparatively low frequency of 400 MHz, which would normally be considered the province of conventional silicon amplifiers. But the IAF opted for gallium arsenide nonetheless: "We wanted to tease out the best possible results in the INUMAC project," says Schlechtweg.

It is clear to see that this goal was achieved from the measurement results recorded by project partners Bruker BioSpin in Rheinstetten, manufacturers of high-field MRI scanners for biological and materials research. Since the weak signals are amplified directly at the coil, they are boosted far above the noise floor, improving the signal-to-noise ratio by up to a factor of four. In the future, this means that MRI scanners will be able to make use of much weaker signals, and doctors will be able to see organ details that until now were hidden from view.

## Gallium arsenide makes it possible: finer, faster and better

Whereas silicon amplifiers consume around 2 watts of power and release most of this energy as heat, gallium arsenide amplifiers using technology developed by the IAF consume just 7.5 milliwatts – less than 1/250 of the amount. Lying beneath dozens of coils equipped with silicon amplifiers, the patient would feel like a chicken being roasted on a spit. The IAF's amplifiers, on the other hand, can barely be noticed at all. "The main benefit of using our technology in MRI scanners is that it generates so little heat," explains Hermann Maßler, who works in Schlechtweg's department at the IAF.

This innovation has created a world of new opportunities. One of the IAF research team's ideas is to construct a helmet with a hundred flexible coils that can be fitted snugly around the head, equipped with a hundred gallium arsenide preamplifiers. Such a device would produce images of the brain with a level of detail that has never been seen before in medical science – while the patient would be able to keep a cool head throughout the procedure. "However, it's up to manufacturers like Siemens and Bruker whether this idea will ever be implemented," notes Maßler.

After all, new technology tends to cost a lot of money, at least when products are launched on the market. On this point, though, Michael Schlechtweg can offer reassuring information. While it's true that gallium arsenide amplifier chips are considerably more expensive than silicon chips, this is only the case for quantities in the millions, which is the usual scale of production for consumer electronics. When manufactured in runs of just hundreds or thousands, gallium arsenide chips are actually less expensive than those made from silicon. Moreover, the cost involved becomes negligible when the components are being used with 9 tesla MRI scanners, which are produced individually at a cost of several million euros. As Schlechtweg says, "In the market for high-end equipment, people pay for performance, and the cost of the amplifiers really isn't a significant factor." ■

# Food without preservatives

Éclairs and other pastries should taste light and fluffy. But, due to its high water content, éclairs dough spoils even after a short storage time. Now, researchers have devised a production system that cleans itself automatically. The equipment is a big help for the bakers.

Text: Janine van Ackeren

A dough machine that automatically cleans itself will make the production of pastry easier in the future. © Fraunhofer IGB

Sitting in a cozy in a French sidewalk café, watching passers by while enjoying a chocolate-cream éclair – for many of us, this is a portrait of a relaxed summer vacation. For the bakers who make the éclairs out of pastry dough, though, the entire procedure is far less relaxing: up to now they have used traditional equipment that is mainly operated by hand. Once made, the dough must be processed quickly – due to its high water content, éclair dough spoils every quickly and is then not suitable for further baking. The baker also has to disassemble the equipment and clean it thoroughly before it is ready for the next batch of pastry dough. In the future, a baker's life could become a bit more relaxed: As part of ProEclair, an EU-funded project, researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart have developed a dough machine with integrated CIP (cleaning-in-place) which will make the cleaning process easier. "Under several circumstances, the dough produced by using this system can be maintained fresh for four weeks – an advantage for the bakers since they don't have to make the pastry dough every day. The choux pastery also can be delivered to the individual bakeries", notes IGB group manager Ana Lucía Vásquez, pointing out yet another benefit. From the outset, the scientists planned to include the cleaning feature in the new system. The researchers' main task involved the interplay of individual parameters: the machine had to be designed to be free of corners and edges where dirt can become trapped. Which material is the best for the job? What characteristics does the surface need to have for an easy cleaning process? The cleaning agents sprayed in series at certain points must also be coordinated with one another – the type of agent and its concentration have to be right, and exposure time and temperature play a role as well. "To make sure the system really is clean after the cleaning procedure is complete, the last rinse fluid is tested for proteins, fats, carbohydrates and residues of cleaning agent," Vásquez explains.

"PreserveWine," another EU project that IGB researchers are working on, goes a step further: here, scientists are not only developing machinery that integrates in-situ cleaning but are also preserving the wine produced. "With the rapid-pressure-drop technology we have developed, we can ensure that the wine has a long storage life – without the use of preservatives," Vásquez points out. Heating, for instance as with milk, is not a solution, because it would harm the wine flavor. Heat also destroys valuable ingredients. So researchers have taken another approach instead: "We subject the wine or other liquid food product to a pressure of 500 bar – 500 times ordinary atmospheric pressure – while adding inert gases at the same time. As a result of the high pressure, the gases diffuse into the cells of the microorganisms in the liquid. If we then drop the pressure back down, the cells burst – the microorganisms have been killed. And the inert gas escapes," Vásquez continues.

Simulation of the particles of a solid.
© *Fraunhofer IWM*

# Countering the muesli bag effect

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Big cornflakes always end up at the top of a bag of muesli – even though they are larger and heavier. The way in which the different components of muesli separate out is a question of particle dynamics.

To help predict how granules and suspensions will move and flow, researchers from the Fraunhofer Institute for Mechanics of Materials IWM have developed a simulation tool. The software program is designed to help scientists depict materials – such as soldering paste for solar cells, or bulk materials in process engineering – on a particle level. That allows them to precisely model the granular form or suspension composition for whatever application they are working on. This new tool can be used to simulate several million particles and to improve manufacturing processes that involve powders, pastes or liquids.

# Performance benchmarking for companies

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One way companies can stay ahead of the competition is by ensuring they launch their products and services rapidly and successfully. The InnoScore® service portal gives managers of small and medium-sized enterprises the opportunity to discover just how good their company is at developing product-related services. They also get the chance to compare their results with similar-sized competitors from the same industry.

The evaluation is based on Fraunhofer's nine-field business model. Users are presented with comprehensive assessments of how they could enhance their innovation potential: www.innoscore-service.de

# Decorative solar cells

*Contact: Dr. Andreas Hinsch,*
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Dye solar modules give architects a new toolbox of design options. One of the biggest challenges researchers face is making the jump from laboratory scale to mass production – but experts from the Fraunhofer Institute for Solar Energy Systems ISE have finally succeeded in producing a dye solar cell module measuring 60 x 100 cm on a continuous substrate material. Together with their colleagues from the Fraunhofer Institute for Industrial Engineering IAO, they are working on new methods of production and quality assurance.

Dye solar cells are electrochemical solar cells which use a conversion process similar to photosynthesis. They are manufactured using screen printing technology and are based on an organic dye integrated in nanocrystalline electrodes made of titanium dioxide.

Prototype of a dye solar cell module (60 x 100 cm) produced using screen printing technology.
© *Fraunhofer ISE*

# Controlled catastrophe

A factory explodes. In a life-size experiment, sensors register whether or not emergency crews can still access the building.

Text: Marion Horn, Photos: Bernd Müller


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The supervisor informs members of the volunteer fire department, the Red Cross and the THW about the planned operation.

Specially-prepared cutting charges for cutting the steel girders in the building's interior.

Round, wireless sensors are screwed into the wall. They record the force of the explosion.

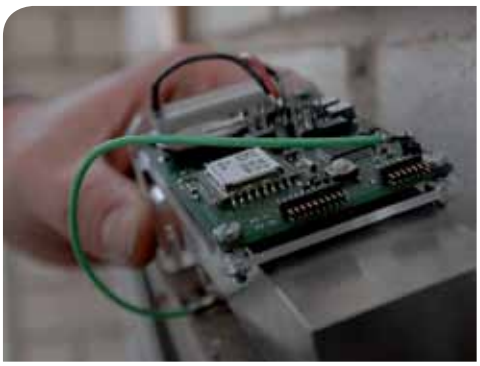
Full of anticipation, 150 men and women stand at attention, lined up in the morning sun in front of the equipment room of Bad Säckingen's volunteer fire station. "Good morning, colleagues. My name is Stefan Rother. I am your Federal Agency for Technical Relief THW trainer and I'll be in charge of today's procedure. After three years of research and preparation, today we begin the full-scale experiment marking the conclusion of the AISIS project. The acronym stands for automated generation of information and protection of critical infrastructures in the event of a disaster." Everyone's attention is focused on Rother. The men and women of the volunteer fire department, the Red Cross and the THW are on edge. Unlike in other drills, this time no one knows what to expect. Rother introduces the program for the day: "Today we're testing a novel safety system that will help us to save human lives in the event of an accident, terrorist attack or earthquake. Sensors have been affixed to the walls of an old factory hall in the industrial quarter. After an explosion, these sensors will provide us with information about the structural condition of the building, so we can decide quickly whether to enter the structure and, if so, which areas of the building we can access safely. After the explosion, I will alert the control center and the exercise will begin."

30 researchers and explosives experts have already spent four days at the testing site preparing the two-storey factory building for the experiment. Now, the big moment is only 90 minutes away. Andreas Fleig, THW project leader, explains: "Several meters of yellow and red ignition cable have been laid and connected to the ignition system. Here on the steel girder you can see a cutting charge equipped with special explosives to cut through the girder. The explosive charges cause a pressure wave down on the ground floor." The red plastic explosive material looks like modeling clay. Fleig pulls on some thin rubber gloves and takes a piece of it in his hand. "We prefer to use as little explosive as possible for a controlled collapse like this to ensure the safety of bystanders."

His colleagues hammer, saw and spread rubble and dirt in front of the building. THW assistants carry life-size wooden mannequins up to the second floor and hide them. Rescue workers are to locate and 'save' them after the explosion. The dummies appear tattered; chances are they've had to endure such exercises before. They're smiling for now anyway – someone drew faces on them with a ballpoint pen. Researchers have used screws to affix 20 round, silver sensors at 8 meter intervals on the walls and ceiling of the 30 meter long and 13.5 meter wide factory hall. The sensors will register the effects on the walls of the force of the explosion. This information will then be transmitted live to the control center. In the future, this sensor technology can be integrated into tubbings, concrete segments used in tunnel construction, where they can transmit information on the situation inside the tunnel in the event of an accident.

## Is the structure stable?

"The stability of damaged walls is difficult to determine after an accident of this kind, and that's been one of the biggest safety issues to date – one that puts the lives of rescue and relief personnel at risk," emphasizes Metin Erd of the Institute for Microsystems Engineering at the University of Freiburg. Erd and his Fraunhofer colleagues have set up their portable laboratory in a tent within visual range of the factory hall. It's close, hot and sticky inside. Laptops, servers, screens and components for the hand-sized sensors cover the picnic tables. "The sensor is installed on the circuit board. The evaluation unit, the radio system and the radio transmission link are encased in a rugged metal housing," explains Erd. Each sensor records the



The view inside a sensor node.

Employees of the Federal Agency for Technical Relief THW prepare everything for the explosion.

Rescue and relief personnel assist the 'injured' actors.

In a tent within view of the factory hall, researchers set up their portable laboratory.

From a safe distance, visitors and journalists watch the building explode.

pressure waves emanating from the detonation and passes the information on. He continues: "We developed this sensor system as part of the AISIS project in collaboration with our partners at the Fraunhofer Institute for High-Speed Dynamics, Ernst Mach Institute EMI, in Freiburg, and many others. The project is coordinated by the international construction company, Ed. Züblin AG, and funded by the German Federal Ministry of Education and Research (BMBF) to the tune of 4.1 million euros." Professor Klaus Thoma, Director of the EMI, proudly explains: "A sensor system like this one has never been seen before in safety technology. Experiments like this are tremendously important for research. We're helping to save human lives. Here, in Bad Säckingen, we have found the ideal location to conduct this spectacular experiment under conditions as close to real life as possible."

Invited guests, onlookers and camera teams gather outside the big white visitors' tent beyond the 100 meter safety zone. "Please don't block the cameras," a cameraman cautions spectators crowding around the barriers. His job is to record the explosion with a high-speed camera. Special cameras have also been placed in the building, and quadrocopters – miniature helicopters one meter across – will film the experiment from above.

Fleig explains the signals announcing the explosion. "In a moment there will be a long horn blast. That's the signal to take cover straight away. You don't need to lay on the ground, though, since we're outside the danger zone. If everything is alright, you'll hear two short horn blasts. That means the explosion is about to happen." The time has come. One long blast, two short. The explosives master counts down. "Four, three, two, one...." Silence. Then a deafening boom. Dark grey dust clouds billow out of the empty window frames. A massive wall of dust floats toward the guests and journalists. The three explosives experts break away and disappear into the dust cloud. They have the risky job of verifying that all the charges actually ignited. All clear, three short blasts. The explosion is over and Stefan Rother alerts the rescue crew.

Fleig reaches for the microphone. "There will be a departure from our standard operating procedures today. We will now take a short 'dramatic pause' to position 15 actors, who will play the role of injured persons, on the grounds and in the ruins." Michael Harter of the company Securiton takes advantage of the break, too. In the visitors' tent, he uses a video projection to explain how the safety system works. "Here is a situation assessment just as it appears on the display of the fire department's officer-in-charge as they approach the scene of the explosion. You can see on this image which sensor is critically overloaded. We get a very clear picture of how the building collapsed. As planned, it was only a partial collapse." The officer-in-charge is provided with valuable information straight away – in addition to data already to hand, such as ground plans showing possible access points, the position of fire detectors and extinguishing systems.

Slowly the dust cloud dissipates. Amidst blue flashing lights and sirens, the fire brigade and ambulance arrive on the scene. The Red Cross sets up its first-aid tents in a matter of minutes. Wrapped in golden insulating blankets, the lightly injured limp to the medical station. Three rescue dogs search for victims buried beneath the rubble. Diggers carefully clear away big chunks of debris. Rother is relieved. "The sensor system passed the test. We all hope nothing bad will happen, but we have to be well-prepared for catastrophes – in case they strike." ■

www.aisis-innovation.org

Every chip is different and therefore unique. Digital fingerprints prevent microchips from being counterfeited.
*© Volker Steger, gettyimages / (Montage)*

# Counterfeit-proof chips

Every computer chip has a unique 'fingerprint' based on its individual physical characteristics. Researchers have now started using these chip-specific properties to achieve physical security. This method offers an effective means of protecting electronic payment cards, smart phones and electronics components against product piracy – because hacking the fingerprint is practically impossible.

Text: Tina Möbius

The idea of a dimly-lit yard full of counterfeiters frantically screwing together cheap forgeries of major-name products may be standard fodder in detective novels, but it has little to do with the reality of today's world. Modern criminals are seasoned professionals who have access to cutting-edge technologies. The problem of product piracy is no longer limited to the consumer goods sector – it is now affecting industry, too, with computer chips, electronic components and machine parts all falling within the pirates' sphere of activity. To protect these items from being illegally copied, they are often provided with a cryptographic code, though this method has so far met with limited success.

By employing chemicals, scanning electron microscopes, focused ion beams or laser bolts, the product counterfeiters frequently manage to open up the chips and hack the security code. No effort is spared if there is any chance of making a tidy profit, and cheap forgeries cost business dear: The German mechanical and plant engineering sector alone lost 6.4 billion euros of revenue in 2010, according to a survey by the German Engineering Federation (VDMA). Sales losses aside, low-quality counterfeits can also damage a company's brand image. Worse, they can even put people's lives at risk if they are used in areas where safety is paramount, such as automobile or aircraft manufacture.

## No two chips are ever the same

To tackle this problem, researchers from the Fraunhofer Research Institution for Applied and Integrated Security AISEC in Garching near Munich are working on innovative methods of protecting products against piracy that offer far higher degrees of security. One promising approach involves methods based on the specific physical characteristics of chips, known as Physical Unclonable Functions, PUFs. "However careful you are in the production process, you inevitably end up with small differences between chips that you can't control," says Dominik Merli, a scientist at the AISEC. Printed circuits, for instance, exhibit minuscule variations in thickness, length or density after the manufacturing process. "So no-one can ever produce two absolutely identical chips," Merli continues. These variations are so small that they do not affect the chip's functionality – but they do serve to make a component unique. The researchers have found a way of using these characteristics to derive a kind of virtual 'fingerprint' which can then be used as the basis for generating a code.

## The long way from a fingerprint to a security code

The researchers start by integrating a PUF module directly within a chip. At its heart is a measuring circuit, for instance a matrix of ring oscillators. Each of these oscillators generates a characteristic clock signal, moving faster or slower depending on the chip's precise material properties. The signal reaches different frequencies depending on whether the wire is slightly thicker or thinner and whether the material is denser or less dense. By measuring a series of oscillating frequencies, it is possible to determine a sequence of 0 and 1 bits which effectively creates each chip's unique fingerprint.

This is where the researchers' real work begins, because the measurement process inevitably involves certain inaccuracies. Firstly, the fingerprint always features some 'noise' – another way of saying that slight signal fluctuations creep into every measurement. The second problem is that you never get a completely even distribution of bits, since different PUF designs produce more 0 bits or more 1 bits. But in order to use this fingerprint to create a component-specific key, the generated bits must match up precisely and the distribution of 0 and 1 bits must be statistically even. The researchers have therefore incorporated a fuzzy extractor, an additional module with an error-correction stage designed to eliminate noise and a second stage that uses a hash function – a mathematical algorithm – to correct the bit distribution.

## Opening the chip destroys the code

The code can be regenerated as and when required by simply measuring the ring oscillators and generating the code using the fuzzy extractor module. One of the key advantages over conventional cryptographic methods is the fact that the security code is not stored anywhere, but is rather regenerated each time based on the current fingerprint. Normally, codes are stored somewhere on the hardware and can be extracted using suitable technological means, but that is not possible with this new method. As soon as the chip's physical parameters change – an inevitable result of an invasive attack – the code is destroyed.

This technology can be implemented in a wide variety of Field Programmable Gate Arrays (FPGAs) as well as in hardware components such as microchips (ASICs) and smartcards. At the AISEC, Merli and his colleagues are working on getting the PUF module ready for practical use, for example by investigating which designs work particularly efficiently and can be integrated in the corresponding component without taking up too much space. Another challenge is that environmental factors such as heat, humidity and wear and tear can influence the PUF characteristics and corrupt the code. Just because something works perfectly in the laboratory does not mean it is easy to implement in practice.

"Obviously the last thing we want is for an ATM to refuse to give customers their money because their bank card has been on a hot beach all day long," says Merli. Fortunately, the developers have some tricks up their sleeves to avoid those kinds of undesirable results, for example by using relative instead of absolute frequency measurements. This involves measuring two oscillator frequencies, both of which are temperature-dependent. If the ambient temperature increases, the absolute temperature readings will certainly change, but there is a high probability that the relation between the two frequency readings – whether bigger or smaller – will remain the same. The fuzzy extractor also acts as a kind of buffer against interference by external disturbances.

The researchers from Garching are constantly on the lookout for any new potential security weaknesses of PUF-based systems that may emerge. They know that product counterfeiters are ready to pounce on any vulnerabilities – so they always need to stay one step ahead. ■

# Fraunhofer visual

The sensory room is a kind of retreat. The sounds and pictures help employees to relax during short breaks from work.

Foto: Thomas Ernsting

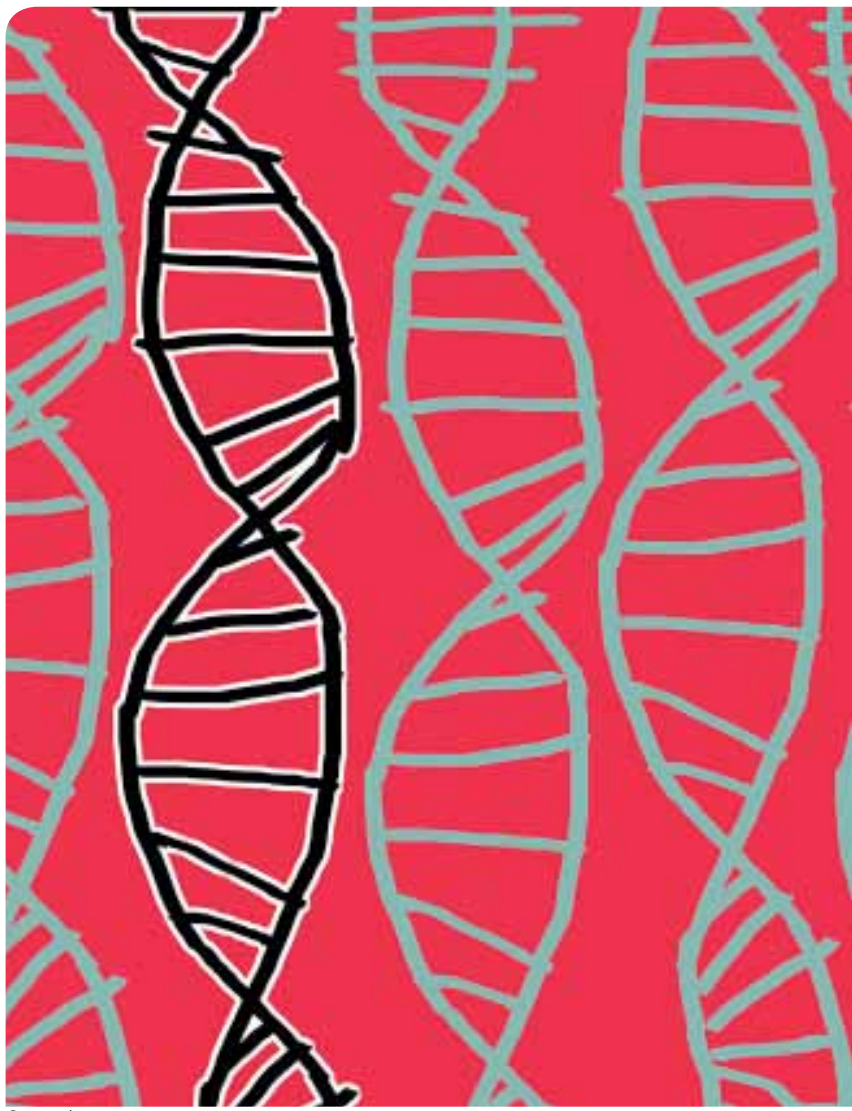
# The RIBOLUTION

For many years, a large part of our genetic code was considered to be 'junk DNA'. However, researchers have since discovered that these seemingly nonfunctional portions of the genome sequence actually serve as a template for ribonucleic acids, or RNAs. These 'junk RNAs' appear to play a role in the incidence of diseases such as cancer and heart disease. Scientists are now hoping to identify new biomarkers for the diagnosis of common diseases.

Text: Monika Offenberger

When the first complete human genome sequence was published ten years ago, it came as a huge surprise to learn that we do not have many more genes than roundworms or similar primitive organisms – and that only a measly 1.5 percent of our DNA is actually involved in coding for protein, the basic building blocks of cells. Biologists were initially at a loss to explain the purpose of the remaining 98.5 percent of the genome, referring to it simply as 'junk DNA'.

"But the interesting question is why this apparently useless genetic material is so much more abundant in the human genome than in the roundworm genome," says Professor Friedemann Horn from the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig. In-depth studies by the international ENCODE research consortium have now shown that even the parts of the genetic information referred to as 'junk DNA' or 'non-coding genes' are transcribed virtually in their entirety into RNA. And they have a function: this non-protein-coding RNA – known for short as ncRNA – regulates the genes that serve as templates for creating proteins. If something goes wrong during this process – for example if the body produces too many or too few proteins – this up-



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The project "RIBOLUTION – integrated platform for the identification and validation of innovative RNA-based biomarkers for personalized medicine" began in January 2011 and is initially scheduled to run for three years. It is funded by the Fraunhofer Future Foundation and involves the participation of five institutes:

- Fraunhofer Institute for Cell Therapy and Immunology IZI, Leipzig
- Fraunhofer Institute for Toxicology and Experimental Medicine ITEM, Hannover
- Fraunhofer Institute for Applied Information Technology FIT, Sankt Augustin
- Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, Stuttgart
- Fraunhofer Institute for Manufacturing Engineering and Automation IPA, Stuttgart

sets the balance of the body's cells and leads to disease. Of the 30 institutions participating in the ENCODE project, just two of them are based in Germany: the University of Leipzig, and the IZI.

This sketchily understood group of RNA molecules is the subject of RIBOLUTION, a research project involving five Fraunhofer institutes. Professor Horn explains the goal of the joint project, which is coordinated by the IZI: "We are hoping to find conclusive biomarkers to help in the diagnosis of common diseases such as cancer and rheumatism. And, at the same time, we are developing efficient and cost-effective methods for identifying those biomarkers." The word RIBOLUTION is a play on the words ribonucleic acid (RNA) and solution, reflecting the hope that RNA could help provide solutions to a range of diagnostic and treatment issues.

Professor Horn explains that ncRNAs act as a kind of central control software for cells: "There are whole families of ncRNAs which are involved in transporting or processing other RNA molecules. Many of these also bind themselves to protein complexes and direct these to specific sites on the chromosomes, where they control gene activation and silencing. Trying to figure out all this complexity is going to be a tremendously challenging task." But the researchers working on the ENCODE project have already made one discovery: ncRNAs are formed and regulated in a much more specific way than the messenger RNAs that exclusively code for proteins. "And that means that the expression of ncRNAs tells us more about the state a cell is in. Plus they describe pathological states, in other words diseases. That's why they have so much potential as specific biomarkers," says Horn.

## Quality-controlled, automated process

The RIBOLUTION researchers are studying this enormous treasure trove of potential biomarkers in order to pick out the most suitable ones for diagnosing three diseases: rheumatoid arthritis, prostate cancer and chronic obstructive pulmonary disease. "Identifying new biomarker candidates is just the beginning of what is a very tricky process," says Horn. "The point at which so many studies reach a dead-end is the validation of those biomarkers. While you might observe a molecule being formed to a greater or lesser degree in a cell depending on the stage of an illness, it is often extremely difficult to draw a statistically sound conclusion on whether that constitutes a diagnostic marker that can be applied in a clinical setting. That's why we're taking a three-phase approach to tackling this problem."

The researchers' first task is to run a comparison between a small number of patients and healthy control subjects, as Horn explains: "In phase one, we sequence the whole genomes of both the patients and the control subjects and retrieve all the RNAs that differ between them." These analyses are carried out at the IZI and the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart. Initial results from Alzheimer patients have shown just how successful this method can be: the difference between brain tissue samples analyzed after the death of the patients and samples taken from healthy control subjects ran to some 2,000 ncRNAs. And the Fraunhofer researchers found even greater numbers of differences in the ncRNA profiles of patients with breast or prostate cancer compared to those of the control subjects. "Our aim in phase two is to analyze this huge mass of different signals to pick out the best ones," says Horn. "We'll do that by combining them all on a small microarray, which enables us to screen ten times as many candidates as before. Then we'll take the most promising ones and test them on a much larger cohort in phase three."

The IZI researcher hopes this gradual process will enable his team to find conclusive biomarkers which could be used to detect the imminent onset of a disease before it actually takes hold. Horn also has a particular interest in the efficacy of treatments for diseases such as rheumatism, a disease where patients do not all react equally well to a given drug, with it providing relief in some while not having any effect on others. Horn suggests that relevant biomarkers could allow this latter group of patients to skip a useless course of treatment – a move that would also save considerable amounts of money. The intention is that the RNA screening should initially be carried out using conventional methods. "But performing those analyses manually in the lab is tremendously time-consuming and resource-intensive," says Horn, explaining that the researchers are hoping to convert the manual procedure into an automated process which would require minimal sample quantities. This automation project is being carried out by the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart. The goal is to create an automated, quality-controlled process; but this is no easy task, as Professor Harald Mathis from the Fraunhofer Institute for Applied Information Technology FIT in Sankt Augustin explains: "At the moment, in the complex preparation of the RNA samples for sequencing and array analysis, almost the entire sample has to be given over to quality control testing – with the result that people often don't bother with quality control at all. We're hoping to develop methods of analysis that only consume a fraction of the sample and that will work with just nanoliters, or even picoliters."

There is a good reason why the name RIBOLUTION sounds like the word 'revolution': RNA molecules genuinely have the potential to revolutionize the field of molecular diagnostics. They could enable us to detect diseases at an earlier stage on a more efficient and personalized basis, ultimately helping us to find the optimum course of treatment for each patient and to prevent diseases from reaching their more severe stages. ■

# Smart energy grids

Wind turbines, solar parks and combined heat and power units are gradually displacing conventional fuels. The expansion of renewable and decentralized electricity production is leading to an increase in fluctuations on the power grid. In response, experts are developing technologies for intelligent and robust power supply grids.

Text: Tim Schröder

Renewable energy is on the march. There is no doubt about that, at least in Germany. Northern Germany has its wind parks, southern Germany its solar power, and more offshore wind parks are in the planning. Two years ago, policymakers had already set themselves the target of producing at least 80 percent of electricity from renewable sources by the year 2050. Now, in the wake of the nuclear plant explosion in Fukushima, Japan, the issue of green energy has become even more pressing.

But it will take considerable effort to bring about the dream of environmentally friendly energy supply. The power grid will have to be fundamentally restructured to take it from a world of large-scale generation and transmission on high-voltage lines to a world of rooftop photovoltaic systems. The reason for this is that the rules of the game are changing. For decades, electricity has been generated in major power plants and transported in only one direction. In future, hundreds of thousands of small plants will feed electricity into the grid. Households will no longer merely draw power from the grid but feed energy back into it too. The old supply grid will be transformed into a power exchange network in which energy flows back and forth – something it was never designed to cope with.

The uneven availability of electricity generated by the wind and the sun requires new electricity transmission lines.
© *panthermedia*

Several Fraunhofer institutes have joined forces to form the Intelligent Energy Network with the aim of developing technical solutions for this huge restructuring of the power supply grid, ranging from the level of private households and low-voltage grids to the highest voltages seen in power lines and wind farms.

Photovoltaic systems are one example. To date, low-voltage distribution grids at the communal level do not have the technology to record in detail the amount of energy being fed into the grid by multiple solar modules. The high-resolution metering technology common in high-voltage networks simply does not exist for low-voltages. As a result, each individual photovoltaic system feeds away into the network without a thought for what other systems might be doing. This in turn leads to massive fluctuations in the power grid – a problem which is making itself felt even now. On sunny days the systems produce at peak levels, but at night production stops altogether. Currently, large-scale, coal-fired power plants are obliged to compensate for this kind of fluctuation, but in the future it will be up to renewable generation itself to manage this problem in its entirety. That will only be possible with new control technology, which is currently under development by scientists such as Peter Bretschneider of the Application Center System Technology IOSB-AST, one of the coordinators of the Fraunhofer Network. He is developing metering and safety technology that is designed to coordinate the activities of photovoltaic systems with one another in local distribution grids. Among other things, the new technology determines the amount of electricity each system feeds into the grid and at what voltage – tackling the problem of fluctuations at source and increasing grid stability. "This approach is particularly attractive in regions where a significant proportion of power comes from photovoltaics," says Bretschneider.

Ultimately, it is a matter of making the power grid more intelligent with a good deal of technical finesse. Experts talk of a "smart grid" through which all power generating systems and electricity-consuming devices, such as dishwashers and electric cars, communicate and coordinate themselves depending on how much wind and solar energy is available. In the future, this will enable electrical devices to match their requirements more and more to the availability of green energy: If there is a lot of green energy in the grid, they will turn themselves on and use it. Several joint projects involving the Fraunhofer Network have shown that this approach can work. For example, the "eTelligence" project in Cuxhaven, funded by Germany's Federal Ministry of Economics and Federal Ministry for the Environment through the E-Energy Initiative. This project is investigating, among other things, the degree to which refrigerated warehouses can be operated to reflect wind energy availability. If there is a lot of wind energy in the grid, the warehouse lowers its target temperature, creating a kind of cold reserve to tide the warehouse over in times of low wind when its cooling units are switched off.

## Smart meters for a sustainable energy supply

Control technology can also be implemented in private households, in the form of smart meters capable of communicating with the power grid. Some utility companies have already begun to roll these out. At the moment, the devices can do little more than show current rates of consumption, but eventually they will be able to control household appliances just like they can a refrigerated warehouse – based on the current price of electricity. When a large amount of wind and solar energy is available, the price drops and it makes economic sense to turn on the dishwasher. Thanks to the smart meter, this process will be fully automatic. "This kind of intelligent energy system is the key to a sustainable and reliable energy supply," stresses Christof Wittwer of the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, a member of the Fraunhofer Network.

Of course, the activity of household appliances will have to be sensibly coordinated to maintain the stability of the energy grid. Philipp Strauss, Division Director Systems Engineering and Grid Integration, and his team of engineers at the Fraunhofer Institute for Wind Energy and Energy System Technology IWES in Kassel have developed a solution: OGEMA software, which allows the smart meter and the utility company to communicate. "This software not only ensures communication, it can control household devices according to the preferences of the individual consumer – based on the price of electricity or on how much carbon dioxide is released as it is generated." The software is already being implemented in two other projects of the nationwide E-Energy Initiative. A project in Mannheim is focused on price-based control. The project in the Harz region goes even further, attempting to automate the coordination of green energy production from wind turbines, a hydroelectric plant, and solar and biogas facilities with electrical systems and appliances.

In cooperation with the experts at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen, scientists hope to further develop and integrate the software with the ISE's openMUC concept to create an OGEMA2.0 framework. This would represent the first important step toward large-scale system control and the virtual power plant of the future, in which intelligent software systems are able to control the many small-scale power generators so that, collectively, they deliver electricity as reliably and consistently as conventional large-scale power plants. IWES experts are currently working on a software package, the Windcluster Management System, that would coordinate the activities of on- and offshore wind farms with one another. Here, too, it is a matter of controlling the energy produced by the parks to compensate for fluctuations.

The final step still remains – a Europe-wide renewable energy grid. "We will probably only be able to guarantee reliable renewable energy supply for Europe once the major generation and load centers are connected to one another other across the borders of individual EU countries," says Kurt Rohrig, power grid expert at the IWES. As they say, the wind is always blowing somewhere. If the air is still over the North Sea, there might well be a stiff breeze over the bay of Biscay. The same principle applies for solar power. Power could be transported from one end of Europe to the other, depending on weather conditions.

Of course, Dr. Rohrig knows the limitations. At present, there is no way to move the required amount of energy back and forth, because transmission capacity across the grid interconnections at national borders is insufficient. One solution, says Rohrig, would be to install new high-capacity DC lines that can transport electricity across greater distances with fewer losses than can conventional AC lines. But the objective is not to cover Europe with a whole new power grid, as Rohrig emphasizes. "That would be too easy. I see our current task as being above all to correctly estimate the need for new transmission capacity. The goal is a reasonable, appropriate expansion of the grid."

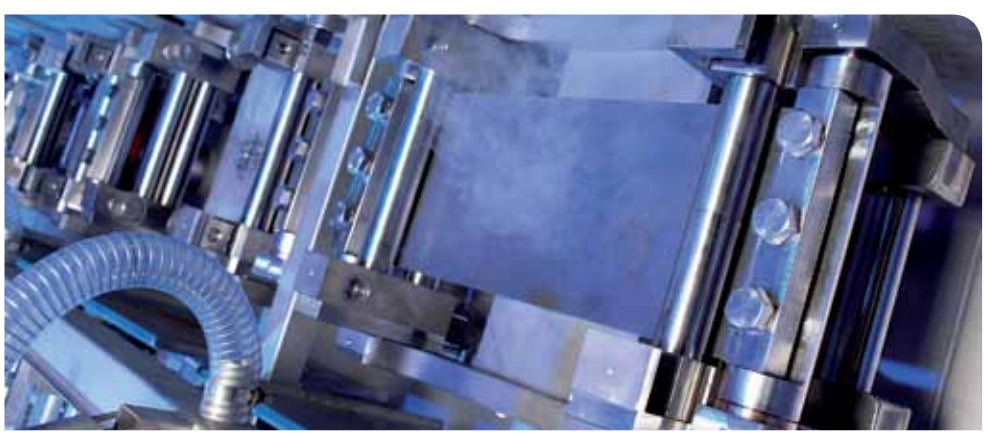
Before this can happen we need to know how well a single region can be supplied with green energy using nothing but a smart grid. The more intelligent and efficient this grid, the less energy will ultimately have to be transported across Europe. The team of network specialists faces many a challenge yet. ■

# North Sea climate at the touch of a button

Out at sea, wind turbines are exposed to especially heavy stresses from salt, UV radiation and wave action. Now research scientists at Fraunhofer have a new test chamber that allows them for the first time to simultaneously test how the climate on the high seas and mechanical stresses damage offshore materials.

Text: Tim Schröder

Parts of offshore structures can be comprehensively tested in the climate chamber. © *Fraunhofer IWES*



To simulate mechanical stress, the material samples are clamped between two steel jaws which bend them backwards and forwards. © *Fraunhofer IWES*

When storm-force winds blow from the northwest the North Sea becomes a bubbling cauldron. Blue-black waves with foaming, white-tipped crests roll towards land, while the wind whips up a veritable fog bank of spray. Heavy waves ten meters high rise up and crash down on anything in their path. Here, and in many other seas, offshore oil platforms and lighthouses have been standing up to the forces of wind and waves for decades. In the future they will be joined by thousands of wind power plants. Although several offshore wind farms are already operating in Europe, nobody knows how well the wind turbines will survive their projected 20 years of service life. After all, no wind power plants anywhere in the world have had to stand up to the punishment these will have to face at sea.

Problem number one is salt. Salt attacks metals, penetrating even the tiniest cracks in protective coatings to cause surreptitious structural damage. The second problem is UV radiation, which attacks surfaces particularly hard. It causes plastics and paints to flake and is especially formidable at sea because of the light reflected by the water. The third problem is gigantic waves during storms. When ice-cold waves crash against a wind turbine tower that has been heated up by the sun, the shock of the resulting temperature change causes material fatigue much more quickly than on land.

## Simulating everything that can happen to a wind turbine at sea

Up to now it has scarcely been possible to assess how destructive all these forces are in concert. This is why the Fraunhofer Institute for Wind Energy and Energy System Technology IWES in Bremerhaven developed its own climate chamber, in which parts of offshore structures can be comprehensively tested. As project manager Leena Kruse sees it, "We get to combine the environmental conditions at sea with mechanical stresses." The sample is bent in a four-point bending test in a typical offshore environment – salt fog, waves, UV radiation and high humidity. In the chamber, which has been filled with salt fog, the component is bent backwards and forwards in a sort of mechanical vice. "Such a combination has never existed before." The chamber stands at over two meters tall and gives the opportunity to clamp 12 component samples into the machine – sheets of metal or fiber composite materials from the wind turbine nacelle or parts of the rotor blades. The system replicates everything that can happen to a wind turbine at sea. It sprays salt fog, exposes the samples to aggressive UV light and even has a test that hits the pieces of sheet metal and plastic with a jet of cold water to simulate the impact of waves. And, of course, the temperature in the chamber can be set from freezing minus degrees to boiling heat, from minus 30 to plus 100 degrees Celsius.

The material samples are clamped between two steel jaws on the left and right. When the machine is started, the two jaws are set in motion to bend the sheet metal. Depending on the type and thickness of the part, various bending speeds can be applied, and a test can be conducted for hours or even weeks. An advantage of the combined test is that for the first time the scientists can now determine what forces or environmental conditions cause a particular type of damage. For instance, is the incipient cracking caused by deformation or mainly by sunlight or salt water? "We can combine various factors in a whole series of ways to narrow down the causes very precisely," says Kruse.

It took two years to get from the initial idea to system startup in February 2011. The task was an ambitious one because the multifunctional machine had to be designed completely from scratch. "That was a real challenge, not just for us as development engineers but also for the machine builder," recalls Kruse. The choice of materials was also crucial. The inhospitable conditions inside the test chamber are designed to attack the sample pieces of sheet metal, but the equipment itself must not be affected. So Kruse and her colleagues decided to use heavy-gauge, highly corrosion-resistant offshore steel, even though it is difficult to machine. The result is an extremely robust, high-performance testing facility, with hydraulic drives, valves, water hoses and nozzles. The engineers can pre-select the test conditions precisely from a control cabinet, and the test is monitored by sensors affixed to the parts. Strain gauges, for example, indicate any cracking of the material and if it is losing tension. The measurements are transmitted to the control cabinet by rugged cables and analyzed. This makes it possible to determine the exact conditions under which a component fails, and the precise time – but also when a sensor stops functioning.

In the future, offshore wind turbines will increasingly be equipped with a whole range of sensors that will make it possible to monitor the condition of marine wind power plants from on land. Robust sensors are particularly important for this. That is why work is being conducted at the IWES to find out, for example, how the sensors can be firmly bonded to the structures and how susceptible they are to corrosion.

## The results are supplemented by open-air tests

The measurements in the climate chamber are accompanied by open-air tests. On test frames in the North Sea Kruse's colleagues are monitoring how the steel plates and other offshore component parts are coping with their time in the water. The growth of marine life on the parts is especially interesting, including the effect of barnacles, whose sharp calcified shell plates can penetrate under the adhesive bond attaching the sensors. Such tests provide an ideal complement to the new chamber.

## Simulation beyond standards and regulations

The climate chamber combines a whole series of DIN and ISO standards, but also goes a whole lot further, as Kruse explains. "No standards or regulations exist for systems which simulate climate tests and mechanical loadings simultaneously." It is therefore entirely possible that the IWES is setting new standards. The project manager expects that numerous manufacturers of offshore components will use the climate chamber for testing. "And of course, we'll be continuing with our own research, attempting to improve the materials and perfect them for use in rough seas." ■

## Cooperation with Brazil

Fraunhofer and the Conselho Nacional de Desenvolvimento Científico e Tecnológico in Brazil will work together more closely in the future. A Memorandum of Understanding was signed recently. Both partners want to promote the exchange of senior researchers to strengthen or broaden the participating institutions' core competencies and to contribute to a long-term partnership. In addition the Brazilian partner intends to set up a variety of fellowship programs that allow scientists to come to Germany and experience the research at Fraunhofer.

## New Project Centre in Ontario

The Fraunhofer Institute for Chemical Technology ICT and the University of Western Ontario in London, Ontario have started a long-term collaboration. In the joint "Fraunhofer Project Centre for Composites Research @ Western" German and Canadian researchers will work togetherto develop processes and materials for the transportation, construction, and renewable energy sectors.

Lightweight construction is a globally significant research field. Fiber composites are finding increasing application, particularly in the automotive sector, as these composites offer not only a low density but also the possibility of integrated functions. Over the past few years Fraunhofer ICT in Pfinztal has carried out extensive process and material research and development work for the lightweight sector. The University of Western Ontario is well known for its scientific excellence in the field of surface technologies and material sciences.

The main focus of research at the "Fraunhofer Project Centre for Composites Research @ Western" will be fiber composites for lightweight construction in various markets. Work will be oriented particularly towards the regional North American market. The Fraunhofer Project Centre will be equipped with a latest state-of-the-art hydraulic press with a maximum clamping force of 2,500 tons suitable for research on parts in full industrial scale. Material and process research will be carried out in the technologies Direct – Sheet Moulding Compound, Long Fiber Reinforced Thermoplastics and High Pressure Resin Transfer Moulding for a sustainable use of the lightweight potential of these high-volume composite technologies in the automotive industry, machines and equipment industry and aviation industry. Equipped with this full industrial-scale processing equipment and as a part of the University of Western Ontario the Fraunhofer Project Centre offers possibilities for collaboration in bilateral projects up to multilateral publicly-funded research projects. The joint Project Centre will be run for an initial period of five years.

The University of Western Ontario in London.
*© University of Western Ontario*

The new Center is located in Santiago de Chile.
© *Fraunhofer*

# *Systems Biotechnology in Chile*

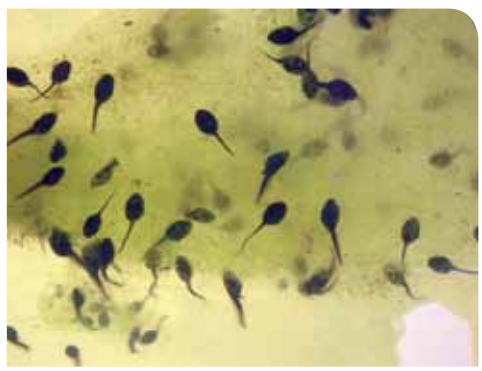
On September 1, 2011 the Chilean Minister of the Economy, Pablo Longueira and Professor Bullinger officially opened Fraunhofer´s first research center in South America. The new ´Fraunhofer Center for Systems Biotechnology´ has been established in Santiago de Chile to develop and optimize new technologies in key areas of importance for the Chilean economy. The research projects are collaborations between Chilean and German scientists and focus at present on aquaculture, renewable energy, agriculture, and bio-computing.

The Fraunhofer Center for Systems Biotechnology is the first research center to be launched by the Fraunhofer Chile Research Foundation which was established on October 4, 2010. The research carried out at the new center will benefit from and make a long-lasting contribution to Chile's pioneering spirit and economic strength, with its the strong emphasis on the traditional economy based upon raw materials, agriculture, aquaculture and the sustainable use of natural resources. Systems biotechnology is an emerging field in life sciences that aims to develop an understanding of the complex and dynamic processes in cells, organisms and ecosystems analyzed at the systems level. This is achieved by creating computer models and mathematical simulations, which can then be applied to real life problems encountered in the relevant industries. The German partner in these projects is the Fraunhofer Institute for Molecular Biology and Applied Ecology IME.

There are lots of applications. The Chilean aquaculture industry suffered dramatic losses during the ISA crisis. The research projects are aimed at avoiding a similar situation in the future. Scientists at the IME, Fraunhofer Chile researchers and partners at Fundación Chile will generate new and more rapid methods for early detection of fish diseases. New vaccines can then be generated against these diseases and major disease outbreaks avoided. Computational biology is being used to drive the innovation process and integrate the various data sets being developed with genomic scale technologies.

The Fraunhofer Division of Nanotechnology at Talca University uses advanced computer modeling to identify ´intelligent polymers´ to remove unwanted small molecules from wines, fruit juices or water. Computer simulations have so far identified key structural features in these polymers which interact with major contaminants in the local water supply. In addition, scientists have developed novel computer-based methods to analyze the molecular interactions seen in these computer simulations. A newly installed Mass Spectroscopy facility, the only one of its kind in Chile, will greatly facilitate in-house-analysis but will also provide analytical services to outside clients. The applications for water purification are being targeted for application research.

The group working on renewable energy and resources at the Pontificia Universidad Católica de Valparaíso is focusing on strategies for carbon sequestration. New strains of microalgae can be adapted or manipulated to provide maximal carbon capture capacity in an industrial setting and simultaneously these organisms are being used to produce high-value products which can be used in the food industry as additives or as neutraceuticals. Scientists have begun work with a local renewable energy company to transfer their know-how into a pilot plant setting. At the same time, local strains of Jatropha will be improved for biodiesel production. An additional project deals with the production of Russian Dandelion which is used for natural rubber and insulin production.



The reserachers will not only study biological systems but also renewable resources.
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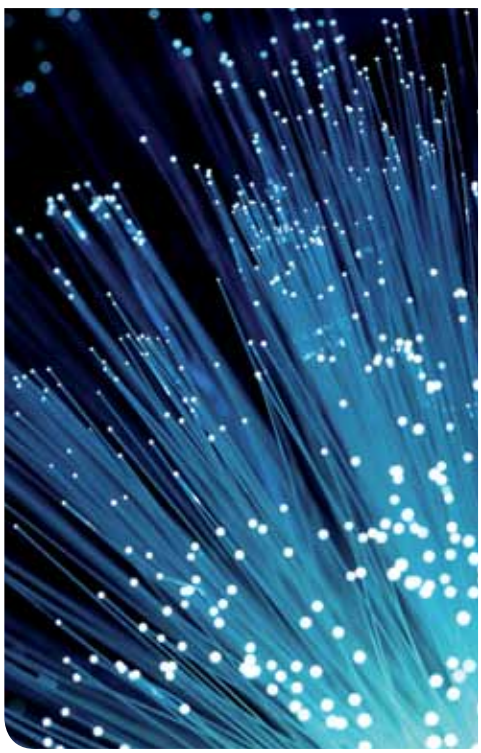
# German-Japanese anniversary

Germany and Japan have been closely linked in many ways, eversince the Prussian delegate Friedrich zu Eulenburg landed in Japan 150 years ago. He and the Japanese emperor signed a trade- and a friendship agreement which last until today. The Fraunhofer-Gesellschaft also celebrated the tenth anniversary of its representative office in Tokyo. It was an important step to get set in Japan, because for Fraunhofer it provides the biggest market in Asia. "Many technological enterprises are based in Japan and we can often offer them new developments and know-how for production", explains Dr. Lorenz Granrath, heading the Fraunhofer Representative Office Japan. Nearly all of the German institutes are strongly linked with Japanese companies and so it was just a matter of time until the first Fraunhofer Project Center opened on the island in November. The basis for the center was a research group of German and Japanese scientists, led by Professor Thomas Gessner from the Fraunhofer Institute for Electronic Nano Systems ENAS in Chemnitz. Since 2008 the team has been working on metallic glasses and nanoporous metals at Tohoku University.

To emphasize the meaning of this strong connection between the two countries Fraunhofer President Professor Hans-Jörg Bullinger traveled through Japan and was also present at the opening of the project group in Sendai. In Tokyo he inaugurated a conference which five Fraunhofer Institutes took part in: "Green technology made in Germany – Efficient use of energy and resources". How to save energy while maintaining their standard of living is an important topic in Japan and the German researchers presented possibilities to reach that goal.



Happy birthday – 150 years ago the basis for the German-Japanese friendship was established. © *istockphoto*

At the Fraunhofer annual convention the Chinese Minister Wan Gang stressed the common goals of all the countries in the world. © *Fraunhofer*


# Connecting China

The importance of the long-term relationship between Fraunhofer and China was emphasized by the visit of the Chinese Minister of Science and Technology. Fraunhofer president Prof. Hans-Jörg Bullinger had invited him to join the Fraunhofer annual convention 2011 in Nuremberg. Minister Wan Gang had worked many years for Audi in Ingolstadt before he returned to China. In his speech he pointed out that all countries have to deal with the same big challenges regarding climate, energy, health and environment. "Only if we make joint efforts, we can solve worldwide problems". Wan Gang indicated the strong connection between the two countries by highlighting the joint projects that he and his German colleague, Federal Minister of Education and Research Annette Schavan, had been advancing together.

Fraunhofer has established close ties with China already. Prof. Bullinger has been an international consultant in the Chinese province Guangdong since 2003. He advises the governor Huang Huahua on research policy. In June 2011, the Party Secretary of Guangdong was welcomed in Munich and came to hear about the Fraunhofer model. In November Professor Bullinger went to Guangdong for a return visit, to participate in the international consultant conference.

# Austria's most efficient factory

Success, speed, efficiency – these qualities were the crucial criteria in the competition "Fabrik 2011". For the second time Fraunhofer Austria and the "Industriemagazin" offered a prize for the most efficient plant in Austria. A Fraunhofer jury of five production experts evaluated 21 factories. The participants had to cope with questionnaires, site surveys and presentations before the first-place-winner was announced: Trumpf Maschinen Austria. "We wanted to know how good we really are," explains Armin Rau, the technical chief of Trumpf Maschinen Austria, as his motives to enter that contest. The factory convinced the jury with its consistent and successful strategy and its strong focus on lean management.The jury states: "The innovation power of the factory is enormous." Close behind in second place came Opel Wien GmbH.

The first prize in the category of medium-sized business, with less than 5000 employees, went to the austriamicrosystems AG, a producer of analog microchips.

Winner of the 2011 competition: Alfred Hutterer, head of Austria for Trumpf Maschinen. © *Helene Waldner*

Walter Mente, manager of austriamikrosystems AG, which won the competition for smaller businesses. © *Helene Waldner*

# New test facility in the US

A unique testing laboratory for solar modules has been located in Albuquerque, New Mexico. The Photovoltaic certification test company CFV is jointly owned by CSA Group, the Fraunhofer Institute for Solar Energy Systems ISE, the Fraunhofer USA Center for Sustainable Energy Systems CSE, and VDE Testing and Certification Institute.

The facility, which is now starting operations, is located within the Mesa del Sol development of Albuquerque close to the airport, Sandia National Labs, the University of New Mexico, and other major players in the PV supply chain. "The decision to place this new solar testing facility in New Mexico puts us in the epicenter of the PV installation market in the U.S." said Randall W. Luecke, President of CSA International.

In addition to the CFV Solar Test Laboratory, Fraunhofer CSE and Fraunhofer ISE will operate an R&D facility at Mesa del Sol, focusing on long-term reliability, decreased cost and increased performance of PV modules. The new location was chosen by CFV Solar Test Laboratory after a thorough evaluation process. "The top officials of the State of New Mexico, Bernalillo County, and the City of Albuquerque are very committed to developing the solar industry in their region, and have given us the necessary support to make this project possible," says Nolan Browne, Managing Director of Fraunhofer CSE. "I also want to recognize the invaluable assistance we received from U.S. Senator Jeff Bingaman and Albuquerque Economic Development, whose interest and support for the project have helped us make this decision."


## Editorial notes

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