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RESEARCH NEWS

06 | 2014 ||

1 Implanted infection prevention

Hospital germs can be fatal, since they are resistant to antibiotics. As a result, alternative methods of defense against bacteria are in demand. Fortunately, a German-French research team has been able to develop bone implants that keep the germs at bay.

2 The fuel cell for home

It converts chemical energy directly into electrical energy. Still, there hadn't been a market breakthrough for the fuel cell. The systems were too complex. Now, Fraunhofer and Vaillant have developed a simple device for home use.

3 Always well ventilated

The inhabitants of Central Europe spend about 80 percent of their lifetime in buildings. With elaborate ventilation systems, researchers have provided a pleasant climate in homes and offices.

4 Efficient thermal cooling and heating

Thermal systems use heat to produce cold, and vice versa. To do so, a material is needed that can dissipate water vapor particularly well and quickly. A new method simply applies this property as a layer onto the components.

5 Safe harbor

One of the most important means of connecting with foreign countries is by sea, especially for the transport of freight. Researchers are assessing harbor safety using simulations in order to help provide smooth and efficient navigation.

6 Solar modules embedded in glass

Organic solar modules have advantages over silicon solar cells. However, one critical problem is their shorter operating life. Researchers are working on a promising solution: they are using flexible glass as a carrier substrate that better protects the components.

7 Collisions with Robots – without Risk of Injury

Teamwork between humans and robots will be the motto of the future. But robots may not injure humans at all. When does contact cause an injury, though? Researchers are exploring this for the first time in a study.

8 Newsflash

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 67 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 23,000, who work with an annual research budget totaling 2 billion euros. Of this sum, more than 1.7 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

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Implanted infection prevention

The figures are alarming: Hundreds of thousands of patients in German hospitals are infected annually with germs that are resistant to all common antibiotics. As a result, wounds remain open and inflammations spread, weakening the organism and sometimes even leading to death. Pharmaceutically, it's hard to get a handle on the problem: The development of new antibiotics is expensive, time-consuming and tedious. When the drug is finally on the market, it's not long until the germs mutate and form new resistance.

Moreover, if surgeons use bone implants, it may happen that germs invade the body. Infections of the bones are especially problematic because they can be difficult to treat – antibiotics, which are transported by the blood throughout the body, only reach the implants in very low concentrations. "It would be best to avoid infection from the outset by providing the implants with an antimicrobial shield," says Dr. Iris Trick, a microbiologist at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart. Along with materials scientists at the French CIRIMAT Carnot Institute in Toulouse, the Fraunhofer team has developed a bone substitute with integrated protection against infection.

No chance for bacteria

At first glance, the fine-grained implant looks like flour. Only under the microscope can one see what is inside: The individual grains of the granules consist of apatite crystals. These are similar in composition and structure to natural bone material, which is formed of the same chemical elements – calcium and phosphorus. The granules make it an ideal material for implants. To prevent complications, some manufacturers coat their bone substitute material with antibiotics. It's not one hundred percent protection, of course, because resistant bacteria can still spread.

The interdisciplinary research group took a different path. The aim was to use natural materials to reduce, suppress or kill bacteria on calcium phosphate crystals. In the project "Biocapabili" – short for "Biomimetic Calcium Phosphate Anti-bacterial Bone Implants for Local-infection Inhibition" – the international team has worked with various substances and compounds: with silver, copper and zinc ions, for example, but also with enzymes and peptides which kill bacteria. The French researchers have managed to incorporate metal ions into the apatite crystals. The biologists in Stuttgart have been able to provide evidence that the finished powder actually protects against infection: In the IGB laboratory, Iris Trick put the samples on microtiter plates in mutually insulated cups, infected them with bacteria, and then allowed the bacteria to grow for several days. Among them were several Staphylococcus species, which are among the most common hospital germs. The result: In the immediate vicinity of the apatite, the number of bacteria was reduced by more than 90 percent.

A peptide coating has turned out to be equally effective: "With the help of peptides, apatite granules and pellets are protected against bacteria," says Dr. Michaela Müller, who applies the coatings at the IGB. The hardness test in the microbiological testing has already been passed: The dangerous bacteria could not multiply on the surface of the pellets and granules. This means that antibacterial bone implants can be produced with the peptide coating.

"However, antibacterial activity alone is not everything in medicine," says Dr. Anke Burger-Kentischer, group manager of Molecular Cell Technology at the IGB. "Before a product can be used in practice, it has to be ensured that it does not harm the patient." The researchers have already taken the first step. Human cell cultures have been added to the implant samples on microtiter plates. "Using these cytotoxicity assays, we have been able to determine how many metal ions, enzymes or peptides in the granules could be tolerated by the cells," summarizes Burger-Kentischer. The clinical studies, which are the next step, will be conducted by the German-French research team in collaboration with the industry.

Whether and how strongly antimicrobial substances have an impact has been examined by the researchers in a screening. In this process, the bone substitute material is combined with various types of bacteria. (© Fraunhofer IGB) | Picture in color and printing quality: www.fraunhofer.de/press

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The fuel cell for home

„One always speaks of a fuel cell system," says Dr. Matthias Jahn from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden. A single cell doesn't produce enough voltage to obtain a sufficient electrical power. In a fuel cell stack, several cells are connected one to the other. Each of them is about the size of a CD. We call the groups ‚stacks'," says Jahn. Fuel cells convert natural gas directly into electrical energy. They are many times more efficient than are combustion engines, such as the car engine. These require an intermediate step. First, they convert chemical energy into thermal energy (heat) and mechanical energy (force). With this force, they drive a generator, which only then generates the electric power. In the process, a large portion of the originally available energy is lost.

Real-life test in private households

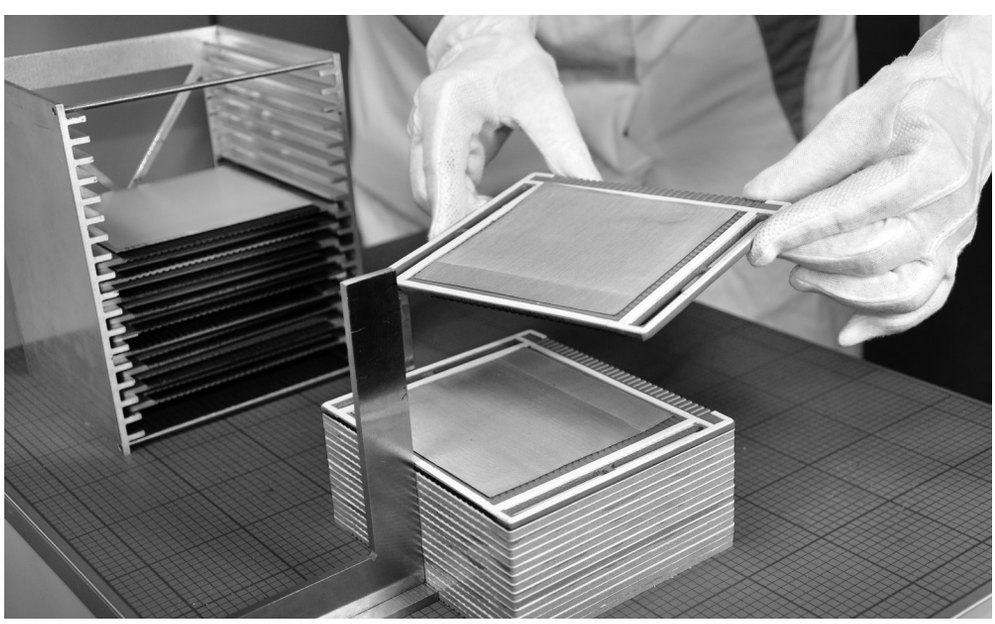
Together with the heater manufacturer Vaillant, the IKTS has developed a compact, safe and sturdy fuel cell system that generates electricity and heat in private households from natural gas. The researchers were particularly responsible for the construction of the prototype, the design of the overall system, the design of the ceramic components and the development of the reformer and the afterburner. The devices are currently being tested in private households in the Callux practice test (www.callux.net).

They are as compact as classical gas heaters that only produce heat. Moreover, they can comfortably be mounted on the wall and easily be maintained. With an output of one kilowatt, they cover the average current consumption for a four-person household. The Federal Ministry of Transport and digital infrastructure BMVI is promoting Callux. Currently, in the European demonstration project ene.field (www.enefield.eu), about 150 further units are being installed in several European countries. In addition, Vaillant started the production of a small-scale series in early 2014. Parallel to the practical test, the two partners are already working on new models. „Now, it's all about decreasing production costs and increasing the lifetime of the equipment," says Jahn.

The principle of the fuel cell has been known for over 175 years. So far, however, there has not been a market breakthrough. The main reason was the invention of the electric generator. It knocked the more complex fuel cell out of the running. Only in the 1960s was the technology put into practice by NASA in some Apollo moon missions. In the late 1990s, there were other projects in the automotive industry, which have so far not been able to prevail. The reasons are that the fuel cell is too complex, too expensive, and too unreliable. „In our project with Vaillant, we have made great strides to bring the technology close to the market. Vaillant is already producing a small-scale series, which is sold in funded projects to customers," says Jahn. „For the market breakthrough, the costs still have to be decreased significantly."

The miniature power station for home use is based on a solid fuel cell (SOFC). SOFCs operate at a much higher temperature in comparison to competing approaches, such as the proton exchange membrane fuel cell (PEMFC), which is used in cars, for example. While PEMFCs only reach 80 degrees, SOFCs can reach up to 850 degrees. „This allows the SOFCs to be built much more simply and cheaply," says Jahn.

The electrolyte of an SOFC only transfers oxygen ions, not electrons. Otherwise, there would be a short circuit. „Ceramic is particularly well suited as a material for the electrolyte. It has the desired conductivity and can also endure high temperatures," says Jahn. As a result, even without the use of precious metals, all reactions proceed smoothly, which is necessary for the direct conversion of chemical energy into electrical energy: If the fuel cell heater is connected to the gas network, a reformer initially converts the natural gas into a hydrogen-rich gas. This then reacts in the stack with the oxygen of the air in a noiseless „cold combustion", producing power and heat.



Production of the cell stacks at the Fraunhofer IKTS. (© Fraunhofer IKTS) | Picture in color and printing quality: www.fraunhofer.de/press

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Always well ventilated

Unpleasant odors, stuffy air or permanent drafts: A person who is regularly exposed at home or in the office to bad air doesn't feel well. Odors from carpets, paints, varnishes and furniture, as well as mold, or air which is too dry, affect the indoor climate. "There are no materials without emissions and odors," explains Dr. Andrea Burdack-Freitag, sensory expert at the Fraunhofer Institute for Building Physics IBP in Valley near Holzkirchen, Germany. "Not all substances that are emitted into the air are harmful. However, sometimes we suffer from watery eyes, sore throat or headache." A trigger for such unpleasant consequences can be dry air or volatile organic compounds: VOCs for short (Volatile Organic Compounds), such as formaldehyde. VOCs are present in almost every component, such as in the form of solvents. "If complaints occur or if there is a continually unpleasant odor, we analyze the emissions that affect the air quality and we look for the cause," explains the researcher. To do so, she and her colleagues from the Chemistry and Sensor Technology Group employ sensors and measuring devices which have been specially conceived for air quality measurement.

New Indoor Air Test Center under construction

How is pollution through VOCs or CO2 distributed in a room? What are the flow conditions and how is the ventilation? Based on their investigations, the scientists develop ingenious ventilation systems together with industry partners. Later this year, the IBP researchers want to open the new Indoor Air Test Center. "There, we can purposefully pollute the air with biological and chemical substances as well as with particles of different sizes and shapes, produce temperatures of up to 80 degrees Celsius, increase the humidity to a maximum of 95 percent and regulate the air volume flows precisely. With the high-tech equipment, we want to test new filter technologies. We also construct complete office or home furnishings and then perform VOC investigations. We're also having the walls, floor and ceiling of the test rooms made of emission-free materials," explains Thomas Kirmayr, Manager of the Climate Systems Group.

In the new laboratories, the scientists also want to work on innovative air ducts for special spaces, such as operating theaters. The new ducts should prevent, for example, that germs enter with the rising air in the operation area during surgery. In the Test Center, there is space for vehicles. As a result, the experts can also check the air quality in cars. These tests are necessary because there are a number of new composite materials in the vehicle models.

In what ways can it now be determined how good the indoor air is, or to what degree it has been consumed? "Until now, only a high concentration of CO2 could be an indicator of poor air quality. This value is measured by sensors, which report it to the ventilation system. We go one step further and investigate other parameters at the

same time. In doing so, we use sensors to record the carbon dioxide, nitrogen oxide and ozone levels. We also rely on metal-oxide semiconductors that respond to food, drinks and human scents," describes Burdack-Freitag. On the basis of various measurement data, a ventilation control can respond more accurately than before, such as to stuffy air during meetings.

Which ventilation should be used in which building is one of the key issues during the planning phase of a new building. "In this process, it's important to keep in mind that air exchange rate and ventilation efficiency are two different parameters. The rate describes the air volume that flows into the room in one hour. If fresh air doesn't move through the room, but instead right back out through the window nearby, an effective exchange doesn't take place," explains Thomas Kirmayr, adding: "It has to be ensured in the planning that the air is actually exchanged. High resolution virtual models help to test these scenarios on the computer first. In this way, subsequent and costly building conversion can be avoided. For the forecast, we at the IBP have developed the three-dimensional zone model VEPZO, with which room and ventilation planning can be assessed and resolved locally through visual representation."

The software can also be used for existing buildings. Based on the simulations, business people can then decide whether it is worth investing in a new or better ventilation system. The researchers at the IBP are also working on flexible systems that adapt to demands and recognize, for example, when some participants in a long meeting need fresh air. "One idea is to vary the air conditions of a room slightly, because people usually find that to be more enjoyable," says Kirmayr.

In the HiPIE laboratory (High Performance Indoor Environment), structural-physical parameters, such as acoustics, indoor climate and lighting, can be selectively influenced in order to explore their effect on people. (© Fraunhofer IBP) | Picture in color and printing quality: www.fraunhofer.de/press

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Efficient thermal cooling and heating

Refrigerators have the human body as an example: When we perspire, water evaporates on our skin and cools it. The lower the atmospheric pressure, the easier this is. If the process is transferred to a vacuum, water already evaporates at a few millibar and a temperature of 10 degrees. So that the devices continuously cool, the vapor must be removed. This is achieved, for example, by an electric compressor, just as the water vapor in our refrigerators is removed from the gas phase and then re-liquefied. An alternative is the thermal compressor, a porous material that can absorb water vapor. In this variant, the operating power is not electrical, but thermal. Heat pumps or chillers operated in this manner produce cold from heat, and vice versa. So far, however, these have not been able to prevail entirely over their electricity-powered counterparts; their power density is too low. What is lacking are materials and components that are capable of sufficiently discharging the water vapor in a shorter time.

Materials must absorb water vapor

Researchers at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg have now closed this gap. Their metal organic frameworks (MOFs) are particularly well suited to absorb water vapor. In this process, a metallic cluster and organic linkers together form a three-dimensional porous structure. "MOFs can be put together arbitrarily like Lego bricks and outperform every previously known class of material in terms of flexibility. The materials are porous and have interior surfaces which can add up to 4,000 square meters per gram. This is sufficient space for the water vapor to be able to adsorb and accumulate," explains Dr. Stefan Henninger, Head of the Sorption Materials Group at the ISE.

Together with his colleagues, the researcher has investigated a large number of MOFs and identified those which are particularly stable with respect to water vapor. Instead of the previous 0.4, these can absorb up to 1.4 grams of water per gram of material. So far, MOFs are usually only available as a powder and can therefore be difficult to incorporate into the relevant device structures, such as heat exchangers. Prior art has been loose granules. This has the disadvantage, though, that only selective contact exists between the adsorbent material and the component. As a result, the material or heat transfer is limited. It is better to apply the MOFs as a layer, in order to achieve the greatest possible surface.

The researchers have accomplished this. Their layers can be directly applied without further auxiliary layers being necessary in between. Moreover, the resulting products reach the cooling and heating thicknesses of 50 to 150 micrometers, which are relevant for cooling and heating. In the prototype form, the MOFs are directly crystallized onto metals. For other materials, such as ceramics, the scientists have accomplished this with binder-based coatings. In both methods, the components of the device are simply

immersed in a fluid containing all the essential components of the material. The temperature needed for the direct crystallization therefore occurs only on the surface of the component. As a result, only minimal waste is produced. "The MOF layer grows directly on the component at a rate of up to 50 micrometers per hour. This is significantly faster than before," says Henninger. The researchers have so far coated components of up to 15 x 40 centimeters with the new procedure.

The technology is not limited to cooling and heating equipment. "Due to the enormous flexibility of MOFs and our manufacturing process, a variety of applications is possible. We can apply the desired structure quickly to almost any component. In principle, our technology could be beneficial for every process in which material or heat transfer plays a role," says Henninger. For example, in the chemical industry, where gases are separated and heating is thereby created or needed. Or in medical technology, where properly coated surgical instruments reduce the bacterial load. The technology can even be of use in everyday life: by eliminating the unattractive water stains on plastic plates and cups, etc. in our dishwashers.

Fraunhofer has concentrated its activities in MOF research in the internal project MOF2market: http://www.mof2market.fraunhofer.de/de/projekt.html

For thermal processes, a surface is required in order to have enough space for the accumulation of water or water vapor – as here with an MOF-coated heat exchanger. (© Fraunhofer ISE) | Picture in color and printing quality: www.fraunhofer.de/press

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Safe harbor

Most imported goods reach us by sea – and the traffic volumes in German ports will be expanding over the coming years. Forecasts indicate that the trade volumes will rise from about 269 millions tons at present to around 468 million tons by 2030. Port operators are faced with the challenge of providing safe and efficient harbor traffic. How should harbor basins or shipping channels be arranged so that large ships can safely navigate the waters also? What must be taken into account in event of adverse weather or complicated traffic situations? How can unnecessary time spent in port be avoided?

Answers to these kinds of questions are being provided by researchers of the Fraunhofer Center for Maritime Logistics and Services CML, an institution which is part of the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund, Germany. The experts in Hamburg simulate realistic scenarios in real time and assess the nautical safety based on the results.

Each of the simulated ships is closely matched to its original shipyard specifications and modeled hydrodynamically using the science of streaming fluids. CML is providing strategic support services during harbor reconstruction, expansion, and new construction.

Simulations with real data

As a first step, the researchers carefully examine the actual conditions in the surroundings – the harbor layout, the approaches, and data on currents, for example – in other words, significant movements of water at the site. The researchers carry out a preliminary assessment based on this information that enables identification of possible critical points. "An approach perpendicular to the direction of the main current is unfavorable, for example. In such a case, we look for alternatives right at the beginning," explains Hans-Christoph Burmeister, project manager at CML. The harbor environment is then digitally displayed in the simulation in keeping with the actual key features.

In addition, the researchers create a 3D model of a reference ship as well as a hydrodynamic computer model. "This consists of various hydrodynamic coefficients that permit the ship's track to be determined from the force of the propeller or bow thrusters. That is important in order to realistically re-create the turning or stopping behavior of the individual ship," explains Burmeister. Finally, realistic scenarios must be worked out for the simulation. Standard situations can be represented just as extreme conditions can be. The set up and running of the simulation can be presented just like flight simulators.

The core is the simulator that the trained maritime personnel use to drive the ship. Actual instruments are utilized just like on a genuine ship's bridge, with radar displays as well as an electronic chart system available. Three monitors provide a 120-degree view of the virtual harbor environment. Piloting commands are incorporated into the computational model in real time.

From these results, predictions can be made for the wind and tidal conditions under which the reference ship can safely enter the harbor, for example, as well as which approach is best. "In some cases, we have attained significantly longer reaction times by modifying the approaches – this means ships can still make port even under poor weather conditions," according to Burmeister. Tug maneuvering can also be simulated to determine the minimum number of tugs required to safely bring a ship to its berth, for instance. "The results nevertheless apply for just one specific situation – if even one parameter is changed, it can lead to a different assessment," Burmeister points out. For instance, a fully loaded ship maneuvers differently from one which is carrying only half a load. This must be taken into account in the hydrodynamic model. There is no such thing as a standard test run. The data are adjusted for the specifics of the situation in consultation with customers – these are port authorities, terminal operators, or maritime engineering firms as a rule.

Smooth as the simulation; Fraunhofer CML in Hamburg offers comprehensive services for safe harbor. (© Fraunhofer IML) | Picture in color and printing quality: www.fraunhofer.de/press

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Solar modules embedded in glass

This approach is already being employed in electronic devices to some extent today: organic photovoltaics (OPVs) are embedded in film. These OPVs are a promising alternative to silicon-based solar cells. The materials can also be processed at atmospheric pressure. However, the main advantage is the modules can be manufactured using printing technology – this is faster and more efficient that the involved processes necessary for fabrication of inorganic components. A flexible type of substrate material is necessary for fabrication that uses a printing process. Polymer films that have certain serious disadvantages have been employed up to now. The films are somewhat permeable to humidity and oxygen. Both of these attack the sensitive solar modules and significantly reduce their operating life. Up to now, substrates with barrier layers have protected the OPV modules, depending on the application. For higher processing temperatures and longer operating life, different carrier substrates must be used.

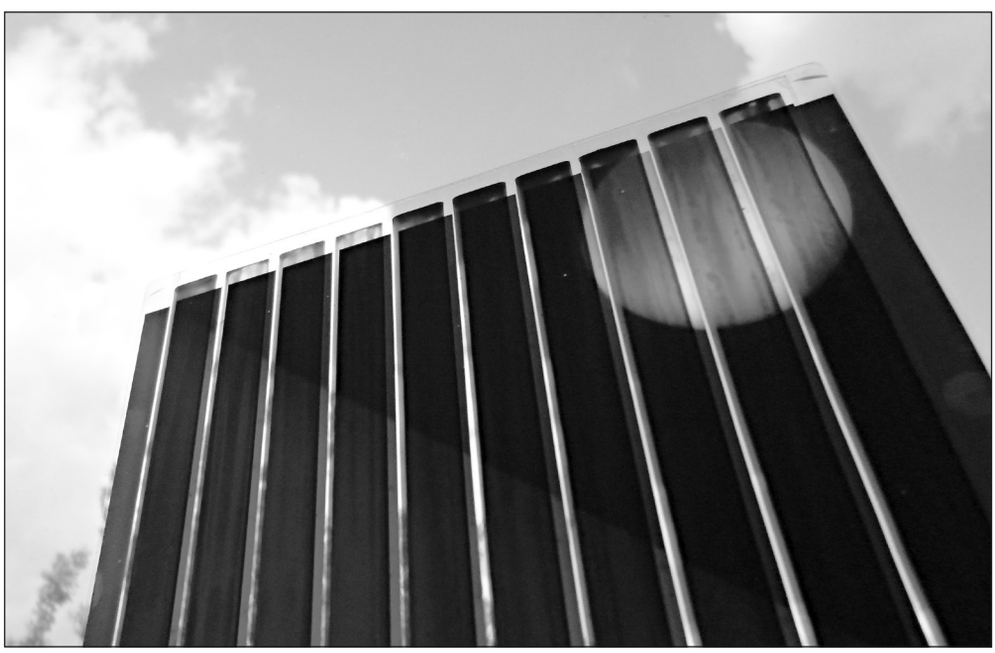
Fracture-resistant and extremely strong

Researchers of the Fraunhofer Institute for Applied Polymer Research IAP in Potsdam, Germany, are working with a new carrier material at present. They are embedding the solar modules in a thin layer of glass. "Glass is not only the ideal encapsulating material, it also tolerates process temperatures of up to 400 degrees," explains Danny Krautz, project manager in the Functional Materials and Components research section at IAP. A specialized glass from Corning Inc. is being employed in the research work. Thanks to its special physical properties, layers can be made that are only 100 micrometers thick. That corresponds roughly to the thickness of a sheet of paper and has nothing to do with the type used to make drinking glasses. The special glass is not only fracture-resistant and extremely strong, it is so flexible that it can be gently bowed even in its solid form. The researchers in Potsdam in cooperation with their partner Corning have already created the first working OPVs with this material by processing stacks sheet-by-sheet.

Production on rolls

The goal is to fabricate these modules in rolls as well. The carrier substrate will be wound on a roll in this case, similar to how newspapers are printed. An empty roll is positioned opposite it. The photoactive layers and electrodes are printed in several steps between the two rolls. Large surfaces can be manufactured effectively in series using this fabrication technology. The team from IAP has already begun a first test of how the flexible glass could be processed in this way. "We were immediately successful on our first run in producing homogenous layers on smaller substrate dimensions," according to the scientist. The technology needs to be modified at many points for the process to meet the demands of industrial applications – and the Potsdam team is already working on these. Long-lived, robust, high-performance OPVs can be fabricated

with this technology for use in a wide range of applications – from tiny solar cells in mobile phones to large-scale photovoltaic modules.



Organic photovoltaics printed on ultra-thin glass. (© Fraunhofer IAP) | Picture in color and printing quality: www.fraunhofer.de/press

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Collisions with Robots – without Risk of Injury

Everybody has experienced this: You aren't careful for just one moment and suddenly you run into the edge of a table. At first, it hurts. A little later, a bruise starts to appear. What falls into the category of "nothing bad, but aggravating" in the case of a table, takes on a new dimension when the colliding partner is a robot, because such a collision can injure humans seriously. That is why these mechanical assistants usually still work behind protective barriers. Since some applications require humans and robots to work hand-in-hand, though, their cooperation has become one of the foci of robotics research worldwide. Where exactly does the threshold between harmless contact and an injury lie, though?

Minor Impacts, Major Findings

How much force does it take for an impact to leave a bruise on different body parts? When do humans suffer permanent injuries? Nobody has been able to say precisely. There are no extensive studies on the subject. Collision geometry, i.e. the geometry of the colliding objects, also has great influence on the severity of injuries from a collision. Researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg are exploring wholly uncharted terrain with a new study: They are systematically studying the thresholds of biomechanical loads resulting from collisions between robots and humans.

The researchers' approach: They load a pendulum with different weights, pull it back and allow it to hit against different body parts of the participants of the study. A special sensor film on the pendulum's impact face measures the pressure distribution upon impact. A force sensor, also located on the impact face, measures the characteristics of the contact force, the maximum force applied and the action time. "This enables us to measure every relevant parameter such as force, pressure distribution, impact velocity, momentum and energy," says Dr. Norbert Elkmann, business unit manager at the Fraunhofer IFF.

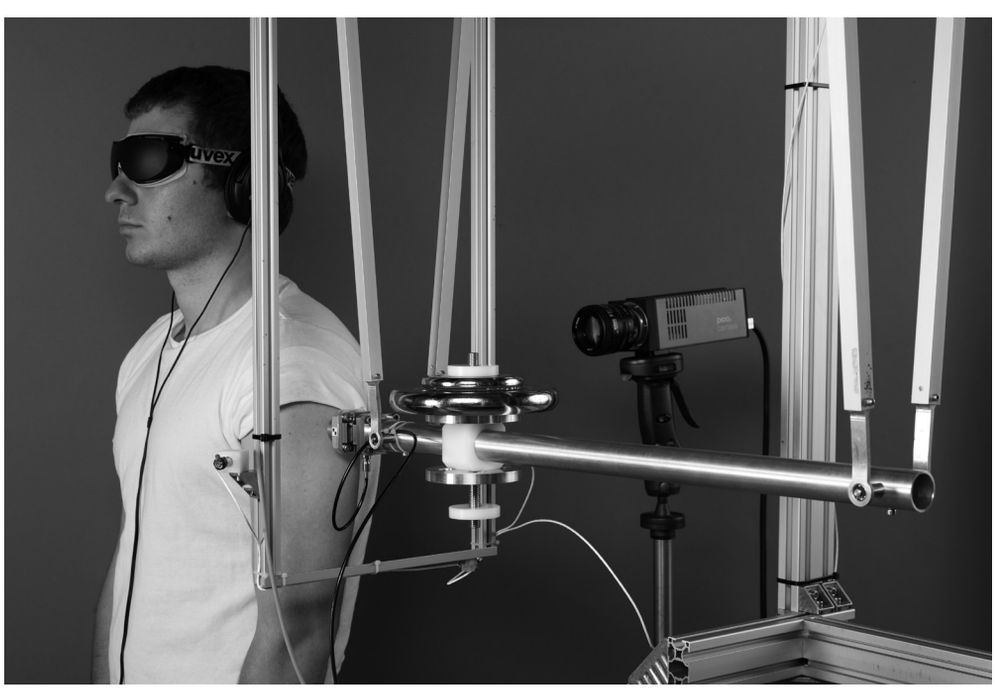
On the medical side, the study is being supported by the Department of Forensic Medicine, the Dermatology Clinic, the Trauma Surgery Clinic and the Department of Neuroradiology of Otto von Guericke University Hospital Magdeburg. The Otto von Guericke University Ethics Commission has given the study its approval. Test discontinuation criteria are incipient swelling or bruising or when subjects reach their pain threshold.

In the pilot phase, the researchers first developed the measurement system and refined the methodology – together with medical professionals. They are now producing the first findings with several subjects in a preliminary stage. Afterward, the researchers will decide how many participants will be needed in the study to obtain representative

results. The researchers from the Fraunhofer IFF will present their initial findings at the International Conference on Robotics and Automation ICRA in Hong Kong in June of 2014.

Their findings will also benefit criminal investigative agencies and medical examiners: Whenever victims of violent crimes come to officials or physicians and their subdermal hematomas are hard to see, the intensity of the trauma can hardly be determined. Victims as well as physicians would be helped greatly if medical examiners were able to fall back on pertinent studies.

The study will also have a value for the consumer sector: After all, robots are now commonplace in many households. They vacuum, mop the floor or mow the lawn. Robots will likely take over even many more jobs in households in the future but only if humans are safely protected against injuries from collisions with them. The Fraunhofer IFF is obtaining fundamental data in its study, the results of which will be incorporated in international standards.



Subjects during the study of biomechanical load thresholds. (© Fraunhofer IFF) | Picture in color and printing quality: www.fraunhofer.de/press

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More security for passports

"Passport inspection" the announcement booms out as you drift in to your local airport all tan from your vacation. Your passport establishes your identity; however, there are also many counterfeits in circulation. Researchers at the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt, Germany, are developing solutions and new designs to better protect these documents from counterfeiters and swindlers through the EU Project named FIDELITY (http://www.fidelity-project.eu/). Birth certificates play an important in the research. Anyone wanting a new passport must present this – at least the first time. But there are 10,000 different types of birth certificates in the 50 US states alone. The situation does not look much better in Europe. How is an official supposed to recognize whether a document is genuine or not? Once the authorities have issued the passport the first time, it is valid – even if it should be established later that the birth certificate was falsified. To increase the security of birth certificates, the researchers are integrating a barcode for example, just like ones you see on packaging in supermarkets. If an official wants to check the authenticity of the document, the barcode can be read using a computer and the information stored in it compared with that on the paper document. In a further advance, the scientists are improving all of the steps of the passport application process.

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Hydrogen storage for renewable energy

If the proportion of renewable energy increases, it also means increased dependency on the weather. Sometimes the wind blows strongly and the sun shines, and sometimes not. Nevertheless, the power grid in Germany is supposed to constantly provide industry and households with stable and sufficient electricity. The solution proposed by the "Hydrogen Power Storage & Solutions East Germany" Consortium (HYPOS): surplus energy from large-scale photovoltaic installations and wind farms will be used for electrolysis – eco-friendly hydrogen will be produced from hydrogen dioxide (a.k.a. water!) – with the products then stored. The hydrogen can be made available as a tailor-made alternative to natural gas at gas stations and for fuel cells. The German Federal Ministry of Education and Research (BMBF) is supporting HYPOS with 45 million EUR in funding until 2020. The innovative conversion will also involve the chemical industry in the cities of Leuna and Böhlen. Prof. Ralf Wehrspohn, head of the Fraunhofer Institute for Mechanics of Materials IWM branch of the institute in Halle, Germany, is coordinating this strategic project and is Deputy Chair of HYPOS, a registered society. IWM is providing support for industrial producers with its research in materials science. In order to store hydrogen in salt domes and distribute it through

pipelines, companies building the production facilities need to harden the materials used for the storage tanks and tubing in order to meet the new requirements. They can corrode due to mixtures of gases, for example, and become brittle due to exposure to hydrogen. Pre-existing defects that have no impact on natural gas pipeline operations often become worse when exposed to mixtures of gases containing hydrogen. The researchers intend to investigate the combined mechanical strength and corrosion resistance required using laboratory tests. IWM is working together with the Fraunhofer Center for Silicon Photovoltaics CSP on the design and development of modules and components for two combination solar/wind farms in Leuna and Böhlen that are planned to be the baseline energy source for the electrolysis.

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Sustainable production in an urban region

Urban jungle or rural paradise? Where people choose to reside is a matter of taste. Companies, by contrast, make their choice of location based on sober cost-benefit analyses. A trend toward re-urbanization can be seen over the past years. Scientists in Stuttgart, Germany, at the Fraunhofer Institute for Industrial Engineering IAO are offering interested companies surveys through which individualized solutions for successful production in urban areas are worked out. Location analyses have to move beyond purely cost-based calculations in order to depict the long-term prospects. The company really needs to be embedded in its environment in a broader economic way to create added value for all the stakeholders – the company, its employees, the cities, and the citizens. Researchers of the innovation association "Urban Production" in Stuttgart are investigating what opportunities production facilities located close to cities offer. Companies in urban areas profit from better access to a larger pool of skilled labor. Since employees have shorter commutes to work as a rule, production can be more flexible. Proximity to service providers and suppliers saves time and money. Dense industrial parks offer greater opportunity to exchange ideas and knowledge between companies. The necessity of carrying on business more sustainably due to dwindling natural resources and the world-wide trend toward urbanization represents a competitive advantage as well. However, an urban site also involves challenges, such as the need for more efficient and low-emission production for instance.

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