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# RESEARCH NEWS

07 | 2014 ||

## 1 Nano-supercapacitors for electric cars

Innovative nano-material based supercapacitors are set to bring mass market appeal a good step closer to the lukewarm public interest in Germany. This movement is currently being motivated by the advancements in the state-of-the-art of this device.

## 2 Formula calculates thickness of bombproof concrete

A new type of steel-reinforced concrete protects buildings better from bomb attacks. Researchers have developed a formula to quickly calculate the concrete's required thickness. The material will be used in the One World Trade Center at Ground Zero.

## 3 New drugs to combat asthma and the like

Science and industry are collaborating to develop future pharmaceuticals for treating chronic inflammatory diseases. The medicines will combat immunological processes that have gone wrong.

## 4 Linking television and the Internet

In the "LinkedTV" project, researchers are seamlessly connecting TV offerings with the Internet. Audiences will benefit from an informative and personalized viewing experience.

## 5 Fast building inspection from the air

Many buildings in Germany are in need of renovation. The reasons for this are often aging building structures and environmental influences. In the future, flying inspection robots will be able to accelerate and simplify inspections, thus reducing the safety risk.

## 6 Managing the data jungle

Many biology labs fight with a glut of measurement data. New software aims to make this a thing of the past: it simplifies laboratory experiment evaluation and unifies how data is saved. It even identifies measurement errors on the spot.

## 7 Telemedicine for patients with chronic liver diseases

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

## 8 Newsflash

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 67 Fraunhofer Institutes and research units at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 23,000, who work with an annual research budget totaling 2 billion euros. About 70 percent of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the Americas and Asia serve to promote international cooperation.

**Editorial Notes:**

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# Nano-supercapacitors for electric cars



Electric cars are very much welcomed in Norway and they are a common sight on the roads of the Scandinavian country – so much so that electric cars topped the list of new vehicle registrations for the second time. This poses a stark contrast to the situation in Germany, where electric vehicles claim only a small portion of the market. Of the 43 million cars on the roads in Germany, only a mere 8000 are electric powered. The main factors discouraging motorists in Germany from switching to electric vehicles are the high investments cost, their short driving ranges and the lack of charging stations. Another major obstacle en route to the mass acceptance of electric cars is the charging time involved. The minutes involved in refueling conventional cars are so many folds shorter that it makes the situation almost incomparable. However, the charging durations could be dramatically shortened with the inclusion of supercapacitors. These alternative energy storage devices are fast charging and can therefore better support the use of economical energy in electric cars. Taking traditional gasoline-powered vehicles for instance, the action of braking converts the kinetic energy into heat which is dissipated and unused. Per contra, generators on electric vehicles are able to tap into the kinetic energy by converting it into electricity for further usage. This electricity often comes in jolts and requires storage devices that can withstand high amount of energy input within a short period of time. In this example, supercapacitors with their capability in capturing and storing this converted energy in an instant fits in the picture wholly. Unlike batteries that offer limited charging/discharging rates, supercapacitors require only seconds to charge and can feed the electric power back into the air-conditioning systems, defogger, radio, etc. as required.

Rapid energy storage devices are distinguished by their energy and power density characteristics – in other words, the amount of electrical energy the device can deliver with respect to its mass and within a given period of time. Supercapacitors are known to possess high power density, whereby large amounts of electrical energy can be provided or captured within short durations, albeit at a short-coming of low energy density. The amount of energy in which supercapacitors are able to store is generally about 10% that of electrochemical batteries (when the two devices of same weight are being compared). This is precisely where the challenge lies and what the "Electro-Graph" project is attempting to address. ElectroGraph is a project supported by the EU and its consortium consists of ten partners from both research institutes and industries. One of the main tasks of this project is to develop new types of supercapacitors with significantly improved energy storage capacities. As the project is approaches its closing phase in June, the project coordinator at Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart, Carsten Glanz explained the concept and approach taken en route to its successful conclusion: "during the storage process, the electrical energy is stored as charged particles attached on the electrode material." "So to store more energy efficiently, we designed light weight electrodes with larger, usable surfaces."

**Graphene electrodes significantly improve energy efficiency**

In numerous tests, the researcher and his team investigated the nano-material graphene, whose extremely high specific surface area of up to 2,600 $m^2/g$ and high electrical conductivity practically cries out for use as an electrode material. It consists of an ultra-thin monolayer lattice made of carbon atoms. When used as an electrode material, it greatly increases the surface area with the same amount of material. From this aspect, graphene is showing its potential in replacing activated carbon – the material that has been used in commercial supercapacitors to date – which has a specific surface area between 1000 and 1800 $m^2/g$.

"The space between the electrodes is filled with a liquid electrolyte," revealed Glanz. "We use ionic liquids for this purpose. Graphene-based electrodes together with ionic liquid electrolytes present an ideal material combination where we can operate at higher voltages." "By arranging the graphene layers in a manner that there is a gap between the individual layers, the researchers were able to establish a manufacturing method that efficiently uses the intrinsic surface area available of this nano-material. This prevents the individual graphene layers from restacking into graphite, which would reduce the storage surface and consequently the amount of energy storage capacity. "Our electrodes have already surpassed commercially available one by 75 percent in terms of storage capacity," emphasizes the engineer. "I imagine that the cars of the future will have a battery connected to many capacitors spread throughout the vehicle, which will take over energy supply during high-power demand phases during acceleration for example and ramming up of the air-conditioning system. These capacitors will ease the burden on the battery and cover voltage peaks when starting the car. As a result, the size of massive batteries can be reduced."

In order to present the new technology, the ElectroGraph consortium developed a demonstrator consisting of supercapacitors installed in an automobile side-view mirror and charged by a solar cell in an energetically self-sufficient system. The demonstrator will be unveiled at the end of May during the dissemination workshop at Fraunhofer IPA.

**Researcher pointing at graphene electrode developed at Fraunhofer IPA for use in supercapacitors.**
**(© Fraunhofer IPA) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Manufacturing Engineering and Automation IPA** | Nobelstraße 12 | 70569 Stuttgart | www.ipa.fraunhofer.de
**Contact:** Dipl.-Wirt.-Ing. Carsten Glanz | Phone +49 711 970-3736 | carsten.glanz@ipa.fraunhofer.de
**Press:** Jörg-Dieter Walz | Phone +49 711 970-1667 | joerg-dieter.walz@ipa.fraunhofer.de

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# Formula calculates thickness of bombproof concrete



Earthquakes and explosions produce tremendous forces. Pressures in the immediate vicinity of a car bomb are in the range of several thousand megapascals, and even further away from the detonation itself, pressures are still in the order of several hundred kilopascals. Pressure in a bicycle tire – at about three bar – corresponds to about 300 kilopascals. "So people at a good distance from the detonation point are not so much endangered by a pressure wave – our bodies can usually cope pretty well with them – it's flying debris that poses the real danger," explains Dr. Alexander Stolz from the Safety Technology and Protective Structures department at the Fraunhofer Institute for High Speed Dynamics, Ernst Mach-Institut, EMI in Efringen-Kirchener, a German town just north of Basel. This is exactly what happens to conventional reinforced concrete when it is hit by an explosion's pressure wave: it is so brittle that individual and often large pieces are torn off and fly through the air uncontrolled.

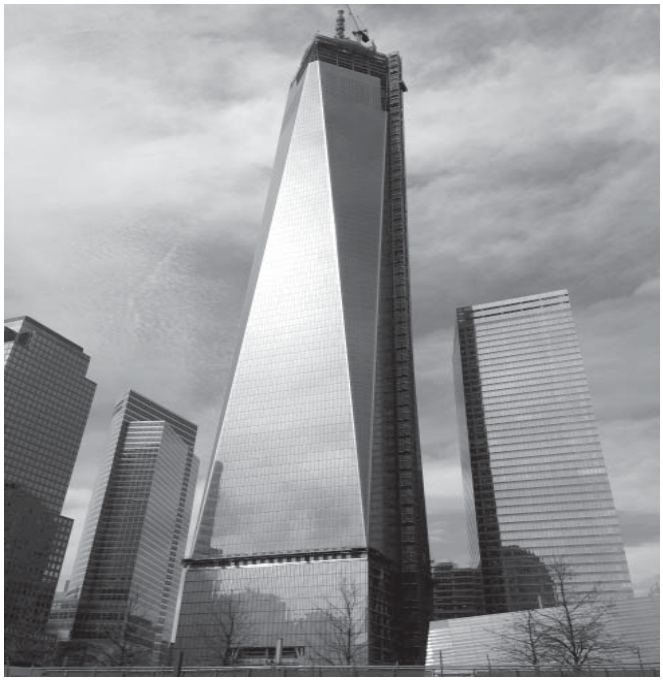
Dr. Stephan Hauser, managing director of DUCON Europe GmbH & CoKG, has developed a concrete that merely deforms when subjected to such pressures – and doesn't break. Behind the development is a special mixture made from very hard high-performance concrete, combined with finely meshed reinforced steel. The EMI has been supporting Hauser for many years in the optimization of his patented innovation. In particular, the researchers take responsibility for dynamic qualification testing of the material under extreme loads. This also involves characterizing the material and calculating characteristic curve profiles. The researchers have developed a mathematical formula that simply and quickly computes the required thickness of the new concrete for each specific application. "Calculations used to be based on comparable and historical values," says Stolz. "Now we can use a universal algorithm."

The formula was developed during a test series with the new shock tube in Efringen-Kirchen. "We can simulate detonations of different blasting forces – from 100 to 2,500 kilograms TNT at distances from 35 to 50 meters from buildings. And that's without even having to use explosives," says Stolz. The principle behind it is this: The shock tube consists of a (high-pressure) driver section and a (low-pressure) driven section, which are separated by a steel diaphragm. Air can be compressed in the driver section to a pressure of up to 30, bar, i.e. to approximately 30 times atmospheric pressure at sea level. The steel diaphragm is ruptured when the desired level of pressure is reached: the air is forced through the driven section as a uniform shock front that hits the concrete sample being tested, attached to the end of the shock tube. "With conventional concrete, the impact pressure ripped out parts of the sample concrete wall, which failed almost instantly, while the ductile and more flexible security version of the concrete merely deformed. There was no debris, and the material remained intact," says Stolz. Thanks to its ductile qualities, the security concrete is considerably less bulky and yet more stable than conventional steel-reinforced concrete. Thinner building compo-

nents are possible. "As a rule of thumb, you get the same stability with half the thickness," says Stolz.

**Formula also appropriate for earthquake and blast protection**

Designing elements with the ductile concrete is easier with the new computational formula. The material's high load capacity, many years of experience in its use in a variety of applications, and ultimately its load limits under explosive charge led to it being used in the new One World Trade Center in New York. The building rests on a 20 story, bombproof foundation that reaches 60 meters underground. Overall, at points within the building where safety is especially critical, several thousand square meters of safety concrete have been used to shore up the construction. Over the past few years, the skyscraper has been growing steadily upwards on the southern tip of Manhattan, on the site of the old World Trade Center's Twin Towers. On September 11, 2001, an unprecedented act of terror resulted in the collapse of the towers, burying more than 3000 people under the debris. At 541.3 meters, the One World Trade Center is the tallest building in the USA and the third tallest in the world. "Our formula allows us to calculate the exact thickness of the concrete required to meet the safety considerations posed by such a special building," says Stolz.



**The One World Trade Center at Ground Zero shortly before the official opening. One safety measure adopted was the use of specially formulated safety concrete, developed by DUCON Europe GmbH & CO KG. Fraunhofer scientists were able to accurately compute how much of this concrete could be efficiently used to best effect. (© Fraunhofer EMI) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for High Speed Dynamics, Ernst-Mach-Institut, EMI** | Am Klingelberg 1 | 79588 Efringen-Kirchen | www.emi.fraunhofer.de
**Contact:** Dr. Alexander Stolz | Phone +49 7628 9050-646 | alexander.stolz@emi.fraunhofer.de
**Press:** Birgit Bindnagel | Phone +49 761 2714-366 | birgit.bindnagel@emi.fraunhofer.de

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# New drugs to combat asthma and the like

Statistics indicate that there are 300 million asthma sufferers worldwide, a further 600 million people living with chronic pneumonia and up to 30% of the global population contending with allergic rhinitis (allergic inflammation of the nasal airways). Chronic inflammatory diseases can also affect other organs and parts of the body beyond the respiratory system; they can occur in the intestine (in the form of inflammatory bowel diseases such as colitis ulcerosa), the joints (rheumatoid arthritis), the skin (scleroderma), or the heart and blood vessels (arteriosclerosis). What each form of inflammatory disease has in common is that it stems from centers of inflammation in the body that are prevented from healing by immunological processes that have gone wrong.

This is where a new product made by the Canadian company Nuvo Research Inc. comes in. It is already approved for use in many countries around the world as a drug to assist local wound healing, and in Thailand is already sanctioned as a means to treat a variety of chronic diseases. Scientists at the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig are now working with a German subsidiary of the company, Nuvo Research GmbH, and the Translational Centre for Regenerative Medicine TRM at Leipzig University to develop a platform that will enable them to better understand the way the substance works. Their objective is to optimize the drug to make it more convenient to administer and better tolerated. Above all, the scientists are keen to develop derivatives of the drug with which it might be possible to alleviate an even broader range of chronic illnesses, and to prepare these drugs for approval on the European and Canadian markets. The cooperation project, sponsored to the tune of 4.4 million euros, is due to be completed in June 2014.

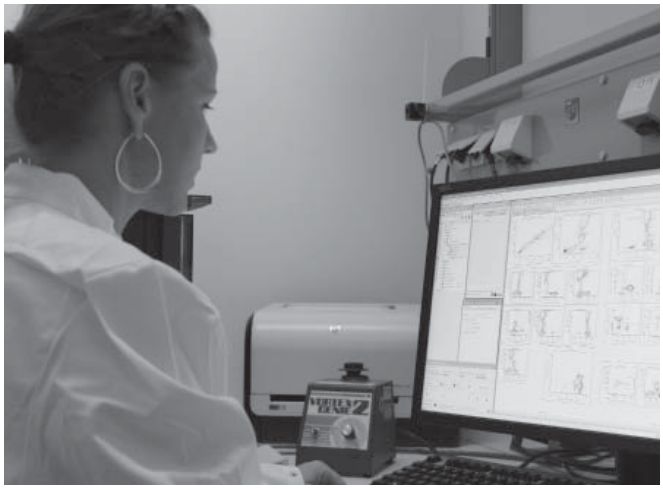
### Regenerative process disrupted in the case of chronic inflammation

"Inflammation is the body's emergency response, but inflammation normally begins to abate the moment it starts. In order for the organism to calm back down and stabilize, the immune system is temporarily suppressed. The body suppresses its defense mechanisms until the inflamed tissue has managed to regain its normal functions. This regenerative process is disrupted in the case of chronic inflammation," explains Professor Jürgen Arnhold, who is based at Leipzig University's Faculty of Medicine and also conducts research at the TRM. Various complications can occur, such as bacterial or fungal infections and disruptions to the wound healing process. If such complications develop beyond a certain threshold, the immune system will suddenly leap back into action very violently. It is this interplay between immunosuppression and immunological overreaction that the scientists are looking into as part of the project. There is clearly a class of enzymes at work that would normally be activated by immune cells within a very specific time window. If this activation occurs in an uncontrolled manner, the last phase of the inflammatory process is disrupted and becomes chronic. This is where the particularly small, low-molecular substance developed by Nuvo comes in: "Studies we

conducted on isolated immune cells indicate that it should be possible to change the function of some of the enzymes involved," says Professor Arnhold.

Where scientists at the TRM are investigating the way selected immune cells react to the Canadian drug, researchers at the IZI are interested in looking at its effect on the organism as a whole. The reason for these investigations is that in order for the drug to be approved in Europe and North America, authorities demand that complex and time-consuming studies be conducted into its safety, tolerability and effectiveness. "We test the medication on mice that display the same sorts of symptoms of illness as patients with chronic inflammatory diseases," explains Dr. Franziska Lange, head of the Inflammation Models and Immunodiagnostics Unit at the IZI. "My working group focuses on three conditions: asthma, smoker's lung and scleroderma, an autoimmune connective tissue disease. We established 20 different model systems with which we are able to simulate different aspects of inflammatory diseases. This enables us to record the effects and side-effects of different doses of the drug on mice. We see ourselves as a service unit and offer many different ways to carry out preclinical tests on potential pharmaceuticals," she goes on to explain. A further three IZI working groups are testing the drug on mice who have suffered a stroke or who have colitis to see whether the animals' symptoms improve. They are also investigating whether the drug might be useful in treating breast cancer.

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



**The researcher analyses immune cells in order to ascertain the effects and side-effects of the new drugs. (© Fraunhofer IZI) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Cell Therapy and Immunology IZI** | Perlickstraße 1 | 04103 Leipzig | www.izi.fraunhofer.de
**Contact:** Dr. Franziska Lange | Phone +49 341 9725-821 | franziska.lange@izi.fraunhofer.de
**Press:** Jens Augustin | Phone +49 341 35536-9320 | jens.augustin@izi.fraunhofer.de

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# Linking television and the Internet

The panel discussion is getting heated – but what exactly is in the new proposed law that the experts on TV are arguing about so vigorously? Up until now, spontaneous questions such as these that arise during a program had to be clarified through a viewer's own research on the Internet.

If it's up to researchers at the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS in Sankt Augustin, Germany, viewers will no longer have to look up such additional information in the future. In the project "LinkedTV", the institute is working with eleven partners from seven countries on a new television concept. "We want to seamlessly combine television and the Internet so that viewers can directly access background information about the current program during the show, without having to spend a lot of time and effort themselves in searching for it," explains project manager Heike Horstmann. Some channels are already taking steps toward such a linking of TV and the Web – but this requires a relatively high amount of effort by personnel: The editorial staff has to scour the Internet or the broadcaster archive for suitable material and provide the links to the broadcast manually.

**Software accelerates the editorial team's research**

The project partners have developed intelligent software which will greatly simplify this laborious work in the future. The solution scans the contents of a show prior to its broadcast via speech analysis and image processing for topic-related content from the Web. Since the software provides a great number of unfiltered hits and semantic links, the researchers have developed methods to narrow down the results according to certain criteria. "For example, content will be displayed only if it complies with laws for the protection of minors and for which the copyright is no problem," Horstmann explains. The editorial team adds the final touches, checking suggested content for relevance and eliminating any duplications from the hit list.

Parallel to the broadcast, the viewer then finds information sorted according to topic for each chapter of a TV program. If desired, he or she can specify filter criteria that determine which content is displayed – defining topics of particular interest or hiding results for specific content. In addition, the software is also capable of learning and adjusts the offer of information to the user's behavior. "If the viewer repeatedly accesses the weather report or information on a particular topic, for instance, this content will be displayed in a prioritized fashion," says Horstmann. The viewer can view both broadcast and additional content directly on the screen of an Internet-capable television or on another end device with Web access, such as a tablet or laptop. The best approach would be to use two screens which are synchronized with each other in parallel. Generally, the show then runs on the television, while further content is displayed on the "second screen." "The user controls both devices via the second screen.

He can then, for example, interrupt the program on the television to inform himself of a particular detail via the tablet," explains Horstmann.

To give a practical idea of how linked television might look, IAIS researchers and their project partners have enriched two real formats – a newscast by Rundfunk Berlin-Brandenburg and a documentary series of the Dutch TV station AVRO – with additional virtual content. The results will be presented this year at several professional events – including IBC 2014 in Amsterdam.

**Accessing matching Web content while watching TV: Researchers are working to connect both worlds so that the consumer can take advantage of the new opportunities easily and comfortably. (© Fraunhofer IAIS) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS** | Schloss Birlinghoven | 53754 Sankt Augustin | www.iais.fraunhofer.de
**Contact:** Heike Horstmann | Phone +49 2241 14-2985 | heike.horstmann@iais.fraunhofer.de
**Press:** Katrin Berkler | Phone +49 2241 14-2252 | katrin.berkler@iais.fraunhofer.de

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# Fast building inspection from the air



Quietly humming, the flying robot hovers up outside the high-rise. The miniature aircraft equipped with eight rotors slowly whirls upwards to the 11th floor. It examines the facade for damage, such as cracks, defective joints, or chipped and crumbling concrete. At a distance of two meters from the building, the octocopter scans the masonry. Also on board is a high-resolution, digital camera that takes detailed images of each part of the building. In addition, the material tester is equipped with sensors that adjust for wind gusts, maintaining stable attitudes and avoiding collisions with the building. As the remote-controlled robot works its way forward meter by meter, it is carefully monitored by Christian Eschmann. He is a researcher at the Fraunhofer Institute for Non-Destructive Testing IZFP in Saarbrücken, Germany, where he develops and adapts micro-aircraft for building inspections.

Buildings, industrial plants and bridges have to bear heavy loads and are exposed to wind and weather. Many buildings in Germany were built in the postwar years and now show damage due to aging. "To inspect their condition and prevent hazards to people, a lot of effort still has to be devoted to buildings that are difficult to access," says Eschmann. To date, test engineers have inspected concrete according to the required tests with nothing but the naked eye, marking any cracks manually in 2D maps: an error-prone procedure. On top of that, places that are difficult to access or view are often only accessible by helicopters, cranes, platform vehicles, industrial climbers and scaffolding.

**3D model images provide information about the state of the building structure**

Compared to many conventional methods, the inspection is more convenient, thanks to the assistance of an aerial robot, and can occur at shorter intervals. In addition, inspection time can be significantly shortened, usually without impeding use of the buildings. "For a 20 by 80 meter wide façade, a test engineer needs about two to three days. Our octocopter needs three to four hours for this," says the researcher. Cracks and other flaws can now be digitally photographed in high resolution. This permits quick conclusions about the state of a building's structure. If necessary, the octocopter can also be equipped with a thermal imaging camera, to check things such as building insulation.

The image yield is high: a mere 15-minute flight can result in up to 1,200 photos. On the computer, the individual images are combined to create an overall picture, and the resulting 2D and 3D data models illustrate the visually imageable condition of the building structure. In the future, there will be software to delete any superfluous images. A complete software suite is planned for the future, including damage recognition, image processing, a database and documentation, as well as the automation of all operations – including stitching of individual images and identification of crack patterns.

The octocopter already took to the air in 2011 for its first inspection. Since then, it has completed numerous test-measurement flights. So far, it has needed to be controlled manually. Eschmann and his colleagues are currently working on navigation sensors which will control the flying robot in the future. Following a predetermined pattern, these sensors will steer the octocopter along the façades – floor by floor, from one side to the other. "It's a bit like flying on rails," says the engineer. This automation process will certainly require another year of development, though, says the researcher. Use of the aerial robot poses no risk to bystanders or passers-by. The device is equipped with eight electric motors. If one should fail, it can always be safely landed.

"Our micro-airplane are no substitute for experts or a close-up inspection. However, the octocopter accelerates the test procedure and enables permanent monitoring and documentation from the beginning. Design defects and warranty claims can be identified at an early stage, so appropriate repair measures can be taken in time. This means more security for buildings and people," says Eschmann.

**The high-tech miniature aircraft scans building structures in just a few hours. (© Uwe Bellhäuser) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Non-Destructive Testing IZFP** | Campus E3 1 | 66123 Saarbrücken | www.izfp.fraunhofer.de
**Contact:** Christian Eschmann | Phone +49 681 9302-3839 | christian.eschmann@izfp.fraunhofer.de
**Press:** Sabine Poitevin-Burbes | Phone +49 681 9302-3869 | sabine.poitevin-burbes@izfp.fraunhofer.de

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# Managing the data jungle

During laboratory testing, countless measurement results accrue. To completely and systematically archive this body of data is extremely time consuming. In fact, researchers in the life sciences spend a quarter of their time managing data, according to an online survey of 70 people working in biology laboratories conducted by the Fraunhofer Institute for Applied Information Technology FIT in Sankt Augustin. Many of those surveyed reported that they have no centralized or structured approach to data collection in their workplace. And when a PhD student or assistant with years of experience leaves the institute and the successor tries to find and make sense of previous results, the search often begins with cryptic Excel tables and stacks of paper.

The FIT has taken steps to alleviate this problem. With its step-by-step operation, its "MPlexAnalyzer" software makes it considerably easier to manage data. Initially, the FIT experts concentrated on cytometric devices, which enable the simultaneous determination of a variety of proteins in a test batch. This approach, also called a cytometric multiplex assay, is a standard method in every biology lab. However, assays such as these are very complex and produce huge amounts of data, so it is no wonder that personnel without access to any supporting software often lose the upper hand with data collection. The FIT software's wizard assistant guides users through the entire measurement process, starting with the selection of the microtiter plates, the choice of samples, and the assignment of standard samples, and provides a clearly arranged PDF report for print out; the process is transparent and easy for beginners to grasp quickly.

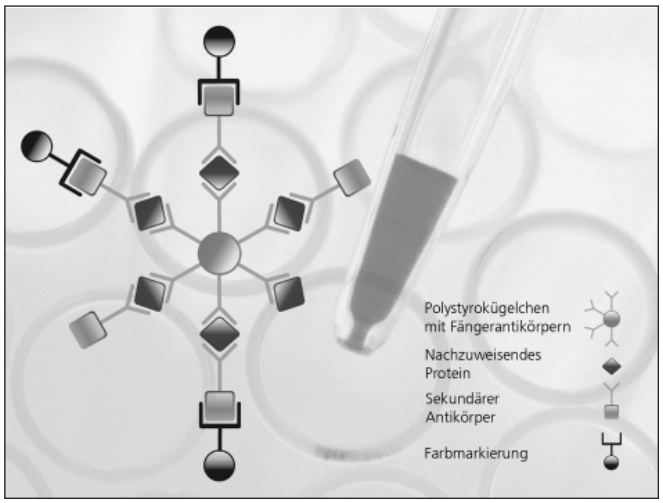
## Antibody coated beads

A cytometric multiplex assay uses polystyrene beads with a diameter of only six micrometers. These are infused with a dye mixture that glows when subjected to two laser beams. The glowing pattern is like a fingerprint; up to a hundred different types of beads can be differentiated in this way. During the measurement, the beads flow through a thin glass cannula like pearls strung on a necklace. Cameras measure the color patterns, counting and sorting them as they go past. But biologists are primarily interested in the beads' second cargo: color-coded antibodies on the surface of each bead that are stimulated by one of the two lasers. This dye emits light at another wavelength – but only if specific substances have bound with the antibodies, such as blood components, cell excretions or cancer cell signal proteins. A multiplex assay examines up to 100 of these substances simultaneously.

The result is a huge data set that records the number of registered beads together with the identified substance. Measurements are highly automated – every minute, up to 96 different samples are tested, each in a little well on a glass plate. One portion of each plate is covered with samples, and another portion with reference substances

used to calibrate the readings. Until now, the process of documenting where each sample is located and which measurement is recorded was a time-consuming manual task. "Our software wizard simplifies the process. With just a few mouse clicks, you can mark on the screen which wells contain reference substances or which ones are empty. If the corresponding field is red, then the specification and the measurement don't match. This means the lab assistant will see immediately if a mistake has been made or if the quality of the measurement is insufficient to reach a statistically reliable conclusion," explains Dr. Andreas Pippow, a scientist at the FIT.

For the FIT, the software is a way in to the data management market for biological labs. The idea will now be carried over to other applications, such as microscopes. At the biology lab of Fraunhofer FIT's Life Science Informatics department in Sankt Augustin, scientists are building special microscopes that can automatically shuttle large samples back and forth under the objective and scan them. There are plans for a database of all lab-performed measurements, such as those from multiplex assays, microscope images or other measuring equipment. The appeal of this common data management approach lies in the built-in ability to perform cross checks. For instance, when body cells emit certain chemical messengers as a result of a disease, often these will have consequences for the tissue structure. But the only way to spot this is by using the software to match the signal substance tested in the multiplex assay against microscope images.




**Many samples have to be matched up. Typical design of a cytometry multiplex immunoassay.**
**(© Fraunhofer FIT) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Applied Information Technology FIT** | Schloss Birlinghoven | 53757 Sankt Augustin | www.fit.fraunhofer.de
**Contact:** Dr. Andreas Pippow | Phone +49 2241 14-1524 | andreas.pippow@fit.fraunhofer.de
**Press:** Alex Deeg | Phone +49 2241 14-2208 | alex.deeg@fit.fraunhofer.de

Fraunhofer

# Telemedicine for patients with chronic liver diseases



The liver is one of the most important organs in the human body. Its job is to ensure that we utilize our food properly – this is its synthesis function – and that toxic substances are removed from our organism – this is its detoxification function. Lack of exercise and too much alcohol, stress, and unhealthy food all damage the liver. The resulting diseased cells can lead to inflammations, cancerous ulcers, fat deposits, cirrhoses, and life-threatening liver failure. According to the German Liver Foundation, over five million people in Germany have liver diseases. Often these diseases take a chronic course. Patients suffer from a variety of conditions, including memory disorders (encephalopathy), peritoneal fluid excess (ascites), and itchy deposits in the skin.

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

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

To this end, the scientists have developed an IT application called Personal Health Manager, which patients can access conveniently on tablet computers in the form of an app. It amalgamates all the data from devices that measure blood pressure, heart rate, weight, temperature, and liver values along with the treatment plans from the Care Flow Engine. "Its main purpose is to ensure optimum treatment for the typical complications that tend to accompany liver diseases," says Kiefer. This can be achieved by means of tests, questioning, exercises, or instructions. For example, patients are regularly asked to weigh themselves, measure their liver values, and accomplish a

cognitive test. This provides indications as to how much patients are suffering from conditions such as encephalopathy and ascites. The system automatically evaluates the results, suggests adjustments to medication doses, and recommends courses of action that are then discussed between the doctor and the patient. "Although the technology is currently set up for liver diseases, it's suitable in principle for the telemedical treatment of any chronic illness. Adapting the existing system to make this a reality is our medium-term goal," says Kiefer. An initial prototype of the IT platform was successfully tested by doctors last year. Preparations are currently underway for a study involving 20 liver patients in the United Kingdom.

**Sensors measure vitality of cells**

The sensor technology for monitoring the liver cells was developed at the IBMT by physicist Dr. Thomas Velten: "Our sensors continuously measure the vitality of the cells in a bioreactor – and they do so by analyzing the cells directly. This is an important new tool to complement conventional biochemical analyses." Thanks to built-in sensors, operators do not have to open the bioreactor for every measurement, eliminating the danger of the cells becoming contaminated in this way. Impedance spectroscopy plays an important role in the methodology. Impedance is the technical term for resistance to alternating electric current. When cells deteriorate, their impedance spectrum changes. So far, scientists have been able to prove this effect in smaller laboratory reactors. At the end of this year, the researchers want to confirm those results using bigger bioreactors that are equivalent to a human liver in terms of their volume. "Online measurement of cell vitality is an important part of our IT-based system to support liver treatment," concludes Velten.


**Telemedicine involves doctors and patients communicating with each other via an IT platform. Researchers are working on technology to extend the benefits of telemedicine to liver patients in the near future. (© Fraunhofer IBMT) | Picture in color and printing quality: www.fraunhofer.de/press**

**Fraunhofer Institute for Biomedical Engineering IBMT** | Ensheimer Straße 48 | 66386 St. Ingbert | www.ibmt.fraunhofer.de
**Contact:** Dipl.-Inform. Stephan Kiefer | Phone +49 6894 980 156 | stephan.kiefer@ibmt.fraunhofer.de
**Press:** Dipl.-Phys. Annette Maurer | Phone +49 6894 980 102 | annette.maurer@ibmt.fraunhofer.de

Fraunhofer



## Control from the cloud

The car has evolved in recent years into a moving computer: Software now controls all the components of a vehicle – from air conditioning and communication and consumer electronics to driver assistance systems. In the future, the vehicles themselves are expected to communicate with each other, thereby helping to avoid accidents. A new approach is the networking of vehicles over the Internet in a cloud.

In collaboration with an automotive supplier, researchers at the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern, Germany, are currently investigating, through a feasibility study, how cloud solutions can be employed to expand and enhance the existing functionality of automotive electronics. The Kaiserslautern researchers are developing suitable software architecture and testing it in real-life scenarios on a model vehicle. It is crucial that the interaction between vehicle and external server work smoothly and that control commands be transmitted to the vehicle reliably and quickly. The greatest advantage of such cloud-based IT services is their flexible use. As a result, vehicle functions can be used by the customer for a fixed period of time as needed – such as cruise control for the long drive during summer vacations. There are also advantages for the manufacturer: In the case of product recalls, for example, affected vehicle owners could be informed more quickly and reliably.

**Fraunhofer Institute for Experimental Software Engineering IESE**
Fraunhofer-Platz 1 | 67663 Kaiserslautern | www.iese.fraunhofer.de
**Contact:** Dr. Jens Knodel | Phone +49 631 6800-2168 | jens.knodel@iese.fraunhofer.de
**Press:** Nicole Spanier-Baro | Phone +49 631 6800-1002 | nicole.spanier-baro@iese.fraunhofer.de

## Understanding production at a glance

In large production halls, many machines rattle along all at the same time – so it's hard to keep track. What projects are running on which equipment? Where have there been stoppages? Until now, factory operators have had to gather such information laboriously by hand, since this is usually collected in different systems. The clarity also leaves something to be desired, since the data are typically represented as a table or bar graph.

In the future, a single glance will be enough to be aware of the state of affairs – for the entire production hall. The basis for this is the "Plant@Hand3D" system. It automatically extracts all the relevant information, bundles it and displays it on a multitouch table. There, the user sees a three-dimensional virtual representation of the entire factory floor, including all the machines. He or she, for example, can identify which orders are currently being processed on the various systems. Even more detailed controls are

available: a user who wishes to look at data for just a single machine can zoom in on the image for that machine. Additional monitors clearly show the selected values. The new system has been developed by researchers at the Fraunhofer Institute for Computer Graphics Research IGD in Rostock, Germany, and the prototype has already been completed.

**Fraunhofer Institute for Computer Graphics Research IGD**
Joachim-Jungius-Straße 11 | 18059 Rostock | www.igd.fraunhofer.de
**Contact:** Dr.-Ing. Jörg Voskamp | Phone +49 381 4024 120 | joerg.voskamp@igd-r.fraunhofer.de
**Press:** Dr. Konrad Baier | Phone +49 6151 155-146 | konrad.baier@igd.fraunhofer.de

## Passenger exchange without loss of time

Almost everyone is familiar with the situation: During morning rush-hour traffic, crowds are waiting in front of the subway doors while alighting passengers are forcing their way through. Quite often, jostling on the platform and in the train leads to delays.

Researchers at the Fraunhofer Institute for Transportation and Infrastructure Systems IVI in Dresden, Germany, have now developed simulation software to tackle the topic of passenger exchange. With this software, it can be analyzed in which ways various factors affect the time needed for boarding and alighting. In order to illustrate individual passenger movements as realistically as possible, the researchers use an agent-based model. Each agent – in the virtual model, this is the passenger – is assigned an individual movement behavior. Even general conditions such as the width of doors, the arrangement of seats and the number of passengers can be specified for each run. Due to the great variability of the simulation parameters, different scenarios can be played through. Based on their calculations, the researchers have managed to identify, depending on the size of the bus, a critical number of passengers beyond which the time for the passenger exchange increases disproportionately. To resolve these »bottlenecks«, it can be useful to design the interior of the vehicle differently. In doing so, the simulation proves to be an important development tool in evaluating potential modifications in terms of practicability.

**Fraunhofer Institute for Transportation and Infrastructure Systems IVI**
Zeunerstraße 38 | 01069 Dresden | www.ivi.fraunhofer.de
**Contact:** Dr. Ulrich Potthoff | Phone +49 351 4640 638 | ulrich.potthoff@ivi.fraunhofer.de
**Press:** Elke Sähn | Phone +49 351 4640 612 | elke.saehn@ivi.fraunhofer.de