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RESEARCH NEWS

08 | 2013 ||

1 Smart sleep analysis

Sleep disorders are a widespread problem. With the aid of smartwatches, researchers are analyzing sleep movement patterns and assisting doctors with diagnosis and therapy. Burnout and diabetes patients stand to benefit.

2 Soccer matches and concerts from any angle you choose

In future, soccer and music fans will be able to choose the camera angle when watching live matches and concerts on TV, or even enjoy a 360-degree view of proceedings: all thanks to a new panorama camera that is small, robust, and easy to operate.

3 Making plants' inner qualities visible

Not only psychologists would be happy to be able to look inside their patients' heads – a plant's "inner qualities" also supply plant researchers with valuable information. A special camera analyzes the constituents of grapevines, corn and other plants.

4 In with antennas, out with cables

An eyesore and a tripping hazard in one: cable clutter is a real nuisance. Now a new kind of antenna is set to banish the pest, hidden in tables and supplying electronic devices with power. The "tables" can transmit data, too.

5 Making cars that are lightweight and crash-safe

Lightweight or crash-safe – must it always be a trade-off for auto makers? The answer is no. With a new lightweight construction technology, researchers are making it possible to do both. The result is less fuel consumption and lower manufacturing costs.

6 Live streaming experience for multi-screen applications

Researchers have developed the FAMIUM development platform and are using it to create new application scenarios for adaptive video streaming in web browsers. One highlight is that content can be split between several devices and played in sync.

7 Saws made of carbon

More material could be saved when manufacturing wafers in future. Ultra-thin saws made of carbon nanotubes and diamond would be able to cut through silicon wafers with minimum kerf loss. A new method makes it possible to manufacture the saw wires.

8 Newsflash

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Smart sleep analysis

Tonight will be another sleepless night for countless people, who will toss and turn for hours. And when they finally drift off, they will wake up with a start a short while later. If their disorder becomes chronic, sufferers often take part in medical sleep studies in an attempt to uncover the reasons behind their sleeping problems. Currently, these studies employ specially developed, very expensive intelligent watches. Doctors read out the data recorded by the watches just once a week in the research lab, which slows down analysis.

Researchers at the Fraunhofer Institute for Computer Graphics Research IGD have now developed software for commercially available smartwatches, so that they too can be used in sleep research. "A smartwatch can do many of the things a smartphone can do: it tells the time and allows wearers to check their text messages and e-mails and find out what's going on in social networks. But smartwatches can also do a whole lot more. These tiny computers fitted with acceleration sensors hold out many exciting possibilities in the field of sleep research," says Gerald Bieber, a scientist at Fraunhofer IGD. The sleep recognition algorithm developed by Bieber and his team helps to detect anomalies in sleep as soon as they occur. Information such as bedtimes and duration and quality of sleep is derived from the watch's sensor data and then analyzed. "Our algorithm detects movements and compares them against normal sleeping and waking patterns. The sensors register both micro-movements triggered by breathing or pulse and macro-movements such as twitches of the leg." Patients can send the recorded data straight from their home to the lab via the smartwatch's radio module.

Burnout from chronic sleep deficit

"For the doctor in charge of the patient's care, a digital sleep diary like this is an important tool for diagnosing sleep disorders and for choosing the right therapy," explains Bieber. "Sleep quality is an important indicator of burnout." According to studies, it is chronic sleep deficit and not stress that is the real cause of burnout. There are many reasons for people having difficulty falling asleep, having interrupted sleep or having non-relaxing sleep: anything from the side effects of medication to too little movement during the day, or even just the wrong mattress.

In future, Bieber and his colleagues also want to detect unconsciousness in sleep. This is an issue that can affect diabetics and epileptics. Type 1 diabetes patients quite frequently fall into a state of hypoglycemia (low blood sugar) during the night, which can result in the patient entering a life-threatening diabetic coma. The software installed in the smartwatch would trigger an alarm in such situations and notify family members or the patient's doctor. The smartwatch researchers are currently in talks with hospitals and soon hope to obtain test data from coma patients, in other words real sample data for comparison purposes.

At present, the smartwatch with the Fraunhofer software is being used in a pilot study. In collaboration with Vital & Physio health resort and mattress manufacturer Malie, the scientists are studying the sleep behavior of test subjects on back-friendly mattresses. The key issue they are investigating is whether the "right" mattress can help people with sleep disorders and enable them to sleep soundly through the night. The information the study will yield on activity patterns and sleeping behavior could be useful in fields such as combating stress and burnout. Fraunhofer IGD is responsible for technology development and modification within the study.

Saving electricity while you sleep

What is more, people suffering from sleep disorders will not be the only ones to benefit from the smartwatch app – it also offers homeowners and renters an opportunity to save on their electricity bills. "Eleven percent of energy consumption comes from devices in stand-by mode. Because our sensitive algorithm is capable of detecting whether, for example, the watch wearer has fallen asleep in front of the TV, the smartwatch could then switch off the TV automatically via a radio signal. Modern televisions already contain the necessary equipment, but older models can also be retrofitted with special network outlets," says Bieber. In future, it will also be possible to switch off such diverse household objects as alarm systems, wireless internet routers, and lights using this technology.

Thanks to specially developed software, this smartwatch can be used for sleep analysis: a benefit for all those who suffer from sleep disorders. (© Fraunhofer IGD) | Picture in color and printing quality: www.fraunhofer.de/press

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Soccer matches and concerts from any angle you choose

A roar of "Gooaaaal!" bursts out of living rooms and bars, before the players celebrate and the successful strike is shown again and again from various different angles. But viewers of soccer games often wish they could have a different view of the pitch than the one shown on TV during the rest of the game as well. This prospect is set to become a reality, with viewers becoming their "own cameraman": using their PC, tablet computer, or even the latest TV sets, they will be able to choose the angle they wish to view on their virtual cameras – live and in real time! They will also be able to turn around in a virtual circle and take in a panoramic view of the pitch and the stands.

This is made possible by the new OmniCam360 camera: when positioned at the halfway line on the edge of the pitch, it shows a full panorama, in other words a 360-degree view. And what is more, the camera weighs a mere 15 kilograms, meaning it can be carried by a single person and mounted on a tripod. Compare that to its predecessor, which weighed in at a hefty 80 kilograms! The new camera is significantly smaller too: whereas the first model of the OmniCam took up around one-and-a-half square meters of space and at times obstructed spectators' view in the stadium, the new version is no larger than an ordinary television camera.

Ten cameras for a panoramic view

In order to achieve a panoramic view, OmniCam360 consists of ten cameras. However, these cameras do not simply point in different directions, as is the case with Street View for example. Because the cameras are arranged in a star shape in such cases, the lenses are very far apart and every camera has a separate angle. This has meant that objects, especially ones near the interface between two images, can often appear distorted or are partially cut off or missing altogether – with the result that the panorama includes "seams" and distortions. The researchers working on the new camera have managed to solve this problem, which was caused by parallax error: "We've developed a mirror system that shifts the entrance pupils of the cameras to a common center," says Christian Weißig, project manager at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institute, HHI in Berlin, where the camera was developed. This mirror system guides the action (the soccer match, say) onto the cameras in such a way that they all have exactly the same perspective. Or rather, almost exactly the same. The researchers intentionally built a tiny "error" into the new OmniCam that ensures the individual camera images overlap by at least a few pixels. The software is then able to merge the images without any seams. If the pixels did not overlap, there would be a small gap in the image at the seam, which would interfere with the panoramic view. By contrast, the tiny shift in perspective is not even noticeable to the viewer.

Another advantage of the mini OmniCam is that cameramen can say goodbye to all those laborious calibrations: with previous technology, the different cameras had to be

matched to each other before panorama recording could begin. Which camera had which angle? How exactly did the individual lenses have to be aligned? And so on. Now with the OmniCam it's a matter of unpacking the camera, connecting it up, and away you go. All thanks to an innovative technique for fixing the ten cameras to a special holder. "By means of optimized design, we've managed to do away with time-consuming calibration – and we've dramatically reduced the size," says Weißig. "This also allowed us to make the OmniCam a fraction of the weight of its predecessor model."

The usefulness of the panorama camera is by no means limited to sporting events. The researchers have also recorded concerts with it, with three cameras placed on the stage and three in the audience. In future, music fans will be able to enjoy such concert recordings "from all angles" via a special app. In a current project, the researchers are planning to transmit a concert by the Berlin Philharmonic live all the way from Berlin to Japan. The 360-degree system can be seen from September 13 to 17 at the IBC trade fair in Amsterdam (Hall 8, Booth B80).

No sweat! The cameraman can carry around the 15-kilogram panorama camera without any difficulty. (© Fraunhofer HHI) | Picture in color and printing quality: www.fraunhofer.de/press

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Making plants' inner qualities visible

A photographic airplane circles above an Australian vineyard in large arcs. An onboard camera takes pictures of the grapevines in regular intervals – anything but ordinary photos, though. Instead, this camera "looks" directly inside plants and delivers valuable information on their constituents to viticulturists. This enables viticulturists to systematically modify their cultivation in order to increase the yield of their grapevines by using hybrids with valuable properties – a real challenge under the basic conditions in Australia: The soil is dry and salty and summer temperatures are often extremely high.

This look at a grapevine's "inner qualities" is made possible by special software that processes data from a hyperspectral camera, which records images of many adjacent wavelengths. Researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg developed the software and the mathematical models it contains. "Every molecule absorbs light in a very specific wavelength range," explains project manager Prof. Udo Seiffert. "The camera chip we use covers a large area of the relevant wavelength spectrum and, together with appropriate software, is able to scan the biochemical composition of every single recorded pixel precisely." The camera thus delivers an overview of every constituent present in a plant in any significant concentration – a kind of hyperspectral "fingerprint".

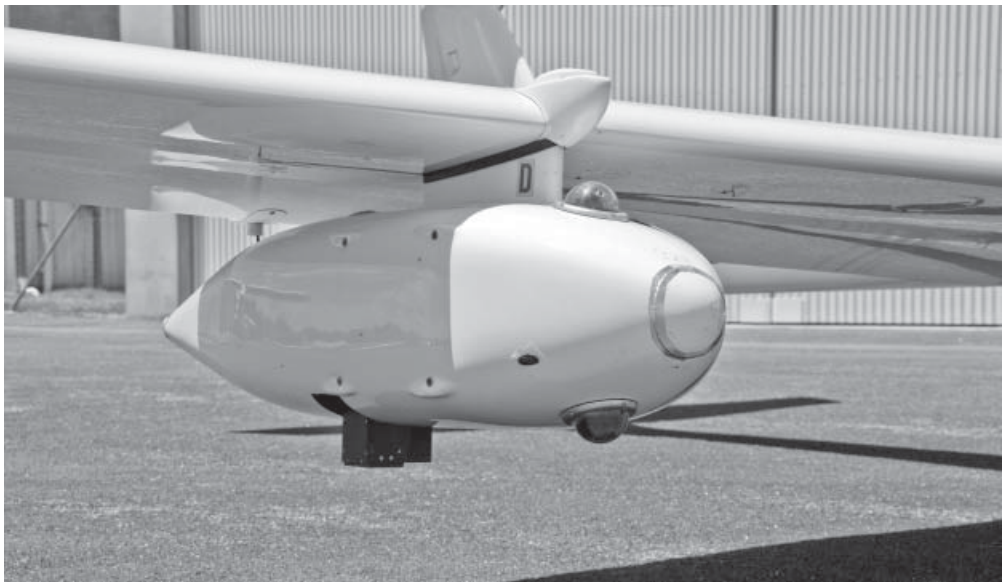
A camera delivers an overview of phytoconstituents

The raw data have to be processed appropriately in order to make them usable for clients. "Our data processing is based on mathematical modeling. On the basis of these algorithms, the software recognizes characteristic absorption properties of defined target constituents and filters them out of the raw data," explains Seiffert. Initially, the researchers have to calibrate the software for the particular application so that it "knows" what constituents it should display. To do so, they photograph reference plants with their camera in order to obtain the fingerprint of the constituents. Then, the photographed tops of the plants are sent to a laboratory in order to analyze the concentrations of the constituents that are relevant to the user. Afterward, the laboratory results are entered into the mathematical model together with the hyperspectral fingerprint. The special thing about the software is its ability to correlate information autonomously and to save this knowledge. "Picture it somewhat like learning vocabulary," explains Seiffert. Once the software has learned the correlation, it automatically filters the relevant constituents out of the hyperspectral camera images the next time. Then, a laboratory analysis is no longer needed for other series of measurements.

Looking inside plants creates effective new options for farmers to increase crop yield. For instance, certain metabolites – products of metabolism – provide information on the quality of a plant's nutrition. Farmers can concentrate on cultivating those plants that thrive particularly well under the prevalent climatic conditions, thus enabling them

to irrigate their fields less, for instance. Diseases such as fungal infections can also be detected faster thanks to hyperspectral technology. An infested plant activates defense mechanisms before an infection becomes outwardly visible – by dead leaves, stalks or mildew. Theses mechanisms indicate that the plant has detected and is combatting the infection. Previously, such tests required lengthy experiments in greenhouses. Not least, aerial photos can be used to detect sources of infection in a field quickly.

The first series of measurements with the project partner, the Australian Plant Phenomics Facility at the University of Adelaide, have concluded – the results are promising. At present, another use of the camera down under is in the planning stage. A demonstrator of the system's use in greenhouses and laboratories will be on display at Booth E72 in Hall 9 at the BIOTECHNICA in Hannover from October 8 to 10, 2013.



The hyperspectral camera is mounted under the wing of the airplane used for research. (© Fraunhofer IFF) | Picture in color and printing quality: www.fraunhofer.de/press

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In with antennas, out with cables

The pretty designer lamp on the table is meant to add charm to the room. If only the annoying cord wasn't there, then you could also put the lamp in the center of the table when it suited you. In future, you will be able to do just that thanks to SUPA Wireless technology. SUPA stands for Smart Universal Power Antenna, and the technology removes the need for electric cables, whether for lamps, laptops or smartphones. Researchers at the Fraunhofer Institute for Electronic Nano Systems ENAS have developed SUPA Wireless together with colleagues at the University of Paderborn and four medium-sized technology companies. "Without cables, you can put your lamps anywhere you like on the table – and they look better to boot," says Dr. Christian Hedayat, department head at Fraunhofer ENAS in Paderborn.

But if there are no cables and no batteries, where does the lamp get its electricity from? The principle is similar to that of an induction cooker: fitted in the table is a network of coils, each of which represents one transmitting antenna. If electricity flows through these coils, they generate a magnetic field. This in turn induces electricity into the coil fitted in the lamp, which lights up. However, the researchers were not satisfied with the lamp being supplied with electricity only at a specific point on the table: they wanted it to work anywhere on the tabletop. But this means that a magnetic field has to be generated wherever electricity is required – in other words, on the whole table. One solution would be to install a giant coil in the table, although this would not be very practicable. The researchers opted for a different route: "We populate a printed circuit board (PCB) with numerous antennas in such a way that a magnetic field is generated only under the surface of the receiver. The distances between the antennas and the dimensions of them are carefully chosen to produce a homogeneous field," says Hedayat.

Cordless lamps available from late 2014

The researchers have also come up with a clever solution to ensure that radiation levels are not excessive: only the antennas fitted directly beneath where the receiver is standing are switched on; all the rest stay switched off. But how does the system recognize where the lamp is standing? "There are two approaches: a physical one and a numerical one," reveals Hedayat. The physical approach is based on the fact that the antennas perceive the receiver – that is, the lamp – as a specific load. The scientists exploit this electrical "signature". The researchers are currently working on the numerical approach: the antenna "speaks" with the receiver, asks for its identification, and then inquires whether it is entitled to receive energy. The researchers also plan to make the question of how much energy the lamp needs part of the "conversation". In order to further reduce radiation, the scientists have restricted it to a very short transmission range above the table. That is enough to power common electronic devices such as cellphones and tablet computers. The final development phase is currently beginning.

Now it is a matter of getting the technology market-ready. According to the researchers' targets, the first application to be launched will be the lamp including PCB in late 2014. The PCBs will be supplied in various sizes so that customers can retrofit both small and large tables.

As well as cordlessly powering lamps, however, the system is also capable of powering laptops and smartphones etc. without any cables. For such devices, the researchers have built in an additional functionality. "We don't transmit just energy through the table, but data too," says Hedayat. And SUPA Wireless can also be integrated in medical applications, for instance to supply implants with energy. Take pressure sensors, which are implanted in the brain of stroke patients and set off an alarm when the brain pressure gets too high. Until now, these implants are usually powered by batteries, and when the batteries were empty, surgery was needed to replace them. With the new technology, these operations become unnecessary – making life a little easier for patients.

These office lamps are powered cordlessly. (© Fraunhofer ENAS) | Picture in color and printing quality: www.fraunhofer.de/press

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Making cars that are lightweight and crash-safe

The auto industry needs to have a rethink: having turned out ever heavier cars year on year, in future vehicles will have to be lighter with lower fuel consumption and CO_2 emissions. If auto makers do not dramatically reduce the average CO_2 emissions of their cars, they will face hefty fines. That was determined by the European Commission in a new piece of legislation. One way to achieve a major cut in fuel consumption is through lightweight construction – in other words, cars have to slim down. But this must not jeopardize the safety of vehicle occupants – and that is a big challenge for auto designers, who are faced with the task of fulfilling these contrasting requirements. Vehicle bodies until now have consisted largely of a homogenous sheet steel structure with constant component sheet thicknesses. Components that are subject to particularly strong local stresses are often oversized, because the wall strength has to be designed to withstand the highest local stress point. This means that the sheet thickness is greater than needed in areas that are subject to less stress, making components unnecessarily heavy. Moreover, automakers use lots of expensive, high-strength steel sheets. At present, then, compromises are constantly being made between component weight, component cost, and crash safety.

Now researchers at the Fraunhofer Institute for Material and Beam Technology IWS in Dresden have developed a lightweight construction technology that makes it possible to reduce vehicle weight while ensuring adequate crash safety. "Safety and lightweight construction need not contradict each other," says Markus Wagner, a scientist at the IWS. In order to match the characteristics of body components more precisely to the stresses that act on them, the engineer and his colleagues are pursuing an exciting new approach called "local laser reinforcement". This approach involves using low-cost, low-strength steel sheets with minimized wall thickness and reinforcing them locally only in those areas that are subject to strong stresses. To do this, the experts guide a focused laser beam over the surface of the unprocessed sheet. The zones treated in this way heat up or even begin to melt, before solidifying again. The heat dissipates quickly into the adjacent cold material, causing the track to cool down rapidly. This produces hard phases and the material is significantly strengthened. "We obtain strengths of up to 1,500 MPa (megapascals). That's roughly twice the strength of the unreinforced basic material," says Wagner. "This enables us to optimize the weights and stresses above all in the design of the front and rear bumper beams, the B-pillar, and various stiffeners."

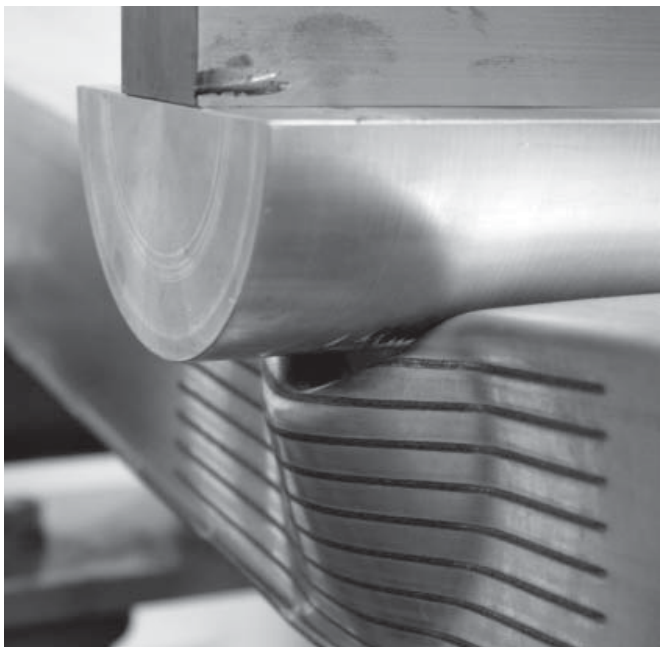
Components that bend only half as much

Crash stresses create complex high-speed deformations in components. By means of local laser reinforcement, scientists are striving to obtain greater resistance to deformation. The less the car body part bends, the greater protection the driver has. At the same time, failure behavior can be influenced by predetermining the position of the

first plastic deformation. For this to work, the researchers have to determine the optimum position and geometry of the reinforcement tracks. Should the tracks be pointed? Slanted? Should they run lengthwise? What should the material's composition be to optimize how difficult it is to deform the reinforcement zone? The researchers can find the answers to all these questions via simulation tests on the computer. "With our simulations, we are able to model field tests. The results obtained from trials and simulations deviate just a few millimeters from each other," says Wagner.

With the aid of numerical simulation, the scientist and his team have developed a crash-optimized track design for bending stress such as might arise when a car collides head-on with a tree or is hit by another car from the side. The track design was transferred onto real components using a laser. "We managed to halve the deflection of a locally laser reinforced pipe profile compared to the reference part, even though we locally reinforced only three percent of the component volume. In other words, we doubled its crash performance," explains Wagner.

The IWS researchers have already applied the method to various crash profiles and seat components on behalf of customers. Thanks to the new, stress-specific design, they are able to significantly reduce wall strengths and thereby make components up to 20 percent lighter, all without neglecting crash safety. As the next stage, Wagner and his colleagues want to perfect their technology by means of an automated optimization of track geometry.



This crash test is designed to establish how much a sample component deforms under a defined bending stress. (© Fraunhofer IWS) | Picture in color and printing quality: www.fraunhofer.de/press

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Live streaming experience for multi-screen applications

Whether you missed a TV show or a concert live recording of your favorite band: the Internet is a treasure trove of videos and all kinds of other multimedia content. Usually this content is streamed – that is, not saved on the computer, rather played directly over the browser in real time. But this method has a major drawback: if the available bit rate deteriorates, transmission quality suffers and the resulting video juddering and interruptions test the user's patience. It can only be avoided if you match the video quality to the bit rate currently available. Although this means that individual sequences are of poorer quality, it guarantees a fluid stream of images. However, the data must be in a certain format for such adaptive streaming: namely, the ISO "MPEG DASH" (Dynamic Adaptive Streaming over HTTP) standard, which has been available since 2012.

Researchers at the Fraunhofer Institute for Open Communication Systems FOKUS in Berlin are building on this technology to create completely new applications for adaptive streaming. Their FAMIUM development platform will make it possible to play live streamed videos synchronously on several devices. "On the one hand, FAMIUM is a player that can play MPEG DASH videos in a browser. Until now, it has only worked in Google Chrome and Internet Explorer 11 on Windows 8.1, but in the longer term other browsers should also support the player," explains Stefan Kaiser, a scientist at FOKUS. "The second major feature of FAMIUM is the additional functionalities such as our multi-screen framework." The researchers were able to base their work in part on existing technologies. For instance, FAMIUM is based on an open source player from the DASH Industry Forum, although the project team optimized it a bit here and there. The multi-screen framework, on the other hand, was developed from scratch at FOKUS.

Playing videos synchronously on your TV, tablet computer, and cellphone

A great variety of applications can be realized with the platform. For example, it is possible to connect a cellphone to a television: once this is done, the cellphone automatically detects a television in the room and media content can be split between the two devices. So while you play a video on the TV, for instance, additional information appears on your cellphone display. "To give an example, we developed a scenario that allows you to follow a Formula 1 race on two screens. While the normal race coverage is shown on the television, a second screen – on a tablet computer, say – shows the view from inside the cockpit," says Kaiser. FAMIUM ensures that the content plays simultaneously and that user commands are implemented on both devices. If the user stops the video on the tablet computer, for example, then the images on the television stop, too.

Providers and marketers of media content can flexibly manage their advertising using FAMIUM. Both dynamic placement – the advertisement is spontaneously displayed

while the content is playing – and static placement are possible. Specific times can be defined at which advertisements should be displayed. A digital rights management (DRM) system can be integrated in order to encrypt content and make it available only to a certain target group, such as for fee-based services.

When the researchers in Berlin started on the project roughly a year ago, they had hardly any suitable media content available to them. "We were left with no alternative other than to generate the content ourselves. So we developed a DASH transcoder, which transcodes media into the MPEG DASH format," recalls Kaiser. Now the transcoder is used, for example, to enable the current TV program to be played live over the browser.

At this year's IFA (Hall 11.1, Booth 21) and IBC (Hall 8, Booth B80) in September, visitors can learn all about the extensive range of possibilities offered by FAMIUM. And Kaiser is not just targeting the entertainment sector either: "The platform is also capable of providing valuable services in the business sector, such as in the area of collaborative work in teams."

With the FAMIUM development platform, live streamed videos can be played synchronously on several devices. (© Fraunhofer FOKUS) | Picture in color and printing quality: www.fraunhofer.de/press

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Saws made of carbon

You can't saw without producing sawdust – and that can be expensive if, for example, the "dust" comes from wafer manufacturing in the photovoltaic and semiconductor industries, where relatively high kerf loss has been accepted as an unavoidable, if highly regrettable, fact of life. But now scientists from the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg together with colleagues from the Australian Commonwealth Scientific and Industrial Research Organisation CSIRO have developed a saw wire that is set to effect dramatic reductions in kerf loss: in place of diamond-impregnated steel wires, the researchers use ultra-thin and extremely stable threads made of carbon nanotubes coated with diamond.

The potential of coated carbon nanotubes has long been understood: possible applications include its use as a hard and tough composite material or as a component of highly sensitive sensors and thermoelectric generators. However, the new material is extremely difficult to synthesize. Diamonds only grow under extreme conditions – at temperatures of around 900 degrees Celsius in an atmosphere containing hydrocarbons. Growing diamonds on nanotubes is a tricky proposition, because carbon tends to form graphite. In order to catalyse the formation of the diamond phase, it's necessary to use reactive hydrogen to prohibit the deposition of graphite. However, this process also damages the carbon nanotubes.

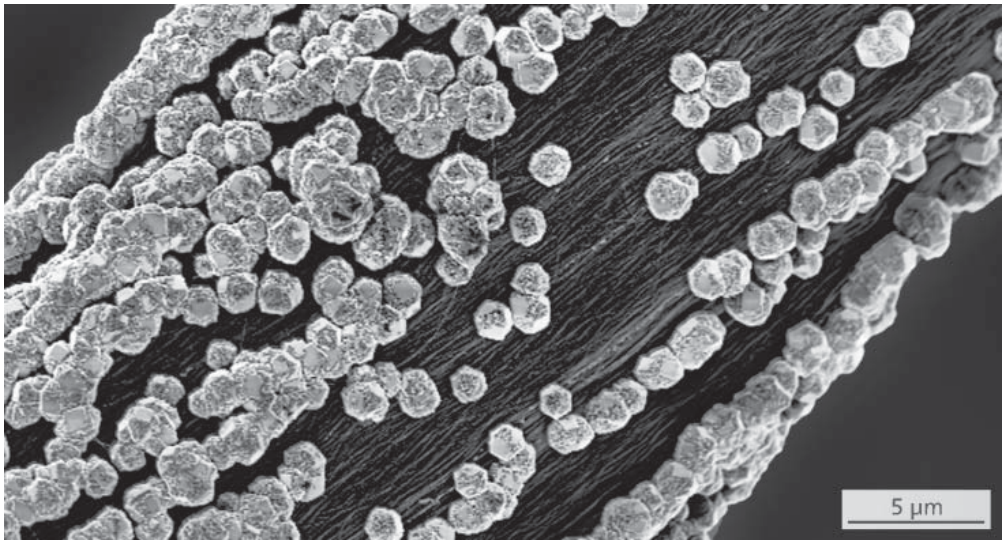
But the IWM scientist Manuel Mee found a solution for protecting the fine carbon nanotubes, which grow like forests on a substrate: "During our first experiments, fused silica from the reaction chamber accidentally came into contact with the coating plasma. It settled on the substrate and protected it against the aggressive hydrogen." And to his surprise, diamonds actually grew on this layer. "What followed was careful, painstaking work," points out Mee. "We had to study the silicon oxide layer, which was deposited in an undefined manner, and find a method of controlling the deposition and optimizing the process." Tests with a transmission electron microscope at CSIRO's lab in Australia revealed that the nanotubes actually survived under their protective layer.

A German-Australian success story

How exactly to proceed from there was the question that now faced the scientists. If they found a way to coat with diamond the nanothreads that the CSIRO specialists make from nanotubes, these diamond-coated nanothreads could be used to manufacture ultra-thin saws capable of cutting through silicon wafers for instance. The Australian team at CSIRO is one of the principal global experts with the know-how to manufacture yarns from carbon nanotubes. The manufacturing process requires special carbon nanotube "forests", which can be extracted as an ultra-thin "felt" and twisted into a very thin yarn ten to twenty micrometers in diameter. In principle, this diamond-coated yarn is the ideal material on which to base a new generation of saws, which

could be used in the solar industry for example. As Mee explains: "The new saw wires held out the promise of being far superior to traditional steel wires. Because of their high tensile strength, they can be manufactured much thinner than steel wires – and that means significantly less kerf loss."

In the meantime, the physicist has managed to implement his idea. A joint patent application by Fraunhofer and CSIRO has already been filed for the method and corresponding products. Mee and his colleagues are currently carrying out sawing tests. "To be able to show our partners in industry the potential the technology holds," says Mee, "we have to demonstrate how it can help solar companies to save material when processing wafers."



New ultra-thin saw wire for cutting silicon wafers: diamond on top of carbon nanotubes. (© Fraunhofer IWM) | Picture in color and printing quality: www.fraunhofer.de/press

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Working in the depths

Able to penetrate ocean depths beyond the range of any diver, remotely operated vehicles (ROVs) are used above all for underwater missions that are too dangerous for manned operations. They inspect underwater pipelines, harbor areas, and offshore wind farms as well as carrying out tasks such as marine biological investigations. Now researchers at the Advanced System Technology (AST) branch of Fraunhofer IOSB have developed C-Watch, an ROV with an energy storage unit that can be replaced particularly quickly, removing the need for an external power supply via cable. The vehicle weighs only 45 kilograms and can dive to a depth of up to 100 meters for a maximum of four hours. C-Watch maintains contact with the control station via a fiber optic cable between 500 and 1,200 meters in length.

The underwater vehicle records razor-sharp video images in real time by means of a front camera equipped with high-performance LEDs. A wide range of different sensors are preinstalled, and the open sensor interfaces enable customers to enhance the vehicle according to their individual requirements and adapt it to perform a huge range of tasks. A C-Watch vehicle was recently delivered to China Agriculture University (CAU). China is confronted with massive environmental problems, and the main role of the 850x550x450 mm ROV will be to investigate water quality.

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Life-saving orbs

An earthquake may last just a few seconds, but that is enough to reduce a town to rubble. Collapsed houses, landslides … the chaos is immense. In such a catastrophe – just as in terror attacks, industrial accidents, or tsunamis – the search for people buried in rubble and for sources of danger is the top priority. In order to save victims as quickly as possible, rescue workers put their lives on the line. But roads are often blocked, sometimes making rescue missions impossible. A solution to this problem in future is to support or replace rescuers with mobile, networked robots and sensors. In the project called SENEKA, six Fraunhofer Institutes are developing components to make this solution a reality.

For example, the Fraunhofer Institute for Physical Measurement Techniques IPM has developed special, tennis-ball-sized sensor orbs that are able to track down gases in the wake of a chemical accident. These orbs are called “sniff nodes” because they sniff out

toxic vapors. As well as measuring the gases, they also measure temperature and humidity. The values they record are transmitted via radio to neighboring sensor nodes for data exchange and then sent to the mission headquarters. Another variant of the technology will see an orb fitted with an infrared sensor guiding rescue workers to people buried under rubble by detecting their body heat. As these sniff nodes are equipped with a microphone and loudspeaker, the victims will be able to draw attention to themselves. Depending on the particular application – whether for an initial evaluation of a situation or for targeted rescue operations – mobile, flying robots scatter the autonomous sensors over the catastrophe zone or "sprinkle" them into the cavities between debris.

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Efficient light guide optics for office lighting and monitors

If office lights were to radiate their light in all directions, it would dazzle the workers. This is why louver diffusers are generally used to soften the light. A new technology is making these louver diffusers superfluous while also increasing the efficiency of the lamps. The technology was developed by researchers at the Fraunhofer Institute for Production Technology IPT, while the basic research was carried out in the EU "Flex-PAET" project.

In office lights and monitors, LED lamps beam their light from the side into an optical fiber panel that fully reflects the light, which is then effectively trapped inside the panel. The light can only escape through deliberately created imperfections – usually white dots printed on the panel. When the dots are distributed in a particular way, the panel appears to shine evenly. The new technology employs a different principle: first the IPT researchers use a hot-stamping method to make a master from metal, in other words a negative with built-in imperfections. This master serves as a stamp: it can be used either to manufacture the panels by injection molding or to imprint the pattern on foil using the roll-to-roll process. The advantage is that whereas the white dots emit light in all directions, the newly invented imperfections radiate light in a directed manner. Moreover, the new technology is also more cost-effective than the old one at high volumes: depending on the application, cost savings of up to 20 percent can be obtained.

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