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Research News

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Nanoparticles connected to antibodies are luminescent in two spectral ranges. This makes it possible to check the homogeneous occupation of the sensor electrode.

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Topic 1

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Detecting cancer early

The earlier the doctor finds the tumor, the better the patient's chances of recovery. A new testing method aims to detect the disease in its initial stages. The technology is based on a microfluidic chip with tiny channels in which a blood sample from the patient circulates. The chip traces marker proteins which are indicative of cancer. The measured concentration of the tumor marker in the blood will help doctors to diagnose the disease at an early stage. Similar testing systems already exist but their measurements are not very precise and they can only detect molecules that are present in the blood in large quantities. What's more, the tests have to be carried out in a laboratory, which is time-consuming and costly. A project funded by the German Ministry of Education and Research and coordinated by the Fraunhofer FIT aims to improve matters. Biofunctionalized nanoparticles developed by research scientists at the Fraunhofer Institute for Silicate Research ISC in Würzburg are the key element in the new sensor. »We have improved the detection limit compared with the present state of the art by a factor of one hundred,« explains Dr. Jörn Probst, Head of the Business Unit Life Science at the ISC. »Whereas previously a hundred molecules were needed in a certain quantity of blood to detect tumor markers, we now need only one. This means that diseases can be diagnosed much earlier than with present methods.«

But how does the biosensor integrated in the chip register the few biomolecules swimming around in the blood that are indicative of a certain disease? »We have placed antibody-occupied nanoparticles on the sensor electrode which fish out the relevant proteins. For this purpose, we repeatedly pump the blood across the electrode surface. As with a river, the flow is fastest in mid-channel and the water runs more slowly near the bank. We have therefore made a sort of fishing rod using nanoparticles which registers the antibodies in the middle of the blood flow where most proteins swim by per unit of time.« If an antibody catches the matching protein, a tumor marker, the electrical charge distribution shifts and this is picked up by the electrode.

The researcher groups are now developing a first demonstrator combining four independent single-molecule-sensitive biosensors. The experts are also working on the simultaneous detection of several tumor markers, which will increase the clarity of tests. The system will be ready to enter the market in a few years' time.

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An asymmetric algorithm in this car key ensures high security when the car door is unlocked by radio signal, but does not drain the battery.

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Research News
Topic 2

No. 2 – 2010

Secure radio signal for central locking

Most drivers love the convenience of remote central locking – the car doors are locked or unlocked just by pressing a button on the key. These systems are not particularly secure, however, as a potential car thief can, for example, use an antenna to eavesdrop on the radio signal and create a second key from the captured data on a computer. The reason for this weakness in security is that the algorithms which encrypt the signals sent from the key to the vehicle are not strong enough. Their code was broken about two years ago. Car manufacturers are therefore using new algorithms to make the radio key systems more secure. But these algorithms too have a major disadvantage – they are symmetric, their codes are embedded in the key and in the car. Also, the same coded information is embedded in numerous vehicles from the same production line. Once one code has been broken, numerous cars are at risk.

Research scientists at the Fraunhofer Institute for Secure Information Technology SIT in Garching have now used an asymmetric algorithm to develop a car key prototype for the first time. »With this type of algorithm the secret is only located in the car key, and not in the car as well,« explains Johann Heyszl, a scientist at the SIT. »Each car key incorporates a different code, and this makes the encryption much more secure than when a symmetric algorithm is used.« Up to now the high computation intensity and associated high energy consumption posed a high barrier against the use of asymmetric algorithms. »We have built a small cryptographic chip which is particularly energy-saving. In addition, we have developed a new, efficient protocol which minimizes computation effort and the amount of data that has to be transmitted,« says Heyszl. As a result, the battery life of the key is about the same as in symmetric encryption, but the new system is much more secure. The electronic immobilizer is encrypted in the same way as remote central locking.

The research scientists have already developed a functioning prototype and will be presenting the system at the Embedded World trade show from March 2 to 4 in Nuremberg (Hall 11, Stand 11-101).

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Electric cars like the one above will be rolling through the Harz region in the future. The fleet of cars is supposed to be increased to twenty-five vehicles by June 2011.

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Research News
Topic 3

No. 2– 2010

Electric cars are going places in the Harz region

The Harz region is banking on electric cars. Electric cars will soon be rolling through Quedlinburg, Werningerode and other cities in the region. Seventeen partners from research, academia and industry have committed themselves to this with their project Harz.ErneuerbareEnergien-mobility or Harz.EE-mobility for short.

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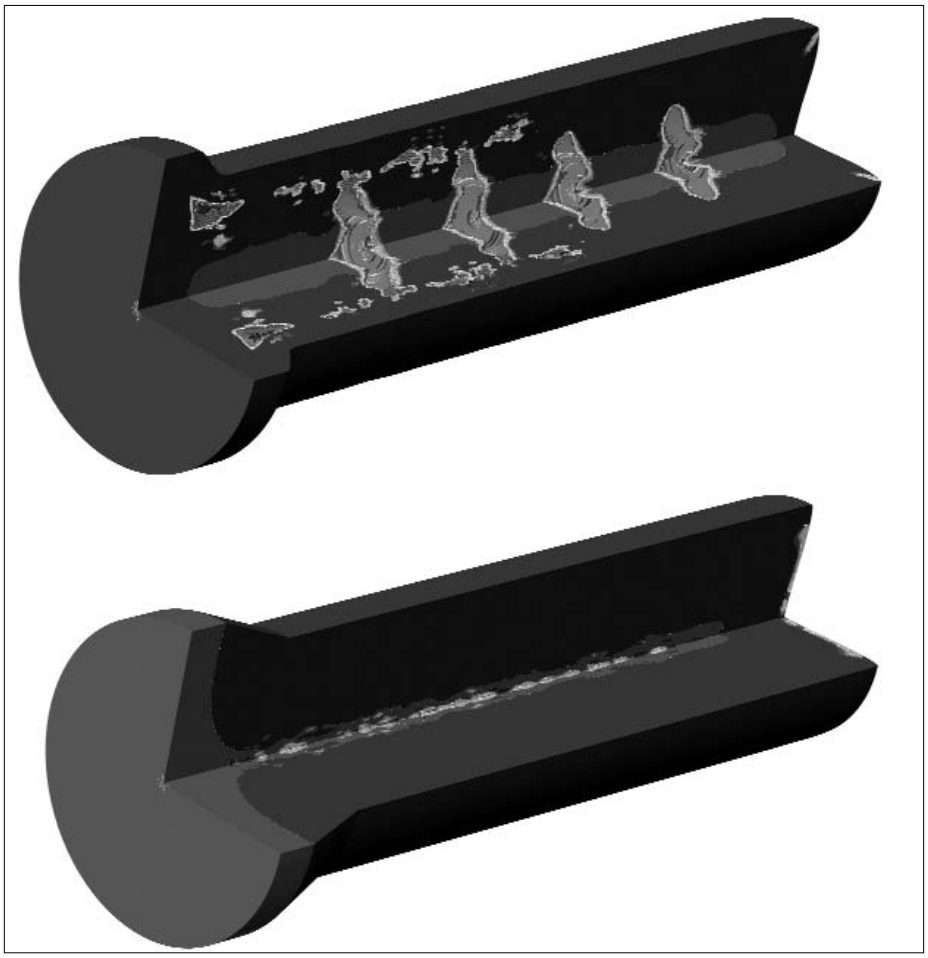
The success of electric cars will stand or fall with the power supply. The ability to charge vehicles with green power anytime and anywhere will boost acceptance of this technology. Hence, charging stations will have to be located astutely enough that electric cars will even be able to reach a city sixty kilometers away without any problem. Researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg are determining the optimal locations for charging stations. »In addition to the flow of traffic, we are analyzing mobility characteristics to find out where vehicles are parked for how long. This time can be used to charge cars. Locations where vehicles may park long enough are favored for charging stations. Garages or parking lots at work or near one's residence are the preferred option,« says Dr. Przemyslaw Komarnicki, Research Manager at the Fraunhofer IFF. »We will also be making a decision about the number of charging stations. However, the results aren't in yet. The placement of charging stations must be carefully considered to keep the network from overloading.« The mobility control center where all the traffic and power data converge advises a driver to head for a suggested charging station based on the battery's charge level. Through the navigation system, the control center informs a driver which charging stations are occupied, being serviced or are closed and have low priced, renewable and/or sufficient electricity. When traffic is backed up, the control center guides cars with a low charge to a nearby charging station. Researchers at the Fraunhofer IFF are developing the necessary database system concept.

The Harz.EE-mobility project is being supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The industry partners are providing part of the total funding of 12 million euros. The official test phase will begin at the end of 2010. 25 electric cars are intended to be underway in the Harz region by June 2011. First, they will be driven in cities in the Harz region. Later, they will also be made available to commuters who travel between Magdeburg and the Harz region.



The simulation shows the results of cold forging. An optimized tool geometry (bottom) keeps pore density low.

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Topic 4

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Perfectly shaped solid components

There are plenty of shiny new automobiles to see at the auto trade show. Over there stands a Porsche covered in gold leaf, and on the other side a Bordeaux-red Mercedes is presented. But behind all the glitz and glamour, the process involved in producing these luxury cars is long and arduous. The properties of the materials used are complex and a number of complications can arise during manufacture. The steel fabricators at the front end of the production chain have to negotiate the first hurdle. They shape solid pieces of metal to make sheets, tubes, rods and bars, which the car manufacturers then process further. In the shaping process the materials can suffer damage if they are excessively deformed, because the friction is too high or the temperature of the forming tool is not exactly right.

To produce a defect-free component, the manufacturers not only have to make numerous prototypes with the right material properties, but also work out by trial and error how the forming tool needs to be set. This is time-consuming and expensive. The research scientists at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg have succeeded in reducing the cost of this process with the aid of computerized models. »With our numerical simulation we can calculate how much deformation a component can withstand before cracking. And we can analyze the effect of factors such as press force and lubricants on the properties of the material,« explains Dr. Dirk Helm, project manager at the IWM. The commercial software currently available cannot predict the deformation behavior of solid metal components in as much detail as his simulation routines. Helm: »We found that by making a specific change to the geometry of a shaping tool unwanted perforations were avoided because the pore density did not rise sharply but only slightly. With our simulation we can identify the optimal properties of components and shaping tools much more quickly than by trial and error.« The research scientist is convinced that these simulations will considerably reduce the amount of waste material.

The software has already proved itself in actual practice. So far the experts have used their numerical simulation in cold-shaping processes in which the temperature of a tool is not a factor. In future the computer simulation will also be used for hot shaping.

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Visitors can browse and select the information that interests them most.

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Topic 5

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Virtual museum guide

Every visitor would like to embark on a virtual time journey into the past. Researchers have already set the stage for just such a journey, as exemplified by a recent exhibition in the Allard Pierson Museum in Amsterdam, where visitors could take a stroll through historical sites. A flat screen on a rotating column stood beside the many art works, showing an extract of the image on the wall – a gigantic black and white photo of the Roman Forum ruins. When the column is rotated to the left, this correspondingly changes what the viewer sees. A camera connected to the back of the movable display provides information about the new view appearing on the monitor – in this case, the Temple of Saturn ruins. At the same time, a digital animation shows what the temple might have looked like when intact. If the screen is rotated further, it displays information, pictures and videos about other ancient buildings, including the Colosseum.

The sophisticated animation is based on software developed by the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt. »We have taught the computer to recognize the image,« explains Fraunhofer IGD researcher, Michael Zöllner. »The program knows where the center of the camera is pointing and can superimpose the relevant overlay – a text, video or animation.« The original image can always be clearly seen under the overlays, so that visitors always know where they are on the virtual tour. This technology is known as augmented reality to the experts.

The Fraunhofer IGD software in the museum currently runs on a minicomputer, controlled via a touch screen. This handy console clearly indicates a trend towards mobile, virtual guidebooks. When tourists will hold their consoles in front of a baroque prince's palace, the relevant customized information will appear immediately on their screens. Fraunhofer IGD researchers have tested this vision in practice in the »iTACITUS« project, in which Zöllner's team programmed a portable computer to act as an electronic tourist guide for the Royal Palace of Venaria near Turin. New mobile phone technology could accelerate acceptance of augmented reality. »The smart phone means that augmented reality is at last suitable for the mass market,« Zöllner says.

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Just point a finger – and the film starts or the light is dimmed.

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Topic 6

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Star chef points the way

Venison from the Sonnwald Forest, Tahitian vanilla, orange blossom salt – Johann Lafer uses only the finest ingredients in the dishes he prepares. The Austrian star chef also chooses the best-quality equipment for his Table d'Or cookery school in Guldental near Bad Kreuznach. The dining area boasts a special technological highlight. A 70-inch Full-HD-display which can be operated just by pointing a finger. When Johann Lafer wants to present the menu sequence to his pupils, call up a short film, play music, change the lighting mood or show pictures of meals, a brief movement of the finger is enough to start the selected program.

This is possible thanks to technology from the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI. The researchers in Berlin have developed a computer control system which is operated by gestures. »The iPoint Presenter consists of two digital cameras which register the movement of the finger and transfer this to the computer. Our software calculates the 3D coordinates of the finger from the video data and recognizes simple hand gestures in real time,« explains HHI scientist Paul Chojecki. The recognition device about the size of a keyboard is housed in a drawer on the front of the large dining table. When the drawer is opened, the gesture recognition system automatically switches on. »The iPoint Presenter tracks the finger and the cursor moves on the display as if worked by an invisible hand. To open a program you just keep your finger pointing at the relevant button,« says Chojecki.

At this year's CeBIT (in Hall 9, B36) visitors will be able to try out the gesture control system for themselves. It can also be used to operate lights and domestic appliances and therefore fits in nicely with the trade show's keynote »Connected Worlds« theme. The researchers are now working on new applications. Chojecki: »As the interaction takes place without anything having to be touched, the system is ideal for scenarios in which contact between the user and the computer needs to be avoided, such as in operating theaters.« In collaboration with medical technology company Storz the engineers are developing an innovative operating theater control system.

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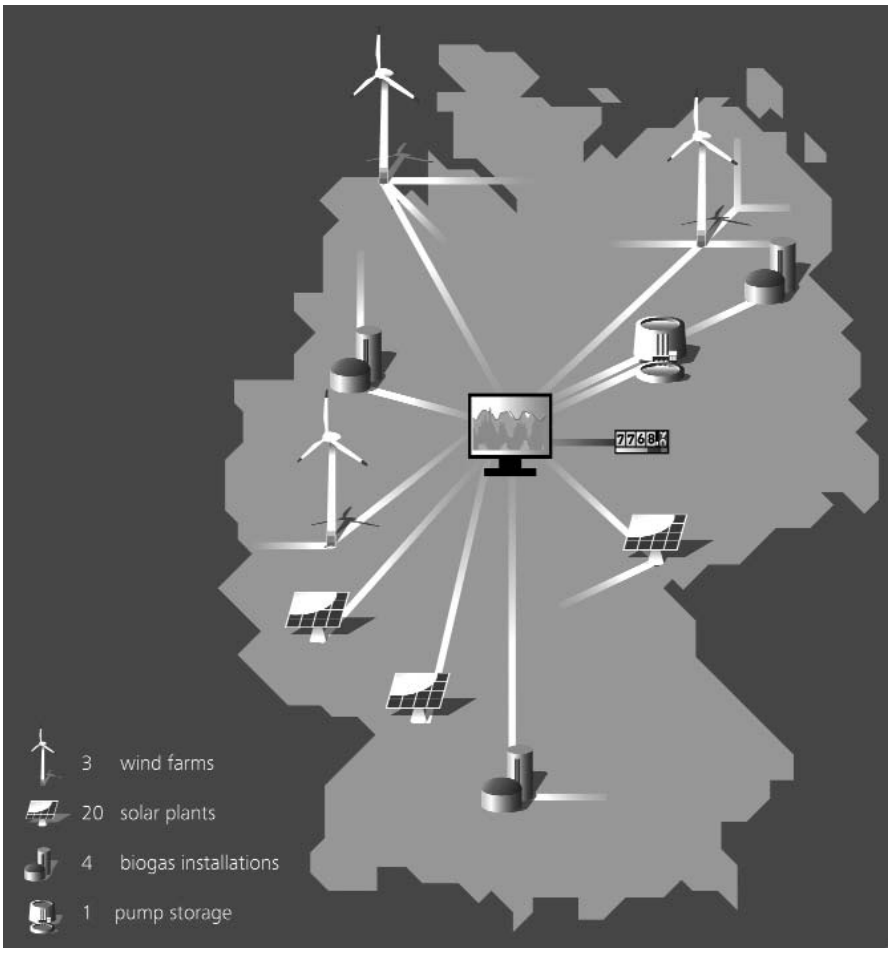

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The combined 28 plants are interconnected via a primary control unit.

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Topic 7

No. 2 – 2010

A clever combination

»Renewable energy sources could in theory provide Germany with a reliable electricity supply twenty-four hours a day,« says Dr. Kurt Rohrig, department head at the Fraunhofer Institute for Wind Energy und Energy System Technology (IWES) in Kassel. Commissioned by – and in cooperation with – Enercon GmbH, Schmack Biogas AG and Solar World AG, Rohrig has developed a virtual combined power plant (www.kombikraftwerk.de). »Every source of energy – whether wind, sun or biogas – has its strengths and weaknesses. If we skillfully combine the characteristics of different renewable energies, we can ensure that Germany is provided with all the electricity it needs,« he enthuses. »We have already developed and installed the software and hardware required for the control system. In the model project, for example, three wind farms, four biogas installations, twenty solar plants and a virtual pump storage station are interconnected via a primary control unit at our institute. In this simulation the local power plant center can cover one ten thousandth of German electricity needs in real-time, around the clock and in all weather conditions.«

Even when the sun goes behind the clouds and there is no more than the gentlest of breezes, factories and houses still need energy. If there is no wind or solar power available, biogas plants and pump storage stations must activate within seconds to supply the electricity required; otherwise the network will collapse. If it's cloudy in the south of Germany, the wind in the north can make up the deficit. And if it's not windy there either, biogas plants help out, producing the necessary electricity within seconds. If there is an overall surplus of energy available, the pump storage station steps into action – water is pumped into an impounding reservoir and can be drained out again when required. The generators then start producing electricity again.

Dr. Kurt Rohrig, scientific project manager, has now been awarded the »German Climate Protection Prize 2009« for his research work. He and his colleagues have succeeded in running the combined 28 plants as a single large power installation. What's possible on a small scale can be applied to the whole of Germany, he stresses. »To ensure nationwide electricity supply in the future, however, we need to build many more plants, expand the existing grid and significantly enhance the storage technology,« adds Rohrig.

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