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RESEARCH NEWS

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1 Radio signals from the heart

Increased pressure in the heart is always a warning sign – it may indicate heart failure. In future, a miniature sensor implanted in a patient's heart could be used to transmit on-demand cardiac pressure readings to their attending physician. The sensor does not require a battery.

2 Active packaging keeps meat fresh for longer

To date, supermarkets have only been able to keep products on their meat counters for a few days. But now researchers have developed an antimicrobial active packaging film that destroys the microorganisms on the product surface, thereby increasing the shelf life not only of fresh meat, but also of fish, cheese and other cold cuts.

3 Plastics and nanoparticles – the perfect combination

Plastic components are vital to many fields of industry – lightweight construction and electrical engineering. Now researchers have found innovative ways to combine plastics with nanoparticles – CNT's – and endow them with new properties. Thanks to these materials, aircraft could in future be better protected against lightning strikes.

4 Electronic searching aid for parents

Just a short call and the "Kidfinder" lets you know where your child is right now via SMS. It can be built into a game console and the locating unit even combines GPS position fixing with GSM tracking. In the best-case scenario, it can even locate the person sought within a couple of meters.

5 When design and Technology form an alliance

Designers love state-of-the-art production technologies. This is the story of how a young designer worked with researchers from Fraunhofer to manufacture the Hydra steel tube chair. This chair is not only lightweight, but also sturdy because it takes a cue from natural forms.

6 Radio chip and sensor in one

RFID technology is on the advance. But, up to now radio chips primarily supply data for the identification of products. Researchers have now developed a transponder which measures temperature, pressure and humidity. The chip with sensor function could revolutionize the applications market.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 59 Fraunhofer Institutes at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 17,000, who work with an annual research budget totaling 1.5 billion euros. Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the USA and Asia serve to promote international cooperation.

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Radio signals from the heart

Different parts of the heart have different functions: The right side keeps the pulmonary circulation going, while the left pumps oxygen-enriched blood around the body. Increased pressure in the left chamber of the heart may be an indication of cardiac insufficiency or heart failure. Until now, coronary angiography has been the traditional method of measuring this pressure. In this procedure, the investigating doctor punctures an artery in the groin and inserts a catheter, then injects a contrast medium which enables him to trace the catheter's path to the heart on an X-ray screen and monitor cardiac activity. The patient lies quietly and unmoving in bed for the duration, and the pressure in the heart chamber can only be measured over that same period of time. Clearly, longer-term measurements under various loading conditions would be considerably more informative, and now an innovative pressure sensor system promises to allow precisely that. The Duisburg-based Fraunhofer Institute for Microelectronic Circuits and Systems IMS will be exhibiting the system at the electronica trade fair in Munich, from November 9 through 12, 2010 (Hall A5, Stand 139). The new pressure sensor delivers up to 200 measurements a second. For the sake of comparison, the heart of an averagely fit adult will beat three to four times a second under extreme loading. "This means even the smallest malfunction of the heart will be revealed. And particularly in the initial stages of illness, these tend to occur only sporadically," says Dr. Gerd vom Bögel, group manager at the IMS.

The rod-shaped sensor, which is 2 millimeters by 10 millimeters in size, is attached to the wall of the heart with the aid of a catheter. When the catheter is withdrawn, the sensor remains in situ. If necessary, it will deliver pressure data over a period of several months. That said, it transmits solely on demand: Just like a passive RFID transponder, the sensor only operates when its associated reader device supplies it with energy – via an inductive antenna coupling. The sensor does not require a primary or rechargeable battery or any other source. An output of 90 microwatts is sufficient to take a pressure measurement and transmit the reading across a distance of up to 40 centimeters. Since the sensor and its integrated antenna can only be positioned longitudinally in the heart, it must be read laterally, on the side of the ribcage. In order to minimize attenuation of the signal by bone, body tissues and liquids, the system transmits in the 10 MHz range. It is encapsulated in a biocompatible polymer shell which, unlike metal, does not block radio waves, but allows them to pass. The Duisburg researchers have also developed a new low-loss transmission process, as vom Bögel explains: "The load modulation that is used for passive RFID transponders deliberately destroys a portion of the transmitted energy in order to encode the

transmitted information. We use that portion of energy, which is usually lost, as transmission energy, and thus achieve significantly longer ranges."

This new form of frequency conversion could also improve the performance of other RFID systems operating in the 10 MHz range – for example in the logistics sphere, when it comes to automatic identification and tracking of gas canisters or hazardous liquid containers. But vom Bögel cautions: "At the moment, we're concentrating solely on medical applications." In order to make their heart pressure sensor even more efficient, the IMS researchers now want to optimize the design of the chip which contains both the sensor and the radio unit.

The reader device supplies the heart pressure sensor with energy. It also receives the measurement data, thereby providing doctors with information about potential cardiac malfunctions. (© Fraunhofer IMS)

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Active packaging keeps meat fresh for longer

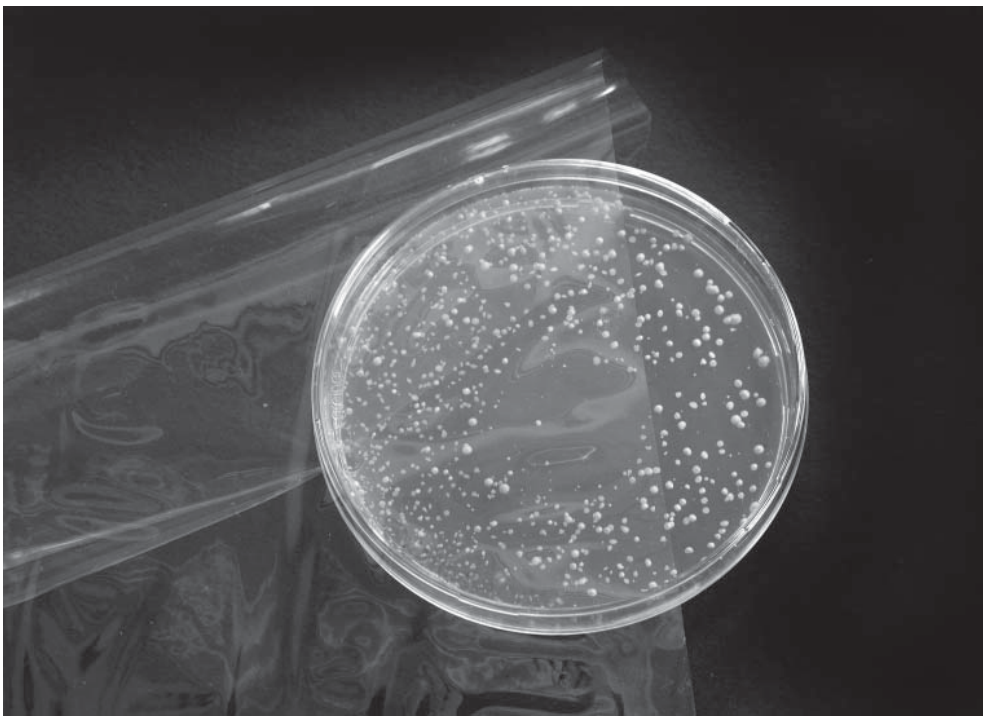
When it comes to quality, consumers make very high demands: They want ready-to-use, pre-portioned foods that will remain fresh and retain their attractive appearance for days. This is particularly true as regards meat and cold cuts. However, while freshly slaughtered meat is virtually sterile, it generally becomes contaminated with microorganisms – feces from hides and skins, germs on tools, hands or in rinsing water – during subsequent cutting and processing stages. Consequently, supermarket meat that initially looks very appetizing tends to change color, texture and even smell within a few days. These changes are caused by chemical, physical and microbiological processes, e.g. the formation of biogenic amines, which occur as microorganisms on the meat that breed and thrive. Around 20 different species of bacteria, yeasts and molds are known to play a part.

Recently, antimicrobial active packaging has opened the door to the possibility of maintaining product quality and safety over a longer period of time. According to EU Regulation 450/2009, these types of material can extend the shelf life of packaged foods, and are permitted to incorporate components specifically designed to release substances into or onto the food in question. This kind of packaging has already been introduced in Japan, where silver, wasabi and ethanol are among the active ingredients used.

Carolin Hauser, a food chemist at the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising, has now developed and tested a new, lacquer-based antimicrobial active film which incorporates a controlled release mechanism. "That means that, on direct contact, an antimicrobial agent is released onto the product surface," she explains. "The surface is the primary point of attack for germs. Using only the smallest quantities of active agent, the packaging thus provides effective protection for food." Of course, only active agents that comply with the rules governing foodstuffs may be considered for use in these films; they must not be poisonous or allergenic, and must be neutral in terms of smell and taste. Furthermore, any active agent must be readily transferrable onto packaging film. Taking into account all these considerations, Hauser elected to use sorbic acid, which she dissolved in a lacquer and deposited on a base film.

When the food chemist conducted her tests, she used several pieces of pork loin. A day after slaughter, she contaminated each of them with around 1,000 colony-forming units of the *E. coli* pathogen, then wrapped some in standard and some

in active film. After seven days in a fridge at eight degrees Celsius, clear differences in color were already apparent. And microbial examination revealed that the active packaging had successfully destroyed many of the germs on the actively-packed meat: The number of *E. coli* bacteria on those pieces had decreased to around a quarter of the original level. Hauser says: "After a week, the total germ count on the surface had decreased significantly compared to the meat packed in untreated film. This indicates that our active film is suitable for maintaining the freshness – and above all the safety – of meat preparations, cheeses, fish fillets and other cold cuts."



This lacquer-based film releases an antimicrobial agent onto the product surface, thus protecting foods such as meat, fish and cheese against bacteria. (© Fraunhofer IVV)

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Plastics and nanoparticles – the perfect combination

Picture the scene: Pitch-black clouds gathering on the horizon, an aircraft winging its way towards the storm. Suddenly a flash of white-hot lightning splits the sky. It is by no means a rare occurrence for aircrafts to have to pass through bad weather fronts, but when they do, there is always one major danger – lightning. Naturally, aircraft manufacturers do everything they can to protect their machines against strikes, but even aircrafts made of aluminum do not always escape entirely unscathed. And when polymer components – usually carbon fiber reinforced plastics (CFRPs) – are incorporated into the design as a weight-saving measure, the situation becomes even more problematic, because they do not conduct electrical current as well as aluminum.

At the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen, researchers have now developed a process for manufacturing new materials that should afford aircraft better protection against lightning strikes. They have been focusing on the unique material properties of carbon nanotubes (CNTs). CNTs are among the stiffest and strongest materials known, and have particularly high electrical conductivity. In order to transfer their properties to CFRPs, the scientists have been combining these nanoparticles with plastics. "By mixing nanoparticles with plastics, we've been able to significantly enhance the material properties of the latter", states Dr. Uwe Lommatzsch, project manager at the IFAM. CNTs are being used to optimize the electrical conductivity of plastics, and their heat dissipation properties are likewise being improved by the addition of metal particles.

The trick is in the mixing process, says Lommatzsch: "The micro- or nanoparticles must be highly homogeneous, and sometimes very closely bound to the polymer." To do this, the scientists employ plasma technology. They use an atmospheric plasma to alter the surface of the particles in such a way that they can be more readily chemically bound with the polymer. A pulsed discharge in a reaction chamber creates a reactive gas. Lommatzsch's colleague, Dr. Jörg Ihde, explains: "We spray the particles – i.e. the nanotubes – into this atmospheric plasma." After plasma treatment they fall into the selected solvent, which can then be used to further process the polymer. The whole procedure takes just a few seconds. A huge advantage over the old method, in which CNTs were prepared in an acid bath using a wet chemical process. That took several hours or days, required considerably more chemicals, and generated significantly more waste. In addition to improved carbon fiber reinforced plastics for use in aircraft manufacturing, the IFAM researchers have several other potential applications in mind. Ihde outlines an example: "We can increase the heat dissipation properties of

electrical components by giving metal particles of copper or aluminum an electrically insulating coating in the plasma and then mixing them into a polymer." This can be pressed onto an electronic component so heat is dissipated directly. "Overheating of elements is a major problem in the electronics industry", he adds. The researchers have also devised a way to reduce electromagnetic losses by using this plasma process to coat soft magnetic particles such as iron and then combining them with plastics. Built into electric motors, they cut eddy current losses, thus improving efficiency and lengthening service life. IFAM experts will be exhibiting surface-modified carbon nanotubes – which demonstrate significantly enhanced miscibility with solvents – at the K 2010 trade fair in Düsseldorf, from October 27 through November 3 (Hall 3, booth E91).

When combined with plastics, these surface-modified carbon nanotubes can, for example, improve an aircraft's protection against lightning strikes. (© Fraunhofer IFAM)

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Electronic searching aid for parents

Now where's that Toby? The eight-year-old was supposed to be home half an hour ago. Not to worry. His mother goes to her phone, calls her son's "Kidfinder", gives her password and gets an SMS with Toby's position data. She can see from the coordinates that her youngest child has taken a little detour to the brook and while playing in the water he forgot what time it is. The Kidfinder is different from exclusive cell phone locating systems because it not only uses the GSM grid (global system for mobile communications) for mobile radio, but also the global positioning system (GPS) for determining Toby's position.

Carsten Hoherz from the Fraunhofer Institute for Reliability and Microintegration in Berlin explains that "This combination of GSM and GPS provides reliable localization regardless of whether the person sought is outside or inside of a building." If the child is on the move outside, it can determine his or her position via GPS to as little as five meters. GPS position fixing with several satellites works with substantially greater precision than localization via GSM because it only gives away what mobile radio cell a user is in at the present moment. On the other hand, mobile radio reception is only possible inside of buildings while GPS signals generally cannot penetrate through walls or the roof. This is the reason why GPS localization precision drops dramatically in urban jungles because of signal reflecting.

Originally, the scientists at the Fraunhofer Institute for Reliability and Microintegration came up with their pocket-sized GSM/GPS system to localize freight or cars. These units have the same technology for these applications. On the one hand, they are somewhat larger and heavier, which means that they have more space for higher-performance antennas and storage batteries. On the other hand, the developers ran up against certain limits with the Kidfinder because they did not want them to be too heavy for kids so that they would carry them voluntarily. This is why they came up with the idea of combining the locating unit with a portable game console. "Children prefer carrying something like that around with them to some extra piece of equipment that isn't of any use to them," Hoherz explains. Kidfinder is not much bigger than an open matchbox and weighs less than 80 grams. It's a real lightweight and fits perfectly into the spare slot of your common or garden-variety game console. What's more, its storage battery has a capacity of 400 mAh which is enough for two days of operation. Finally, it can be charged with the console. The localization module offers the option of expanding the scope of the console's function by providing local information for ground games.

The Kidfinder was created as a joint project of the Fraunhofer Institute for Reliability and Microintegration and the Schmidt Engineering Office in the German city of Potsdam. By the way, the locating unit doesn't only react to parents' queries. It also independently monitors a zone it has been trained on – such as the way to school – and transmits a message when the child leaves this zone. Schmidt Engineering Office also has visualization software that transmits the position data of the locating units to cards for PCs or handhelds wherever necessary. While Schmidt Engineering Office is in charge of advancing the Kidfinder for market readiness, the researchers at the Fraunhofer Institute are working at making the unit even smaller by integrating it into an armband or belt for persons with dementia who easily lose their way and might need help.

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When design and technology form an alliance

Jörg Höltje from Studio Hausen in Berlin, Germany created a steel tube chair that takes its cue from organic forms in nature. This seat is lightweight and still sturdy and, as he emphasizes, "This chair is designed to be something akin to a bone because the steel tube has greater volume at highly stressed points." Although he made it generally as thin as possible to lend the chair a special elegance, he also gave it differing thicknesses at various points. His comment: "The legs and the sections of the lateral parts of the chair have thicker portions that look organic and remind you of calves or muscles."

You can design a lot of things on paper, but how can you produce a chair like this in real life? This was the problem that Rico Demuth tackled. He is working at the Fraunhofer Institute for Machine Tools and Forming Technology in Chemnitz, Germany. "It would have been possible to apply conventional technologies to build the individual components. That would have meant that the components were solid, not which isn't what the designer wanted," Rico knows.

Therefore, researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU put their heads together with Jörg to outline a manufacturing process for this chair. "We finally selected the next-generation technology of hydroforming for the legs and frame construction," Rico remembers. This is a technique that previously was used mainly in the automobile industry where a pipe filled with water is formed by controlled increase of inside pressure. It is in a tool that specifies to him the exterior contour that is calculated in advance according to CAD data. In this process, the tube can change its diameter without cracking. With other manufacturing methods, the diameter of the steel tube does always stay the same, it can only be bent. The seat of the chair is manufactured with a similar method: sheet metal hydroforming where the sheet-metal blank is formed into the desired shape with the pressure of water inside of a tool.

Hydroforming and inside high-pressure sheet metal forming technologies enabled Höltje to give the elements of his chair an elegant contour, form branches and let the object's structure look as if it were organically grown. This required full-fledged development work between the designer, engineer Demuth and the department head Markus Werner and his team. There are even a couple of prototypes of the chair they built and they illustrate both the technical possibilities and the aesthetic ingenuity of the hydroforming technology. The researchers at the Fraunhofer Institute for Machine

Tools and Forming Technology and the artist created a dialog to launch a project that sounds out the opportunities and potential of this technology for a wide range of new applications in the furniture industry. The Hydra steel tube chair will be shown to the public at the Euromold fair from December 1 to 4 in Frankfurt (Hall 11, Stand D66).

The Hydra steel tube chair is both lightweight and sturdy because the legs and frame construction were built with a special technique called hydroforming. (© Matthias Weingärtner)

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Radio chip and sensor in one

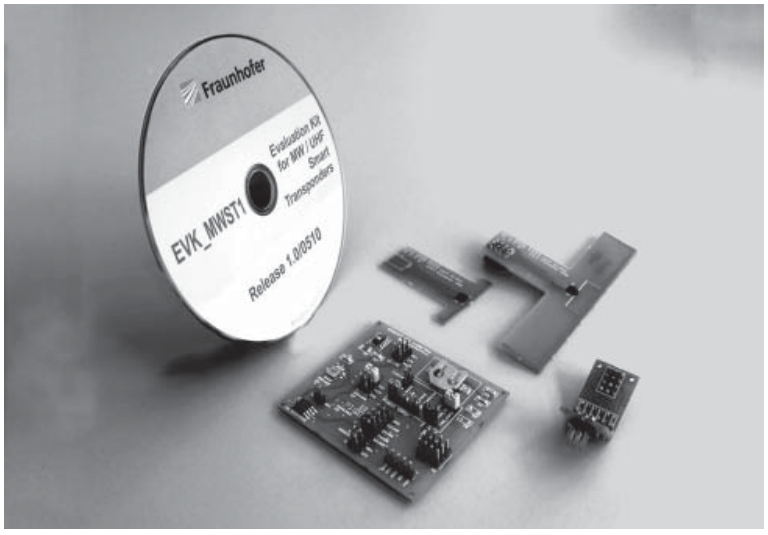
"Special storage instructions: The serum has to be stored at between +2° Celsius and +8° Celsius. Freezing as well as storage at a higher temperature has to be avoided as the efficacy and tolerability could be affected." Instructions of this kind are found on many package inserts. Drugs, vaccines or banked blood are very sensitive to temperature. Therefore, doctors, pharmacists and hospitals have a refrigerator for this purpose. But, what happens during transport between the pharmaceutical supplier and the ultimate customer? In order to monitor temperatures during transport, manufacturers can rely on a new RFID technology in future: If the temperature rises unexpectedly during refrigerated transport, the intelligent chip notices the variation immediately and reports the fact to the reader.

This extended RFID technology is a development of the Fraunhofer Institute for Photonic Microsystems IMPS located in Dresden. The researchers have fitted the small radio labels with a sensor. Now this new type of transponder transmits not only data, such as batch or identification numbers. They have integrated sensors which measure certain parameters: irrespective of whether it is temperature, pressure or humidity - the requested ambient parameter is permanently controlled in this way. "We have combined the UHF (Ultra-High Frequency) transponder technology with sensor technology," says project manager Hans-Jürgen Holland.

The UHF transponders transmit signals in a frequency range between 860 Megahertz and 2.45 Gigahertz, and have a larger transmission range than conventional RFID transponders. But, joining a transponder with a sensor module has been a challenge to researchers so far: "The maximum energy which can be transmitted to a UHF transponder is very low," explains Hans-Jürgen Holland. Passive tags are radio chips which draw the energy for signal transmission from the energy field of the reader – that is from the unit which receives and reads all data. Thus, passive transponders do not need a current source of their own, but however they can operate only in the range of the reader. As a rule this is between two and six metres in UHF transponders. "Given this tight energy balance, it has not been possible up to now to integrate sensory functions in addition," explains Hans-Jürgen Holland. "After all, the sensors need current as well. But now we have managed", says the researcher. A micro-controller on the module ensures that the data measured by the sensor are compressed and partially processed. In this way the data volume which the transponder transmits to the reader is decreased – the energy consumption decreases as well. In addition, the reader can transmit the command to control the sensors. Thus, they are not in

continuous operation. Now the researchers have developed a basic element which can be adapted to the requested applications of the customer. This module contains specifically manufactured chips suitable for series production which permit the transponder module and the sensor module to be coupled.

Researchers anticipate many areas of application for the UHF transponder technology, primarily in the medical field – they call it Lifetronics: apart from conventional batch documentation, the tags could be used to monitor the cold chain of blood products or vaccines. But, plasters could also be provided with the transponders. Moisture and temperature provide information on the progress of wound healing. During the Electronica Fair organised in Munich from 9th to 12th November (Hall A5, Booth 221), the experts will present an evaluation kit which consists of a motherboard, two antennas for UHF and MW range and the software. Thus, users can develop their individual solutions.



By means of the evaluation kit consisting of a motherboard, two antennas for UHF and MW range and software, users can develop their own solutions. (© Fraunhofer IPMS)

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