

Research News

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1 Electricity from straw

Researchers have developed the first-ever biogas plant to run purely on waste instead of edible raw materials – transforming waste into valuable material. The plant generates 30 percent more biogas than its predecessors. A fuel cell efficiently converts the gas into electricity.

2 Automatic measuring stations for pollen

The snow is thawing, the first crocuses are fighting their way through the cold earth into the daylight and hay fever sufferers are already pulling out their handkerchiefs. A new type of measuring station will automatically determine the pollen count and thus improve the forecast.

3 Artificial intelligence – child's play!

Scientists have developed a computer game called "Gorge" – designed to help children understand artificial intelligence through play, and even to change it. It can also improve the children's social interaction skills.

4 The cockpit of the future

Research scientists have developed a novel car dashboard that functions as a 3-D display and shows velocities, engine speeds or warnings in three dimensions. The display's design can be chosen individually by the driver.

5 RFIDs transmit through metal

Metal efficiently blocks radiation, such as that emitted by RFID chips – small data storage units that are integrated in various objects and transmit their information to a reading device. Now, it is possible to access the information on an RFID chip even if it is surrounded by metal.

6 Nano-structured parts

Materials with a nanoparticle structure are stronger and harder than materials made of larger particles. A new manufacturing technique ensures that such microcrystalline structures remain intact when being processed.

7 Second Emmy for the H.264 video standard

The Joint Video Team recently received the Technology & Engineering Emmy® AWARD in the "Daytime" category for developing the H.264/MPEG4-AVC video standard. This same standard had already been awarded the tech Emmy in the "Primetime" category last year.



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The new biogas plant is the first-ever to run exclusively on waste material such as corn stalks. There is no need to add edible crops.

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Electricity from straw

"Corn belongs in the kitchen, not in biogas facilities" – objections like this can be heard more and more frequently. They are protesting against the fermentation of foodstuffs in biogas plants that generate electricity and heat. One thing the opponents are afraid of is that generating electricity in this way will cause food prices to escalate. In collaboration with several small and medium-sized enterprises, research scientists at the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden have developed the first-ever biogas plant that works entirely without edible raw materials. "In our pilot plant, we exclusively use agricultural waste such as corn stalks – that is, the corn plants without the cobs. This allows us to generate 30 percent more biogas than in conventional facilities," says IKTS head of department Dr. Michael Stelter. Until now, biogas plants have only been able to process a certain proportion of waste material, as this tends to be more difficult to convert into biogas than pure cereal crops or corn, for instance.

This is not the only advantage: The time for which the decomposing waste material, or silage, is stored in the plant can be reduced by 50 to 70 percent. Biomass is usually kept in the fermenter, building up biogas, for 80 days. Thanks to the right kind of pre-treatment, this only takes about 30 days in the new plant. "Corn stalks contain cellulose which cannot be directly fermented. But in our plant, the cellulose is broken down by enzymes before the silage ferments," Stelter explains.

The researchers have also optimized the conversion of biogas into electricity. They divert the gas into a high-temperature fuel cell with an electrical efficiency of 40 to 55 percent. By comparison, the gas engine normally used for this purpose only achieves an average efficiency of 38 percent. What is more, the fuel cell operates at 850 degrees Celsius. The heat can be used directly for heating or fed into the district heating network. If the electrical and thermal efficiency are added up, the fuel cell has an overall efficiency of up to 85 percent. The overall efficiency of the combustion engine is usually around 38 percent because its heat is very difficult to harness. The researchers have already built a pilot plant with an electricity output of 1.5 kilowatts, enough to cover the needs of a family home. The researchers will present the concept of the biogas plant at the Hannover-Messe on April 20 to 24 (Hall 13, Stand E20). In the next phases of the project, the scientists and their industrial partners plan to gradually scale up the biogas plant to two megawatts.



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In future, a new type of fully automated weather station will measure current pollen levels and transmit the data to the German weather service.

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Automatic measuring stations for pollen

"And here is the pollen forecast for tomorrow: Low levels of alder and hazel..." – we are all familiar with such reports from the radio and the television, but they are not always very reliable. The forecast is based on the weather and the amount of pollen currently in the air. The problem is that few data on current pollen levels are available, as it is difficult and time-consuming to obtain them. Ambient air flows onto a piece of adhesive tape, and the pollen sticks there. Laboratory workers examine the trapped pollen under a light-optical microscope and count the quantities of different grains. This is a tedious procedure and is only carried out at selected locations. A truly reliable forecast would require a closer-knit network of measuring stations.

The German weather service has therefore ordered 15 measuring stations: Researchers at the Fraunhofer Institute for Applied Information Technology FIT and for Toxicology and Experimental Medicine ITEM have developed these in collaboration with scientists working for Helmut Hund GmbH. The innovative feature is the analysis method: The stations determine the pollen composition fully automatically and transmit the data to the weather service. "To do this the stations, which are housed in a large container, ingest a controlled amount of air. The pollen grains contained in this air are cleansed of any impurities and deposited on a carrier, " says Prof. Dr. Thomas Berlage, director of Life Science Informatics at FIT. The object carrier, a thin sheet of glass, is covered with a layer of gel. The pollen grains sink into this gel. A light-optical microscope automatically takes pictures of the pollen. However, there is a difficulty: In these two-dimensional images, the primarily spherical pollen grains – regardless whether they come from birch, hazel or alder trees – are only displayed as circles. When viewed in three dimensions, however, the different types of pollen exhibit differences such as furrows. "To overcome this difficulty, the microscope examines 70 different layers by automatically readjusting the focus 70 times, " explains Berlage. In some views the highest point of a pollen is in focus, in others the center. For each level, the system calculates the points that are most clearly pictured. It then combines all these points to form a two-dimensional image that contains the three-dimensional information – the image shows the "flattened" top half of the pollen. If a pollen grain has a furrow at this point, it can be seen on the image. From this information, the system calculates certain mathematical features, compares these with a database, and determines the type of pollen. The results are available within one or two hours and are transmitted to the weather service via a network connection.





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Artificial intelligence - child's play!

Intelligent robots come to life – a popular theme of science fiction movies. The creatures break away from their makers, develop feelings, become superior to humans, and ultimately attempt to conquer the world. The phenomen of artificial intelligence, AI for short, has fascinated mankind since before the time of Frankenstein.

Researchers at the Fraunhofer Institute for Digital Media Technology IDMT in Ilmenau now plan to teach even children what AI is all about. "To do this, we have developed a very simple computer game called 'Gorge'," says IDMT head of department Prof. Klaus Peter Jantke. "Gorge enables children to find out through play how AI works, because they can influence it themselves." The rules of Gorge are simple: Teams of pieces have to move around a board and reach a destination, rather like in 'Ludo'. The die decides where a piece has to move to. Jostling is allowed – so if a piece lands on a square already occupied by another piece, it is pushed onto the next unoccupied square. The paths are crisscrossed by gorges – hence the name of the game. A piece can only cross a gorge if helped by another piece. Then this piece can decide whether to help the other piece get out again or leave it to perish in the gorge – in other words, it can adopt the role of a hero or a villain.

"The great thing about this game is that not only people can play against each other. You can also play against the computer, or have one computer play against another," says Jantke. "That's even more exciting because the person can set how 'good' or 'bad' the machine is. "For example, the player can define a rule that says: "If you find someone in a gorge, you must always pull them out." Or: "Never go into a gorge." In this way, children can decide for themselves whether they prefer to play against a good or a bad opponent. And they can observe what sort of behavioral patterns the artificially intelligent machine develops, whether its actions are more aggressive or more defensive.

What happens when several "baddies" play against each other? Who wins if all the players are good? Do the "goodies" always beat the "baddies"? Children can make interesting observations about AI and thus learn a lot about it. The researchers will be presenting a prototype of "Gorge" at CeBIT in Hannover (Hall 9, Stand B36) on March 3 to 8.



© Fraunhofer HHI

The novel car dashboard shows velocities or models of the town in three dimensions.

Picture in color and printing quality: www.fraunhofer.de/press

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The cockpit of the future

A driver gets into his car and turns the ignition key. The dashboard, which was black just a moment ago, now reveals itself as a 3-D display with a simple but modern design. If his son were at the wheel, the controls for the mp3 player would now appear in the foreground: "Please select an artist". After choosing some music, he would set off. The display would show a 3-D model of the town, and the integrated navigation system would direct him to his destination. The car owner, however, prefers other types of information, such as the latest traffic reports. He also likes to have the rev counter in view at all times. After he has driven for a while, the display changes and an alert message literally jumps out at him: "Please refuel".

The new 3-D cockpit developed by researchers at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI in Berlin not only looks classy but also offers a variety of useful functions. While conventional dashboards have a round disk with a scale and moving mechanical hands to indicate the velocity, and another for the engine speed, the new display is digital and shows three-dimensional depth images. "The information most important to the driver at any given time is displayed in the foreground – be it the air pressure, the route or the title of the song currently playing," says HHI project manager Dr. René de la Barré. So how does the system know which information the driver wants to see, and when and in what size? "Before setting off, the driver can choose how he wants the information to be displayed, and can save these preferences," the expert explains. The depth images are made possible by sophisticated equipment: Two cameras inside the car measure the position of the driver's eyes and the distance between them – in real time. The two superimposed images that generate the 3-D effect on the display are thus individually adapted to the driver's vision. This ensures the full effect from every viewing direction and every sitting position.

A round or a ladder-like scale? Blue or red background light? The 3-D cockpit can be personalized, so each driver can individually set their preferred design and functional navigation menu. The researchers will be presenting the first prototype of the cockpit display at CeBIT in Hanover on March 3 to 8 (Hall 9, Stand B36).



© Fraunhofer IMS

The adapter, here being inserted into the spindle (below), contains an RFID chip. The finger is pointing towards the coils which wirelessly transmit the information stored on the chip to the spindle.

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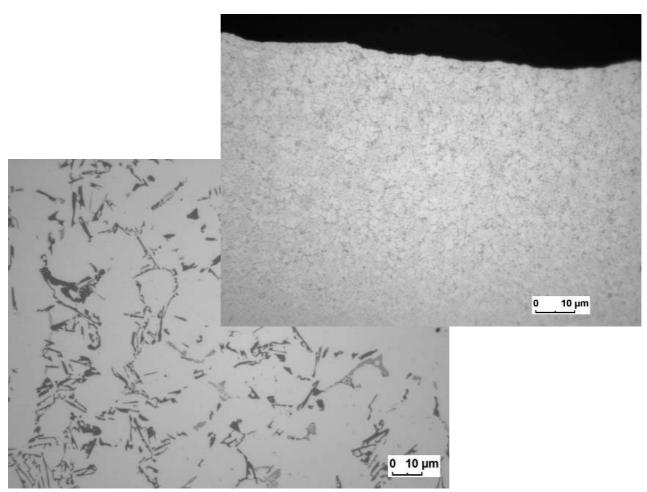
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RFIDs transmit through metal

Machining processes call for the utmost precision, often down to the nearest hundredth of a millimeter. If a milling cutter or drill is worn out, it can no longer guarantee this precision. The tools therefore have to be regularly surveyed before they are put to work on the processing machine. They revolve during the inspection so that even the smallest deviations from their rotational path can be detected. At present, such inspections are performed manually. Drills have to be placed in a holder, or spindle, with a suitable adapter. The tool and the adapter each have their own serial number. These and other data, such as the dimensions, are typed into a computer by hand. Errors creep in all too easily.

This process is set to become easier in the future. On behalf of Kelch & Links GmbH in Schorndorf, researchers at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg have found a way of integrating RFID chips in metal tools for the first time. On request, the tiny data carriers transmit information to a reading device located outside the metal spindle holding the tool and adapter. The main challenge involved is that metal efficiently blocks radiation – as anyone who has tried to use their cell phone inside a house made of reinforced concrete will be able to confirm. The same applies to RFID chips: If they are located inside objects made of metal, their information cannot penetrate the material to reach the reading device. "We have now split up the transmission path," explains IMS group manager Dr. Gerd vom Bögel. "From the RFID chip, which is located inside the adapter, the data are first transmitted via a cable to the interface between the adapter and the spindle. From here, they are forwarded wirelessly to the spindle by two antenna coils, one of which is in the insertion module, the other in the spindle. The interface between the rotating spindle and the stationary part of the measuring device is also bridged wirelessly."

A small batch of the new RFID measuring devices, integrated in tools made by Kelch & Links GmbH, is already being used by selected customers. Vom Bögel also envisages other areas of application: "This transmission principle can be applied wherever information needs to be transmitted wirelessly across several path segments – for instance in a robot arm with swiveling joints."



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Structure of a conventional (bottom left) and a microcrystalline (top right) aluminum alloy.

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Nano-structured parts

Aluminum is light but also bends easily. However, if it has a nanometer structure, it features quite different properties: The material is much stronger and firmer, and this makes it ideal for engine screws, which have to withstand high temperatures. It is also eminently suitable for making lightweight parts, for the stronger the material, the thinner the sheets for the components can be made. The material's properties are mainly due to the tiny size of its crystals. These are much smaller than those in conventional materials, hence the designation "microcrystalline structures".

One of the challenges posed by such nano materials lies in processing them to make tools or components. Pressing or joining requires that the material be heated. This causes the crystals to grow, so the structures become larger. In short, the material loses its "nano properties" as it heats up. Researchers at the Fraunhofer Institute for Manufacturing Engineering and Applied Materials Research IFAM in Dresden have risen to the challenge. "Our goal is to preserve the material's microcrystalline structure throughout the entire component manufacturing process," states IFAM project manager Dr. Ronny Leuschner. To this end, the researchers have set up a special technology chain for manufacturing nano-structured aluminum and other materials. "First of all, we produce a special aluminum alloy," says Leuschner. "The metal melt has to be cooled very rapidly, so we virtually freeze it." This is done using the "melt spinning" technique: A specially developed spraying device pours the melt onto a water-cooled rotating roller, producing uniform strips or "flakes" no more than a few micrometers thick. As soon as it hits the roller, the melt rapidly loses heat and the flakes solidify at top speed. The advantage of this system is that it can handle several kilograms of material and withstand temperatures of more than 1700 degrees Celsius. "Once they have solidified, the flakes need to be compacted and pressed into the desired shape," explains Leuschner. During this step, too, their microcrystalline structures must remain intact. The method the researchers use in this case is spark plasma sintering: High-frequency current pulses inside the press compact the material in a very short space of time so that the fine microstructures are preserved. Applications for these nano materials range from lightweight aluminum parts with greater strength and improved wear and corrosion resistance, to hydrogen storage, energy production with thermoelectric materials, and electrical engineering.



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Prof. Dr. Thomas Wiegand is delighted to receive his second Emmy.

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Second Emmy for the H.264 video standard

Mobile television, high-resolution TV, films on DVD, videos on cell phones – all this is only possible thanks to video compression. The compression standard ITU-T Recommendation H.264 / ISO/IEC 14496-10 AVC, or H.264 for short, is particularly efficient. It reduces the data rate required for transmitting a video by more than half without compromising quality.

The standard's developers were officially presented with the Technology & Engineering Emmy® Award 2009 by the National Academy of Television Arts & Sciences (NATAS) at the International Consumer Electronics Show in Las Vegas. The prize was received by the leaders of the Joint Video Team, Thomas Wiegand (Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI), Gary J. Sullivan (Microsoft), Ajay K. Luthra (Motorola) and Jens-Rainer Ohm (RWTH Aachen). The Joint Video Team is sponsored by the International Telecommunications Union (ITU), the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The Emmy is the most distinguished television prize in the United States and is awarded by three organizations. NATAS presents the awards for films and programs shown during the daytime as well as for sports and news broadcasts and for technical categories. Evening programs are honored by the Academy of Television Arts & Sciences (ATAS) based in Los Angeles, and foreign TV broadcasts are acknowledged by the International Academy of Television Arts & Sciences based in New York.

This is the second time the H.264 video standard has won an Emmy, having already received the Primetime Emmy for Technology & Engineering from ATAS in Hollywood in 2008. Prof. Dr. Thomas Wiegand can be particularly proud of this second award, for the developers of H.264/MPEG4-AVC are the only ones to have received two Emmys in different categories. The Fraunhofer scientist has written and edited a comprehensive set of H.264 specifications and also contributed significantly to the standard's technical content together with his team at the HHI. Much of the work carried out at the HHI has been sponsored by the German Federal Ministry of Education and Research (BMBF).

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The global alignment of industry and research has made international collaboration imperative. Furthermore, affiliate Fraunhofer Institutes in Europe, in the USA and Asia ensure contact to the most important current and future economic markets.

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