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RESEARCH NEWS

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Phone: 089 1205-1302
presse@zv.fraunhofer.de
www.fraunhofer.de/presse

1 Interactive Window Shopping

Researchers want to make shopping trips a special experience in future by enabling passers-by to operate window displays with hand and facial gestures. Four cameras record the 3-D positions of people's hands, face and eyes and transform them into commands for selecting and purchase goods – even after the shop has closed.

2 Impregnating plastics with carbon dioxide

Everyone has heard that carbon dioxide is responsible for global warming. But the gas also has some positive characteristics. Researchers are now impregnating plastics with compressed CO_2 in a process that could lead to new applications ranging from colored contact lenses to bacteria-resistant door handles.

3 Radiometer finds sources of fire

Forest fires usually spread out of control very quickly. Fires that produce a lot of smoke are particularly challenging for the emergency services, because the source of the fire is then especially hard to find. A new radiometric sensor can pinpoint the heart of the flames, even when visibility is limited.

4 Minerals provide better indoor air

One of the sources of emission for pollutants in living spaces are particleboards glued with adhesives that contain formaldehyde. There is a new method that will now provide another way to reduce these vapors. The trick can be found in special minerals that equip wood materials with properties for cleaning air in living spaces.

5 Learning while driving

Everyone learns differently. Research scientists have therefore developed a system which adapts learning content to specific individual requirements. LogiAssist addresses the needs of companies in the logistics sector and long-distance truck drivers. They can learn while out on the road using audio lectures, text documents or video.

6 Eating low-fat, thanks to lupin proteins

Food should be delicious, healthy and sustainably produced. Researchers are working on new methods to use as many parts of plants as possible for nutrition. In the future, vegetable ingredients could replace animal raw materials. Lupin seeds, for instance, can be used to produce low-fat, exquisite sausage products.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 60 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 1.7 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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Interactive Window Shopping

A woman passing by the window display is captivated and asks her companion "Isn't the leather bag chic?" "Which one do you mean? There are so many of them." The woman points to one of the bags and as if by magic the luxurious purse appears on a display behind the shop window. Then she points to a button and the designer object rotates on the screen. "So that's what it looks like from the back." The woman passing by is impressed. She makes another gesture to zoom the bag towards her letting her to see every detail.

This particular shopping experience is courtesy of new type of 3-D camera system from the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute (HHI) in Berlin, Germany. Its interactive shop window enables people passing by to put goods behind shop windows onto a display with simple hand and facial gestures. Paul Chojecki is a scientist at the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute and he puts it this way: "Interactive shopping has been standard operating procedure in the web for a long time. Now, we're putting this technology into pedestrian passageways and shopping centers with the entire unit behind the window."

Four little cameras continually record the 3-D positions of the hands, faces and eyes of persons passing by. Then, image-processing software calculates the coordinates and transforms them into the corresponding inputs for selecting goods, viewing them in detail and immediately purchasing them – even after business hours. Anyone interested can have also themselves shown product information such as color, material, price, availability and information on the manufacturer. Paul Chojecki remarks that "there's nothing comparable in Germany yet and today shops only use touchscreens in shop windows, if at all. But, you can interact with our interactive shop window without any physical contact, which is a benefit if hygiene is important to you."

The interactive shop window consists of four cameras and visualization software. Two of these stereo cameras record the face and eyes while the other two record the motion of the hands. Image processing recognizes both gestures such as when you turn your hand and when you point to a button with your finger that you can see on a monitor. The researcher adds that "the system doesn't store any personal data and only the coordinates of the body parts it recognizes are passed onto the visualization."

Interactive shop window is compatible with all displays and the shop owner can select any monitor size or type of monitor from plasma, LED, LCD, projection or reprojection screens. Beyond this, shop owners can link the system with any software already there such as content management or merchandise information system enabling them to portray all of their stock of goods on the display. The way the payment process is taken care of is also left up to the shop owner. But that's not all. The interactive shop window not only identifies how many people are in front of the shop window, but it also can suggest on the basis of the gathered data what products and information the people passing by are interested in. Finally, it has customized greeting texts on the display to guarantee a close bond to the customer.

The interactive shop window was developed for use in shopping centers and the retail trade, although Chojecki thinks it would be possible to install it in museums or at trade fairs. This 3-D recording system is only a prototype at present, but the researchers will be demonstrating it at the CeBit Fair in Hannover, Germany Fraunhofer's joint stand (Hall 9, Stand B36) March 1 to 5, 2011.

Women passing by the shop window can get the facts on the scarf they are interested in with the shop window display and even buy it then and there. (© Fraunhofer HHI)

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Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute HHI
Einsteinufer 37 l 10587 Berlin, Germany l www.hhi.fraunhofer.de
Contact: Paul Chojecki l Phone +49 30 31002-281 l paul.chojecki@hhi.fraunhofer.de
Press: Dr. phil. Gudrun Quandel l Phone +49 30 31002-400 l gudrun.quandel@hhi.fraunhofer.de

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Impregnating plastics with carbon dioxide

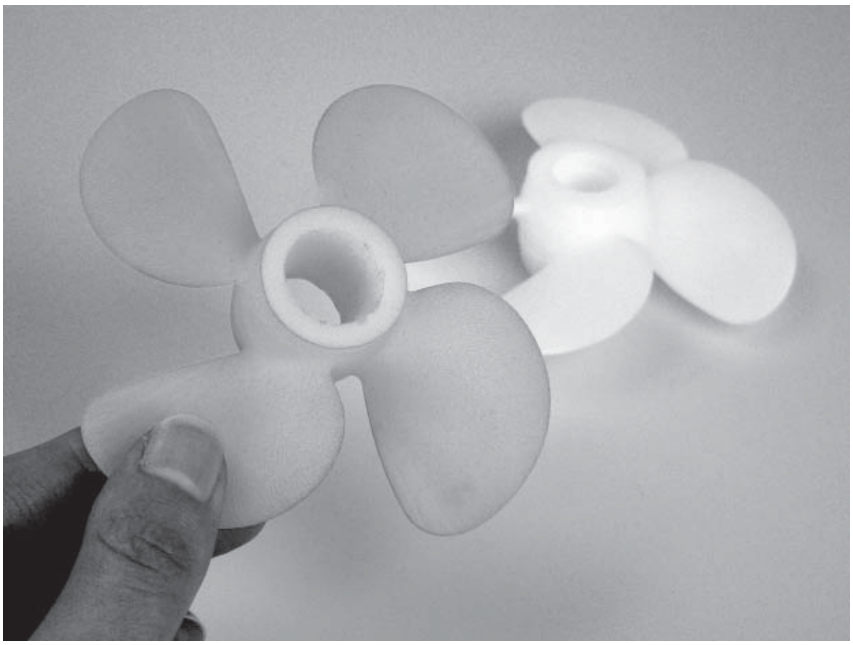
CO_2 is more than just a waste product. In fact, it has a variety of uses: the chemical industry makes use of this colorless gas to produce urea, methanol and salicylic acid. Urea is a fertilizer, methanol is a fuel additive, and salicylic acid is an ingredient in aspirin.

Researchers at the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen are pursuing a new idea by testing how carbon dioxide can be used to impregnate plastics. At a temperature of 30.1 degrees Celsius and a pressure of 73.8 bar, CO_2 goes into a supercritical state that gives the gas solvent-like properties. In this state, it can be introduced into polymers, or act as a "carrier" in which dyes, additives, medical compounds and other substances can be dissolved. "We pump liquid carbon dioxide into a high-pressure container with the plastic components that are to be impregnated, then steadily increase the temperature and the pressure until the gas reaches the supercritical state. When that state is reached, we increase the pressure further. At 170 bar, pigment in powder form dissolves completely in the CO_2 and then diffuses with the gas into the plastic. The whole process only takes a few minutes. When the container is opened, the gas escapes through the surface of the polymer but the pigment stays behind and cannot subsequently be wiped off," explains Dipl.-Ing. Manfred Renner, a scientist at Fraunhofer UMSICHT.

In tests, the researchers have even managed to impregnate polycarbonate with nanoparticles that give it antibacterial properties. E-coli bacteria, placed on the plastic's surface in the institute's own high-pressure laboratory, were killed off completely – a useful function that could be applied to door handles impregnated with the same nanoparticles. Tests conducted with silica and with the anti-inflammatory active pharmaceutical ingredient flurbiprofen were also successful. "Our process is suitable for impregnating partially crystalline and amorphous polymers such as nylon, TPE, TPU, PP and polycarbonate," states Renner, "but it cannot be applied to crystalline polymers."

The process holds enormous potential, as carbon dioxide is non-flammable, non-toxic and inexpensive. Whilst it shows solvent-like properties, it does not have the same harmful effects on health and on the environment as the solvents that are used in paints, for example. Painted surfaces are also easily damaged and are not scratch-resistant. Conventional processes for impregnating plastics and giving them new functions have numerous drawbacks. Injection molding, for instance, does not permit the introduction of heat-sensitive substances such as fire retardants or UV stabilizers.

Many dyes change color; purple turns black. "Our method allows us to customize high-value plastic components and lifestyle products such as mobile phone shells. The best about it is that the color, additive or active ingredient is introduced into layers near the surface at temperatures far below the material's melting point, in an environmentally friendly manner that does away with the need for aggressive solvents ," says Renner. The process could, for example, be used to dye contact lenses – and lenses could even be enriched with pharmaceutical compounds that would then be slowly released to the eye throughout the day, representing an alternative to repeated applications of eye drops for the treatment of glaucoma. According to the scientist, this new impregnation method is suitable for a broad range of new applications.



This propeller was dyed yellow in only five minutes at 90 degrees Celsius and 200 bar. At this pressure, the yellow dye powder dissolved in the CO_2 which transferred it into the plastic. (© Fraunhofer UMSICHT)

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Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT
Osterfelder Straße 3 l 46047 Oberhausen, Germany l www.umsicht.fraunhofer.de
Contact: Dipl.-Ing. Manfred Renner l Phone +49 208 8598-1411 l manfred.renner@umsicht.fraunhofer.de
Press: Iris Kumpmann l Phone +49 208 8598-1200 l iris.kumpmann@umsicht.fraunhofer.de

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Radiometer finds sources of fire

The number and scale of forest fires has increased dramatically in recent decades. Who can forget last summer's television images of blazing infernos devouring miles and miles of forest in Russia, Australia and California? In Germany, too, several regions are under threat precipitated by climate change – Brandenburg, for example, is one of the areas of Europe that are most at risk.

Often, fires can only be contained from the air. In order to fight them in a targeted way, firefighting planes need to be given precise information on where the flames are at their worst. Infrared (IR) cameras have long been a trusted aid, since fire glows most intensely in the infrared range. IR cameras measure the intensity of the heat radiation emanating from a forest fire, and this leads them to its source. But despite the high-resolution images such cameras produce, they cannot be used to find the source of a fire in very smoky conditions because the dust and smoke severely dim the infrared rays.

Researchers from the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg have found a way around this problem by developing a radiometer that can scan fires even when visibility is limited. The radiometric sensor works in the microwave range between 8 and 40 GHz. At these low frequencies, radiation is scattered far less by dust particles than at the high IR frequencies. "Measurements we took during testing showed that the dimming effect was negligible at 22 GHz. Particles of dust and smoke are practically transparent in the microwave range, but the radiation is still strong enough for the source of a fire to be detected. From a height of 100 meters, we were able to locate fires measuring five meters by five meters in low visibility conditions," says Dipl.-Ing. Nora von Wahl of Fraunhofer FHR. For the test flights, the scientist and her team mounted the microwave sensors on the underside of an unmanned airship belonging to the FernUniversität Hagen. "Along with the sensors themselves, the radiometer comprises a calibrating unit, a planar antenna array, and software for recording and visualizing the data," says von Wahl. The system's resolution is determined by the antenna's angular aperture, so it depends on the size of the antenna, the frequency and the distance from the ground. Using an antenna measuring 20 centimeters at its outer rim, operated at a frequency of 22 GHz and from a height of 30 meters, the radiometer can resolve details on the ground to a grid accuracy of 2.6 meters. "The radiometer doesn't give us as much detail as an infrared camera," says the scientist, "but if we increase the size of the antenna we can achieve higher resolution."

The radiometric sensor allows the researchers to locate pockets of fire even behind a curtain of foliage. "After a forest fire, it is often the case that new fires start underground. To find them, firefighters have to go in and dig around by hand. Our radiometer can detect fires below the top layer of earth," says von Wahl. She goes on to explain that the system is principally suited to fire protection with firefighting planes, but could also be used to monitor industrial sites. This would, for instance, enable early detection of smoldering fires at waste incineration plants.

The radiometer, which measures 105 by 150 by 73 millimeters, is currently a prototype. The scientists' aim is to make the device even smaller, and they also want to optimize the antenna. Future designs will be based on microchips.

Test flight: Mounted on an airship belonging to the FernUniversität Hagen, the radiometer can detect the sources of fire even in low visibility. (© Wolfgang Krüll)

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Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR
Neuenahrer Str. 20 l 53343 Wachtberg, Germany l www.fhr.fraunhofer.de
Contact: Dipl.-Ing. Denis Nötel l Phone +49 228 9435-578 l denis.nötel@fhr.fraunhofer.de
Press: Dipl.-Volksw. Jens Fiege l Phone +49 228 9435-323 l jens.fiege@fhr.fraunhofer.de

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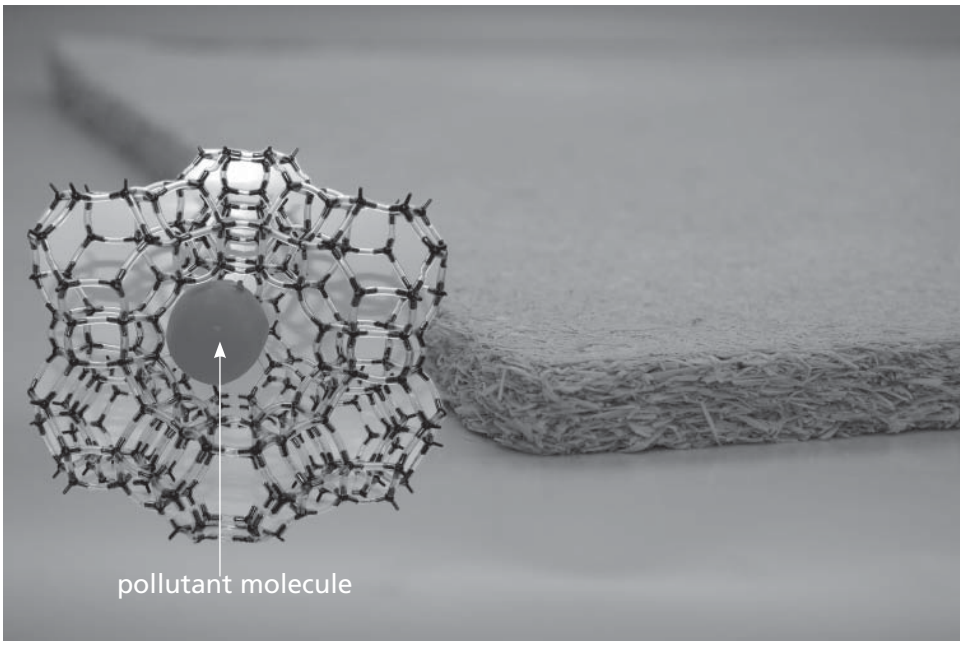
Minerals provide better indoor air

Since the 50s, formaldehyde has been the basic material for many artificial resins and glues used in particleboards and plywood boards. Estimates indicate that more than 85 percent of all wood materials have adhesives containing formaldehyde. This substance escapes from the materials and, along with other sources, pollutes indoor air. This is why numerous ways have been developed to reduce emissions, and the International Agency for Research on Cancer (IARC) of the World Health Organization WHO has even classified formaldehyde as carcinogenic for humans. Thereupon both the existing threshold value of 0.1 ppm issued by Germany's then-Federal Health Office in 1977 and WHO's standard value of 100 micrograms per cubic meter (µg/m³) have been confirmed.

Researchers at the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI in Braunschweig, Germany, and the Fraunhofer Institute for Silicate Research ISC in Würzburg, Germany, have found a new method to reduce formaldehyde emissions from particleboard: modified zeolites. These are aluminosilicates that function as a molecular sieve due to their extremely large inner surface and porous structure so that they can absorb formaldehyde particularly well. Dr. Katrin Bokelmann ought to know because she is the project manager at the Fraunhofer Institute for Silicate Research who, along with her team, is in charge of manufacturing mineral compounds. As she puts it: "Zeolites are already used as a filling material in particleboards, but it's an entirely new idea to use them for adsorbing pollutants in wood materials."

The researchers were not able to achieve sufficiently high rates of adsorption in their tests of various commercially available or natural minerals. The best adsorption properties of these aluminosilicates were measured in synthetic zeolite Y, which the experts modified and improved with amino groups. Dr. Jan Gunschera is the project manager at the Fraunhofer Institute for Wood Research and this is how he sees it: "We noticed a 70 percent boost in the adsorption rate after we added formaldehyde to the processed material in our measuring chambers and then we put five percent by weight of the zeolite powder directly into our sample particleboards made of spruce roundwood. The result was that formaldehyde emissions from the board dropped 40 percent – both short-term and long-term tests of one month confirm these findings. In other words, the air in living spaces should be measurably improved. Our tests indicate that this technology can even reduce indoor air pollutant levels." The properties of the wood materials did not undergo any negative influence from the zeolites, it was reported.

The researchers have applied for a patent for the new technique and think that modified zeolites – worked into furniture or ceiling panels – could conceivably reduce not only formaldehyde but also other aldehyde levels in indoor air. Scientists are currently looking for partners from the wood materials industry to mass-produce particleboards. A sample panel is on display at the Bau fair in Munich, Germany, from January 17 to 22 at Fraunhofer's joint stand 131 in Hall C2.



The structural model of a mineral with the dispersed pollutant molecule. When it is introduced into particleboards, the mineral reduces formaldehyde emissions from the wood material. (© Fraunhofer ISC)

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Fraunhofer Institute for Wood Research - Wilhelm-Klauditz-Institut WKI | www.wki.fraunhofer.de |
Fraunhofer Institute for Silicate Research ISC | www.isc.fraunhofer.de |
Contact: Dr. Jan Gunschera | Phone 531 2155-352 | jan.gunschera@wki.fraunhofer.de |
Dr. Katrin Bokelmann | Phone +49 931 4100-403 | katrin.bokelmann@isc.fraunhofer.de |
Press: Simone Peist | Phone +49 531 2155-208 | simone.peist@wki.fraunhofer.de |
Marie-Luise Righi | Phone +49 931 4100-150 | marie-luise.righi@isc.fraunhofer.de |

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Learning while driving

The days are long gone when all you needed to be a truck driver was a heavy goods vehicle license and the ability to read a map. Nowadays it is a skilled occupation which requires lots of qualifications. Modern truck drivers have to operate electronic devices, adapt their routes expertly to the given traffic and loading situation, know how to drive fuel-efficiently, be up to date with statutory regulations and monitor the safety of their load. Then there is all the complex legislation introduced at EU level. What's more, drivers who make trips to other countries also need some knowledge of foreign languages and have to be familiar with the regulations applying in different countries. Modern truck drivers always have something new to learn, and are even obliged by law to keep up with developments. The problem is that they spend most of their time behind the wheel. Trucks only earn money when they are out on the road and so the driver's time for anything else is very limited.

With this in mind, research scientists at the Fraunhofer Institute for Applied Information Technology FIT in Sankt Augustin, working in close cooperation with partners from the logistics and training sectors, have developed LogiAssist. "The purpose of the system is to help drivers and trucking firms handle their occupational training needs," explains project manager Dr. Martin Wolpers. The idea is for truckers to listen to an audio lecture after work, during their breaks, or even while driving, and to receive specifically tailored assistance while they are out on the road. Training content is offered via smart phone, tablet computer or laptop – in other words, on devices the driver already uses in his cab. It is tailored to the learning needs of the sector and can be adapted to the relevant context, taking account of prior knowledge, the driver, the vehicle, the load or the route.

The group of research scientists at the Fraunhofer FIT has been working for years on the development of such learning environments in the EU project ROLE – Responsive Open Learning Environments (www.role-project.eu). "We are addressing the needs of several target groups," adds Wolpers. "These include university students, knowledge workers, suppliers of educational materials and also people with mobile non-desk jobs such as truck drivers – basically anyone who wants to learn by electronic means." The scientists have worked out standards and applications which enable learners to use a wide range of materials on an individually configured learning platform. The content can be put together from a kit of ready-made tools, which can be operated with the software users are familiar with, including the same browsers and search engines. People can also learn in groups and contact other participants on the online course

by chat program, Outlook or Skype. The learning environment is designed to adapt to the learning and working style of the individual. Some may prefer to work through the course on screen using documents, others will mainly use short course sub-units on their cell phone as a video sequence or audio file.

From March 1 to 5 the Fraunhofer FIT will be demonstrating the practical application of these individual learning environments at CeBit in Hanover, Hall 9, Stand B36. Visitors will have the opportunity to try out LogiAssist for themselves. They can also see how Chinese students used ROLE to learn English in a very different way , by putting together their own learning programs.

Truck drivers can develop their occupational skills with the LogiAssist system, for example using a smart phone. (© Fraunhofer FIT)

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Fraunhofer Institute for Applied Information Technology FIT
Schloss Birlinghoven l 53757 Sankt Augustin, Germany l www.fit.fraunhofer.de
Contact: Dr.-Ing. Martin Wolpers l Phone +49 2241 14-2128 l martin.wolpers@fit.fraunhofer.de
Press: Alex Deeg l Phone +49 2241 14-2208 l alex.deeg@fit.fraunhofer.de

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Eating low-fat, thanks to lupin proteins

In emerging countries such as China or Brazil, meat consumption is rising dramatically. Indeed, worldwide consumption of red meat has quadrupled since 1961. The United Nations Food and Agriculture Organization (FAO) expects increasing prosperity to lead to a doubling of global meat production by the year 2050. The question is whether our planet, with its limited farmland resources, will still be able to meet all of our needs into the future. Possible solutions for the brewing dilemma are familiar to Dr.-Ing. Peter Eisner of the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising, Germany.

It takes a lot of land to produce meat. "Producing a kilogram of meat consumes between seven and 16 kilograms of grain or soybeans as animal feed," Eisner reports. "As a result, in the US around 80 percent of grain is fed to livestock." Compared to meat production, the cultivation of plants as a food source is considerably less land-intensive. It takes 40 square meters to produce a kilogram of meat, yet that same space could produce 120 kilograms of carrots or 80 kilograms of apples instead. As the researcher points out: "Plants are a source of high-quality foodstuffs, but they can also provide raw materials for technological applications – and are a source of energy." He demonstrates this in the case of sunflower seeds: up until now, they were used for oil production, their residues serving as low-grade livestock feed. As a result, a 2 ½ -acre parcel of land could be expected to yield around 950 euros. If all of the components were processed and converted to high-quality raw materials for the food, cosmetics and fuel industry, that same parcel would generate some 1770 euros in income.

Plant-based food ingredients can be expected to play a particularly important role as a substitute for raw materials derived from animals. Eisner presented a "milk substitute" made from lupin proteins and suitable as a basis for foods such as ice cream or cheese. It contains no lactose, has a neutral flavor, is cholesterol-free and rich in polyunsaturated fatty acids. Lupin seeds are also the basic ingredient in a new vegetable protein isolate with fat-like properties that has been developed by IVV researcher Daniela Sussmann. A special production method applied to the lupin seed yields a highly viscous protein suspension with a very creamy consistency. "The microscopic structure of this product resembles that of the fat particles in sausage meat. So you can use it to produce low-fat sausage products that taste just as good as the original," the researcher added. In sensory tests she investigated whether adding lupin protein could improve the juicy and creamy impression of a low-fat sausage

recipe. With success: "By adding 10 percent protein isolate, we were able to markedly improve the fat-like impression of low-fat liverwurst."

Since sausage products are among the foods with the highest levels of fat, this would certainly be a step in the right direction. On average, a German eats 31 kilograms of sausage products each year. The result: An overweight population and cardiovascular disease. If some of the fat could be replaced with proteins derived from plants, everyone would benefit: the consumer by eating less fat, the farmer through higher income, and the environment because plants can be produced more sustainably than meat.

Lupin seeds yield a creamy protein suspension suitable for the production of low-fat sausage products. (© Fraunhofer IVV)

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Fraunhofer Institute for Process Engineering and Packaging IVV
Giggenhauser Straße 35 l 85354 Freising, Germany l www.ivv.fraunhofer.de
Contact: Dr.-Ing. Peter Eisner l Phone +49 8161 491-400 l peter.eisner@ivv.fraunhofer.de
Press: Karin Agulla l Phone +49 8161 491-613 l karin.agulla@ivv.fraunhofer.de