Fraunhofer

RESEARCH NEWS

12 | 2011

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

1 Recognizing blood poisoning quickly

Speed can save lives – especially in the case of blood poisoning. The more quickly and directly doctors recognize and treat sepsis, the greater the patient's chances of survival. With the help of a new biochip, physicians will now be able to analyze blood within their own practice.

2 Thinner thermal insulation

Insulation panels that are both thin and effective are expensive. At present these high-end products are built into energy-saving refrigerators. Innovative components and production techniques are now set to sink the costs – so that private home-builders can also benefit from the new technology.

3 Lying and sitting more comfortably

People who have to sit at work often have back pain. People permanently confined to bed are even worse off – they frequently develop bed sores. New smart cushioning is intended to eliminate the discomforts of lying and sitting. An integrated sensor system equalizes pressure selectively.

4 Monitoring food with millimeter waves

We may be able to see through glass, water and air, but not packing paper, plastic or cardboard. What remains hidden from the human eye is made visible by a new millimeter-wave sensor: unlike x-ray scanners, it can see through non-transparent materials without sending out harmful rays.

5 Bobsled runs – fast and yet safe

They should prove a challenge for the athletes, but not put them in danger: bobsled runs have to be simulated before being built. This simulation is based on the friction levels of the runners on the ice. Now it has become possible to measure these levels accurately. These results will help build the run for the 2014 Olympic Winter Games.

6 First aid after tick bites

They come out in the spring, and each year they spread further – the ticks. Thirty percent of them transmit borrelia pathogens, the causative agent of Lyme borreliosis that can damage joints and organs. The disease often goes undetected. In the future, a new type of gel is intended to prevent an infection – if applied after a tick bite.

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 18,000, who work with an annual research budget totaling 1,66 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.

Editorial notes:
Research News l Frequency: monthly l ISSN 09 48 - 83 83
Published by Fraunhofer-Gesellschaft l Press Office l Hansastraße 27 l 80686 München l
Telefon +49 89 1205-1333 l presse@zv.fraunhofer.de
Editorial Staff: Franz Miller, Janine van Ackeren, Britta Widmann l Reprints free of charge.
We encourage you to favor the online version and newsletter via www.fraunhofer.de/fhg/EN/press
This bulletin is also available in German as "Mediendienst".

Fraunhofer

Recognizing blood poisoning quickly

Is the patient suffering from blood poisoning? To answer this question, the doctor draws a blood sample and sends it to a central laboratory for testing. This takes up valuable time, which could cost the patient his life. In future, physicians will be able to analyze blood there and then and have the results within twenty minutes. This is made possible by a biochip, developed by scientists at the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg. "To analyze the biochip we have also designed a fully automatic device to carry out all the examination steps," explains Dr. Albrecht Brandenburg, group manager at the IPM. "All the doctor has to do is place the sample in the apparatus and wait for the results."

Meanwhile, within the device there's plenty going on: it starts by preparing the blood sample. Red blood cells are separated from the blood and the plasma that remains is guided onto the biochip. When patients are suffering from sepsis, their immune system reacts by producing certain proteins. The biochip uses these in its diagnosis: there are antibodies positioned on the chip which fit these proteins like a key fits a lock. If the proteins are present in the blood, the antibodies fish them out of the fluid and bind them to the chip. But how does the apparatus know if proteins have been caught? "The chip is rinsed with a solution containing the appropriate antibodies, which have in turn been marked with a fluorescent dye," explains IPM scientist Dr. Manuel Kemmler. "These bind to the proteins – meaning antibodies, protein and marked antibodies are all firmly linked to each other and to the chip's surface. When the chip is illuminated, the dye lights up." The apparatus sees lots of little illuminated dots that show the protein was in the blood. If the patient is healthy, however, the chip remains dark.

The researchers can even test for different proteins at the same time in one cycle. This is done by placing various different catcher molecules on the chip, to which specific molecules in the blood attach themselves. A cunning selection of proven protein markers allows the scientists to obtain additional important information about the severity and cause of the illness.

Together with colleagues from a university hospital, the researchers have already successfully tested prototypes of the device and biochip. Each biochip can only be used once – so they have to be affordable. "We predict that in the long run, with production on a large enough scale, each chip will cost no more than one euro," says Brandenburg. There are various possible applications: other conditions such as heart

attacks or cancers can also be investigated this way. What's more, the chip facilitates doping and urine testing as well as the quality assessment of foodstuffs.

The biochip is analyzed in a fully automatic portable device. Physicians find out right away if the patient suffers from blood poisoning. (© Fraunhofer IPM)

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

Fraunhofer Institute for Physical Measurement Techniques IPM
Heidenhofstr. 8 l 79110 Freiburg, Germany l www.ipm.fraunhofer.de
Contact: Dr. Albrecht Brandenburg l Phone +49 761 8857-306 l albrecht.brandenburg@ipm.fraunhofer.de
Press: Holger Kock l Phone +49 761 8857-129 l holger.kock@ipm.fraunhofer.de

Fraunhofer

Thinner thermal insulation

In Germany, the rising cost of heating has sparked a renovation boom. In order to lower energy costs, more and more homeowners are investing in insulation facades. But the typical insulation layers on the market have one drawback: they add bulk. The 20-centimeter-thick outer skin changes the building's visual appearance and can result in significant follow-up costs – with a need to fit new, deeper window sills and sometimes even roof extensions. Fraunhofer researchers are now developing films for a material that will insulate homes without much additional structural alteration: vacuum isolation panels, VIPs for short. The panels are only two centimeters thick and yet perform just as well as a classic 15-centimeter-thick insulation layer made from polyurethane foam. The inner workings of the VIPs are made mostly from pyrogenic silica. A high-tech film holds the material together and makes it air-tight.

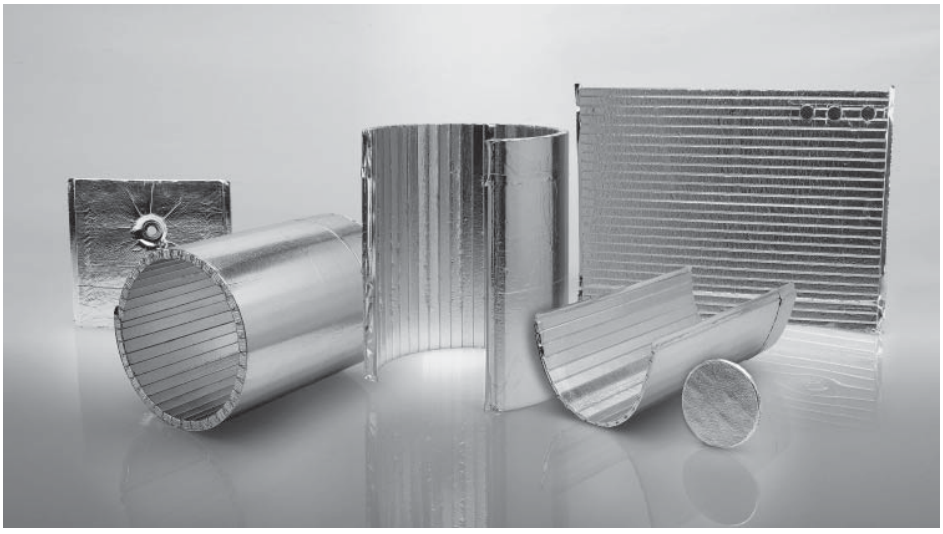
Dr. Klaus Noller from the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising and Prof. Gerhard Sextl from the Fraunhofer Institute for Silicate Research ISC in Würzburg have been involved with the development of VIPs since the very beginning. They now want to ready the panels for cost-effective mass production. "The key elements are the films: they dictate the quality, life span and price," acknowledges Noller. "The current production method is time-consuming and expensive: three of the five layers of plastic have to be coated with aluminum and stuck together. This requires seven production steps, which drives the price up." At present, these expensive VIPs are employed only where a space saving is worth the money: for example in high-end refrigerators and freezers.

The new film is easier to produce because it is made up of just two plastic films with three barrier layers: one aluminum-coated plastic film is coated with a micrometer-thin layer of ORMOCER® – an ISC invention – and then coated again with aluminum. ORMOCER®s contain an organic-inorganic hybrid silicon-oxygen polymer matrix, which makes the material exceptionally tight and stable. "That's what makes it perfect for insulation panels," says Noller. "Gases and liquids cannot easily penetrate the ORMOCER® layer." The new insulation films can be fashioned in just five stages. First a film is coated, then the ORMOCER® layer applied, then coated a second time before the barrier film is applied to the sealing film. "The end product is better and cheaper than the insulation films already on the market," claims Sextl.

Researchers have also optimized the production of the VIP insulation elements: at the Fraunhofer Application Center for Processing Machines and Packaging Technology

AVV in Dresden they have developed an automated process for gently sealing the pyrogenic silica cores with the high-barrier film. The films and production process have now been patented. As soon as the new VIPs are being produced in large enough quantities, the price should fall. Sextl and Noller are convinced that the thin panels will then be of interest for the building industry.

Now researchers want to simplify the production process further and carry out long-term tests. Until now the panels had to last just twelve years – the average lifespan of a refrigerator. The building sector has higher expectations: a facade should last fifty years. Noller and his colleagues are now testing the stability of films and insulation elements in climate chambers, which simulate the seasonal changes in heat and frost and in humidity. The results should be available in just a few months.



Vacuum insulation panels, VIPs for short, insulate ten times better than conventional insulation of the same thickness. (© va-Q-tec AG)

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

Fraunhofer Institute for Process Engineering and Packaging IVV
Giggenhauser Straße 35 l 85354 Freising, Germany l www.ivv.fraunhofer.de
Contact: Dr. Klaus Noller l Phone +49 8161 491-500 l klaus.noller@ivv.fraunhofer.de
Press: Karin Agulla l Phone +49 8161 491-120 l karin.agulla@ivv.fraunhofer.de

Fraunhofer

Lying and sitting more comfortably

Anyone confined to a wheelchair or a bed has to deal with numerous complications. Frequently, they suffer from bedsores or decubitus ulcers as physicians call them. Bony prominences, such as the sacrum, coccyx and ischium, are especially endangered spots. Unrelieved pressure can lead to tissue necrosis. Damage can extend into the periosteum and, at the worst, into bones themselves. The ulcers are entryways for germs, which can trigger sepsis. While hitherto available passive aids such as air, gel or vacuum cushions relieve pressure, they do not relieve the affected area optimally. Some patients are also unable to actively control the distribution of pressure and alleviate their own suffering. They are dependent on others for help. Personal care assistants or family caregivers must constantly keep an eye out for the formation of pressure ulcers. A newly developed sensor mat will take over this job in the future and thus prevent tissue damage: Researchers at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg are endowing textile cushions with the capability to "feel" by outfitting them with smart sensor systems.

"Every person has a unique build, which must withstand differing compressive loads. Our sensor mat made of ordinary foam and conductive threads automatically detects how a person is sitting or lying, and automatically equalizes the pressure at endangered points by activating an actuator. One hundred measured points on a typical seat suffice to do this," says Martin Woitag, research manager at the Fraunhofer IFF. The trick is that the tactile sensor mat functions based on the principle of a parallel-plate capacitor. Instead of plates, two textile components are employed, which form sensor cells arranged in a matrix. Conductive thread functions as an electrode. Sensor cells are mounted in commercially available foam at intervals of four centimeters. The compression of a single cell varies the voltage and produces an electrical impulse. Measurement electronics connected to the sensor system analyze the data in real time, evaluate them and regulate air cushions located beneath the sensor system. If, for instance, the sensors indicate that the pressure to the rear right is too high, then air is let out of the cushion at that spot – the cushioning is modified flexibly and selectively.

While comparable sensor mats already exist, they are so expensive to manufacture that they are unsuitable for the mass market– a high resolution sensor mat costs several thousand euros. "Since all the materials we use are inexpensive, we can already produce single items for a few hundred euros," says Woitag. Another advantage is that the weave of the textile employed is breathable and thus prevents moisture buildup. Present systems rely on film technology, which causes sweating.

At around one centimeter, the sensor pad is so thin that it can be integrated in existing applications without any problem. A mat has been prototyped in various shapes and pressure resolutions. First, wheelchair users' lives will be bettered. Then, the researchers intend to test the system in mattresses, too. In addition to the medical field, the experts are setting their sights on other fields of application: Drivers spend long hours behind the wheel and therefore often suffer from back problems. When integrated in truck seats, the sensor mat will provide drivers more comfort and help prevent postural defects. The prototype has already been produced. The researchers have recruited several industry partners, Isringhausen GmbH, warmX GmbH, Rehability GmbH and the Gesellschaft für Biomechanik Münster mbH, which are providing them support for their project.

A sensor mat integrated in a wheelchair set helps prevent pressure ulcers. (© Fraunhofer IFF)

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

Fraunhofer Institute for Factory Operation and Automation IFF
Sandtorstr. 22 l 39106 Magdeburg, Germany l www.iff.fraunhofer.de
Contact: Dipl.-Wirt.-Ing. Martin Woitag l Phone +49 391 4090-231 l martin.woitag@iff.fraunhofer.de
Press: René Maresch l Phone ++49 391 4090-446 l rene.maresch@iff.fraunhofer.de

Fraunhofer

Monitoring food with millimeter waves

Has the packet been properly filled? Are there impurities in the chocolate? Have the plastic seams been welded correctly? Is there a knife hidden in the parcel? Answers to all these questions are provided by SAMMI, short for Stand Alone MilliMeter wave Imager. The millimeter-wave sensor is able to see through all non-transparent materials. Researchers at the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg have developed the device, whichat 50 centimeters wide and 32 centimeters high is no larger than a compact laser printer. SAMMI can happily deal with all non-metallic materials. "The system detects wooden splinters lurking in diapers, air pockets in plastic, breaks in bars of marzipan, and foreign bodies in foodstuffs. It can even detect and monitor the dehydration process in plants and how severely they have been stressed by drought," says Dr. Helmut Essen, head of the FHR's millimeter-wave radar and high-frequency sensors department. This makes the scanner extremely versatile – it's just as suitable for industrial product and quality control as for analyzing materials in the laboratory. Because the system can detect dangerous substances such as explosive powder hidden in letters, vulnerable people such as politicians or freight handlers can be protected by millimeter-wave radar.

SAMMI's most striking feature is its ability to pick out the smallest differences in materials – differences that are invisible to x-rays. SAMMI can for example differentiate between the different fillings of chocolates, or between rubber composites that have similar or identical absorption qualities. Another advantage is that the scanner doesn't employ ionizing radiation, which can damage health. It is also low-maintenance, not requiring the regular checks necessary with x-ray tubes.

But how does SAMMI work? Inside the system's housing, there is both a transmitting and a receiving antenna on each of two opposing rotating plates. A conveyor belt transports the sample – perhaps a package whose contents are unknown – between the antennae, while these send electromagnetic waves in a high frequency of 78 GHz. Different areas of the sample absorb the signal to different degrees, leading the varying material composition across a sample to show up in distinguishable contrast. "Basically we examine the scanned objects for dissimilarities," explains Essen. The content of the sample appears in real time on the scanner's fold-out display. If the package contains a knife, even the grain of the handle is discernible. If the handle is hollow, the millimeter-wave sensor would show that, too. The device scans an area of 30 x 30 centimeters in just 60 seconds.

Our system can be operated without safety precautions or safety instructions, and since it weighs just 20 kilograms it's eminently portable. It can also be adjusted to various measuring frequencies," the scientist points out. In future, the researchers aim to "upgrade" the system for terahertz frequencies of 2 THz. "Then we'll be in a position not just to detect different structures but also to establish which type of plastic a product is made from. That's not possible at the moment," says Dr. Essen.

At present, SAMMI is only suitable for spot checks. However, the FHR researchers are working on adapting the millimeter-wave sensor for industrial assembly lines for the fast, automatic inspection of goods. They envision mounting a line of sensors over the conveyor belt, so that in future products can be scanned at a speed of up to six meters per second.

The millimeter-wave sensor can look through all non-transparent, non-metallic materials. (© Fraunhofer FHR)

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

Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR
Neuenahrer Str. 20 l 53343 Wachtberg, Germany l www.fhr.fraunhofer.de
Contact: Dr. Helmut Essen l Phone +49 228 9435-249 l helmut.essen@fhr.fraunhofer.de
Press: Dipl.-Volksw. Jens Fiege l Phone +49 228 9435-323 l jens.fiege@fhr.fraunhofer.de

Fraunhofer

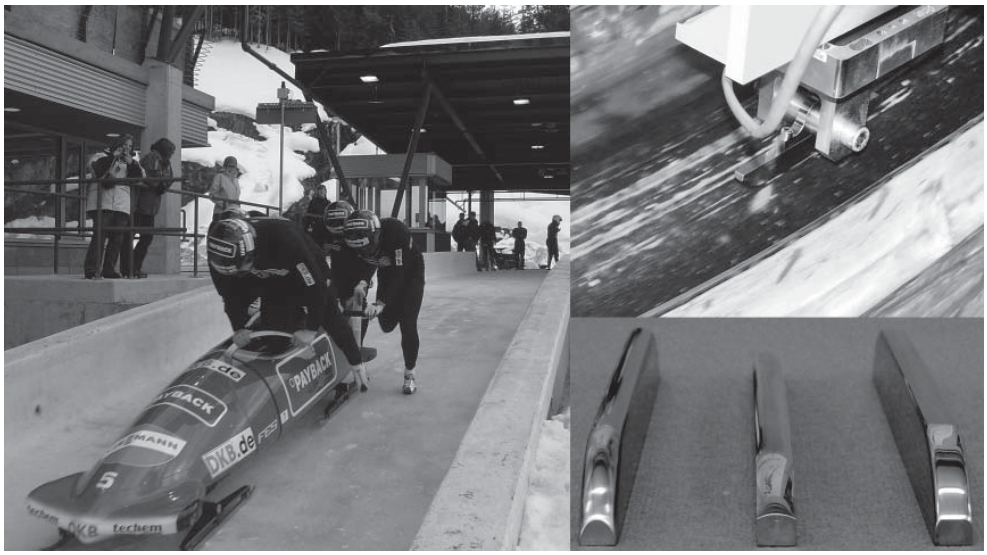
Bobsled runs – fast and yet safe

Lightning fast, the sled bolts down the icy run. Will the team make it to the finish faster than their competitors? The tension in the crowd depends partly on the run itself: the faster the sleds can travel on the run, the more thrilling the race. But the track mustn't be too fast: the crew still needs to be able to reach the bottom safely. So engineers have to calculate and simulate exactly how fast a sled can travel on specific sections of the track. The calculations are based on the friction levels between the runners and the ice. Up to now, the problem has been the difficulty of measuring these levels at such high speeds, and the data collected have been rather far from reality. This meant that the speed of the sleds was often estimated too high or too low, which could lead to accidents.

In future tracks are set to become safer. Researchers at the Fraunhofer Institute for Mechanics of Materials IWM at the Microtribology Center µTC in Pfinztal have now developed a method of measuring the friction levels accurately. In so doing, they are able to provide their colleagues from Gurgel+Partner, consulting engineers responsible for design and construction of the bobsled track for the 2014 Winter Olympics in Sochi, with a solid basis for their calculations. "This measuring device allows us to ascertain the precise level of friction between the sled and the ice at high speeds – from which we can calculate the maximum speed a team can reach," explains Prof. Dr. Matthias Scherge, business unit manager at the IWM. Our "bobsled track" is in fact a large drum, similar to that of a washing machine, which is 3.8 meters in diameter and open on one side, situated in a bunker that has been chilled to -4°C. On the inside of the drum is a layer of ice, on which the test runners slide. A hydraulic cylinder presses each runner to the ice, simulating the weight of the sled and the crew. Whenever the drum rotates, the ice moves out from under the runner, slightly displacing both it and the attached friction force sensor. So instead of remaining at the lowest point, the runner is carried along a little by the rotating drum. Just how far depends on the amount of friction between the runner and the ice.

In their experiments with this apparatus and with other test rigs, the researchers take into account numerous factors, such as the nature of the ice itself. Ice at Whistler ski resort in Canada, for example, has different friction qualities than ice in Krasnaya Polyana near Sochi. Atmospheric humidity is significantly higher at Whistler because of its proximity to the Pacific, so ice accumulates faster there. The scientists can adjust the climatic conditions in the lab accordingly. They are also looking into the effect on runners of having a good finish. To what degree does a professional finish affect

the speed of a bobsled weighing up to 630 kilograms? Researchers also recreate the steering movements of the racing vehicle: the runners on the glide body can be set at an angle to simulate cornering. The minimal friction level – which is to say the fastest possible speed the sled can achieve on any particular track under various ice conditions, providing the team does everything right – is taken by Gurgel+Partner engineers as the basis for their calculations. In the meantime, construction is underway in Sochi.



The friction levels of runners can now be measured accurately: top right, the measuring setup with runner and sensor in the ice channel; below right, various types of runner: (left to right) bob, skeleton and luge. (© Fraunhofer IWM)

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

Fraunhofer Institute for Mechanics of Materials IWM, MikroTribologie Centrum µTC
Joseph-von-Fraunhofer-Str. 7 l 76327 Pfinztal, Germany l www.mikrotribologiecentrum.de
Contact: Prof. Dr. Matthias Scherge l Phone +49 721 4640-750 l matthias.scherge@iwm.fraunhofer.de
Press: Katharina Hien l Phone +49 761 5142-154 l katharina.hien@iwm.fraunhofer.de

Fraunhofer

First aid after tick bites

For years, Mrs. S. suffered from joint pain and headaches. After an odyssey through doctors' waiting rooms, one doctor diagnosed Lyme borreliosis – an infectious disease transmitted by ticks. With its bite, the parasite introduced bacteria that then spread throughout the entire body. Mrs. S. is not alone – very often, the disease is recognized too late or not at all, or is not properly treated. Doctors are provided with no clues if the characteristic redness around the bite area is missing. Left untreated, Lyme borreliosis can cause symptoms that resemble rheumatism, damage joints, muscles and nerves and affect the organs.

If found in time, it can be successfully treated. If patients exhibit the disease-specific rash known as erythema migrans, doctors will prescribe antibiotics for several weeks. However, if, as in the case of Mrs. S., the disease has progressed far and is chronic, it is very difficult to treat. Currently, there is no prophylactic treatment and no vaccine against the infection. In the future, a new type of gel is supposed to nip the infection in the bud: the patient applies it locally immediately after the tick's bite. Researchers of the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig developed the medication in close cooperation with the Swiss company Ixodes AG and the Institute for Infectious Diseases and Zoonoses of the Ludwig-Maximilian University in Munich (Institut für Infektionsmedizin und Zoonosen der LMU München). Ixodes AG is responsible for developing the formula, while IZI and LMU are carrying out the pre-clinical studies and the serological examinations.

„If the gel is applied immediately to the bite after the tick has been removed and one does not wait for any potential symptoms to show, Lyme borreliosis could be prevented. This is because during the first few days, the bacteria stay right around the spot where the tick bite occurred and spread out only after that. The active ingredient of the gel is azithromycin, which is highly effective against borrelia bacteria and kills them locally in the skin," says Dr. Jens Knauer, project manager at IZI. Unlike other antibiotics, there is no known resistance of borrelia strains against azithromycin. Another advantage of the active ingredient: it has few side effects and as a result does not stress the body. It also distinguishes itself by its good depot action of up to five days in the tissue. The treatment is successful only if the medication is applied within the first few days after the tick's bite. „This gel, however, cannot be used to treat an established infection; it is suitable only for prophylaxis," emphasizes Dr. Knauer.

The pre-clinical studies have already been completed successfully; in mice, the gel was effective even five days after a tick's bite. The application has been patented. Starting this past summer, in a clinical phase III study (www.zeckenstudie.com), the researchers are testing the medication on persons with proven tick bites. „Should the results of the pre-clinical studies be confirmed on humans, the gel will help to significantly lower the number of new infections," the expert adds. Annually, up to 60,000 are stricken with Lyme borreliosis in Germany alone, according to estimates by the Robert Koch Institute, with an upward trend – since, due to climate change, ticks are expanding their range ever further. „As soon as the gel can be purchased at the pharmacy, persons who are particularly endangered, such as forest rangers, hunters, joggers or soccer players, should always carry it with them," Knauer recommends.

Fraunhofer Institute for Cell Therapy and Immunology IZI
Perlickstr. 1 | 04103 Leipzig, Germany | www.izi.fraunhofer.de
Contact: Dr. Jens Knauer | Phone +49 341 35536-1206 | jens.knauer@izi.fraunhofer.de
Press: Jens Augustin | Phone +49 341 35536-9320 | jens.augustin@izi.fraunhofer.de