Fraunhofer

RESEARCH NEWS

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Detecting diamonds with X-ray technology

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The Development Center for X-ray Technology EZRT in Fürth has developed a demonstrator that detects diamonds hiding inside rocks of volcanic origin. EZRT is a division of the Fraunhofer Institute for Integrated Circuits IIS cooperating closely with the Fraunhofer Institute for Nondestructive Testing IZFP in Saarbrücken. The department focuses on the subjects of X-ray sensor technology, computed tomography, image processing and optical 3D inspection systems as well as applications.

The process is based on dual-energy X-rays. In the process, two images of the same object are produced using two different X-ray spectra. An algorithm developed at EZRT filters out the data about the material from both images. Different substances can be identified with very high reliability. The new technology is capable of detecting diamonds of just a few millimeters in size in kimberlite ore – of grain sizes up to 50 millimeters. Together with colleagues from the Fraunhofer Institute for Optronics, System Technologies and Image Exploitation IOSB in Karlsruhe, the researchers are working on the advanced engineering of the demo model. The objective is to achieve a prototype that can inspect the ore on a fully-automated basis.

Currently, the diamond industry is already using X-rays in order to find the coveted gems. The conventional process, however, can detect the diamonds only at the surface of the ore. The diamonds irradiated and activated by X-rays emit light in the optical spectrum. "With particularly pure specimens, this technology does not work because it is precisely these that do not radiate under X-ray light," explains physicist Jörg Mühlbauer of EZRT. In order to find the gems nonetheless, it has so far been necessary to break up the igneous rock into very small pieces. That consumes large quantities of water and energy. "Moreover, there is also the risk of damaging the larger – and therefore more valuable – diamonds," says Mühlbauer.

Screen instead of pulverize

With the EZRT demo model, the crushed rocks pass through an X-ray machine at a speed of three meters per second. Both X-ray images produced provide data about the chemical atomic number of the materials – the number of protons in the respective nucleus. Diamond is pure carbon, a relatively light-weight element with the atomic number 6. Kimberlite typically holds a conglomerate of silicates and aluminates. Depending on the excavation area and mine, the atomic numbers vary between 12 and 14. The new algorithm uses this data. It links them with the data from both X-ray images, separates the diamonds from the kimberlite, and displays the results on two separate images.

This method is not limited to the detection of diamonds. Anywhere that materials have to be identified and cleanly separated, their use is possible. Another example is the processing of industrial coal. Rocks have to be sorted out, or the ash content kept to a minimum. The X-ray's eagle eye could even find the highly coveted rare earths that are concealed in old cellphones, computers, and television sets to utilize them. "We were adverted to the diamonds through a request from the industry. The demo model successfully passed the initial practice tests. Now, together with our colleagues from IOSB, we intend to take the technology to the next step and make it ready for industrial use. Our goal is to develop an industrial testing process that allows several tons of bulk material per hour to run through the system and be analyzed," Mühlbauer stated.

Several thousand euro per carat

Diamonds are among the most expensive raw materials worldwide. In contrast to the price of gold, the diamond index held a healthy new level in 2013. Brilliants, cut, and processed raw diamonds achieved prices of several thousands of euros per carat – about 0.2 grams – by the end of the year. The gems originate under immense pressure and extremely high temperatures at depths of between 150 to 650 kilometers. Gaseous volcanic rock and kimberlite containing magma transport the diamonds to the surface with fragments of the earth's mantle when the volcanoes erupt. The largest diamond reserves are found in Russia, Africa, Australia, Canada, and Brazil.

Kimberlite stone transports diamonds (center right) from the earth's interior to the surface. Now a new X-ray technology holds the promise of more efficient extraction. (© Fraunhofer IIS/EZRT) | Picture in color and printing quality: www.fraunhofer.de/press

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Fraunhofer

Freighter without crew

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Hans-Christoph Burmeister scans over the onboard instrumentation: an electronic maritime chart; a display of water depths; the adjacent monitor that displays the radar image. Burmeister then reaches for the wheel and steers his 220 m mass-goods freighter into a new direction. "We are now sailing on a course of 290 degrees, speed twelve knots." Even if this scenario is quite realistic, Burmeister is no captain on the bridge, but is standing instead in a room at the Fraunhofer Center for Maritime Logistics and Services CML in Hamburg. A ship navigation simulator has been installed at the facility of the Fraunhofer Institute for Material Flow and Logistics IML. The steering and display instruments resemble those of a freighter. The simulator is expected to help advance an ambitious undertaking: under the EU Project MUNIN, the Fraunhofer researchers, together with partners from five countries, are engineering the design for an autonomous ship – a bulk carrier that sails across the world's seas without a crew. The motive: "In Europe, making a career in shipping is no longer a popular choice," explains Project Coordinator Burmeister. "This industry has successor problems."

In the approach, there is already technology for an autonomous ship – on the modern bridge of a ship, quite a lot is already automated: The autopilot steers a pre-set course with the support of GPS, at tempo automation system maintains the pace of speed. Radar equipment and ship detection systems search the surroundings and sound the alarm automatically in the event of risk. In addition, an autonomous ship should be equipped with other sensors: Original and infrared cameras are to observe the ocean surface, in order to detect specifically smaller vehicles, flotsam, or shipwrecked.

In an emergency, operators can intervene via satellite

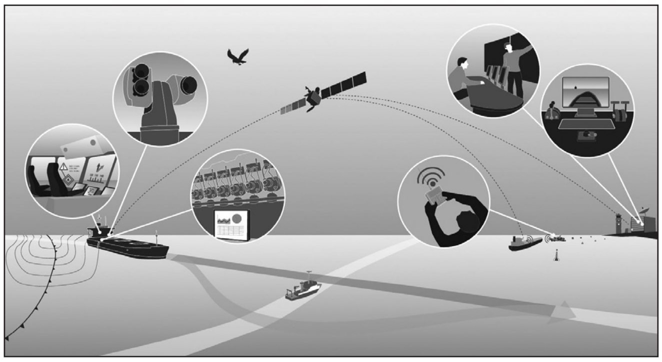
The core of the unmanned freighter is served by a centralized software application. It analyzes the data from all sensors and determines, for example, if and how the ship changes its course in order to avoid collisions with, for example, a loose container floating around that may have fallen from another freighter. Nonetheless, the unmanned ship will not be travelling. A human being is supposed to monitor all events and, if necessary, intervene. "Certain situations are conceivable in which the autonomous on-board systems are overextended," Burmeister explains, „such as when multiple ships are simultaneously on collision course or technical breakdowns arise." For these cases, a station is at the ready on land which will intervene via satellite and can steer the ship remotely.

In order to demonstrate how this might appear in an actual setting Burmeister is putting his simulator into gear. On the screen, you can see a container ship approaching from port. Although Burmeister's freighter has right-of-way, the other ship just will not budge. In order to prevent collision, the researcher takes control through the autonomous ship. “I deactivate the autopilot, set a course change for starboard, reduce speed and wait until the other ship has been passed. “Even when docking and casting off, a human being should be at the helm. If the ship departs from the harbor, a crew is on board. Once the freighter reaches open sea, the team leaves the ship via pilot vessel or helicopter, and automated steering takes over. At the destination, the reverse is conducted: Right in time, just before entry into the harbor, a team goes on board in order to steer the freighter in.

The MUNIN project was launched in autumn of 2012. Since the demands for an autonomous ship are highly diverse, the experts work meticulously on the various detail issues. This way they can guarantee that the ship’s propellers are also running reliably during those times when no mechanical technician is available. The engine rooms have to this date been configured so that you can leave them unattended for a 24-hour period. Were a fire to break out on board – due to a short circuit – an automatic sprinkler system would have to start up. As a precaution, critical areas are flooded with CO2, so that no fire can catch here in the first place. For tough sea passages, the autopilot should turn the hull in such manner that the waves hit it as little as possible, and in general one would circumnavigate impending inclement weather at the outset.

Computer simulation ready by 2015

The EU project is slated for completion by the autumn of 2015. The goal is a computer simulation that allows experts to test and review their ideas on a virtual basis. After that, it would be conceivable to furnish a real ship with a completely automated system. “Yet even beforehand, manned navigation could benefit from our results,“ says Burmeister. Because individual components that the MUNIN technicians are assiduously working on would already be helpful on the bridge of any vessel today. Thus, an automated lookout system would ease the burden on the crew just as much as an improved collision warning system.



On the bridge of a modern ship, a lot already runs automatically. But these unmanned ships of the future are not intended to operate completely unsupervised. (© Fraunhofer MUNIN) | Picture in color and printing quality: www.fraunhofer.de/press

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Fraunhofer

Wire inspection: As fast as a world-class sprinter

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The wire blank shoots from the drawing die which molds it into the desired shape. Up to ten meters per second, the workpiece is fast – and thus can keep pace with world-class runners like Usain Bolt. At these speeds, an in-line inspection – inspecting the workpiece during the production process – would have been inconceivable, until now. Researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg have now closed this technological gap. Their optical inspection system, WIRE-AOI, can detect defects in strip products in real time. Strip products are long workpieces – like pipes, rails, wires, or boards – that are manufactured at high flow velocities. The inspection system detects micro-defects that zoom past it at ten meters per second, and are no thicker than a human hair. Workers then see the processed defects depicted graphically on a monitor, and can remove the corresponding pieces. The system marks the location of the defect, and stores the associated camera image in a database. This way, the makers of strip products can identify, classify, and document defects during production. For instance, by determining surface defects at the threshold levels for depth, width, and length adapted for their own production. If the workpiece exceeds these parameters, then the software sounds the alarm optically and acoustically.

10,000 images per second

Four high-speed cameras deliver the images of the defects. Each one is capable of shooting 10,000 images per second, and processing them in real time. “Only a handful of models for industrial camera inspection are able to record this number of images in the first place, much less analyze them in real time,” says Dr. Daniel Carl, group manager for Inline Measurement Techniques at IPM. Prerequisite for this peak performance are cellular neuronal networks. “That means each pixel is itself a computer in its own right. In order to program these, you need specialized knowledge about parallel architectures that the team at IPM has at its disposal.” The corresponding software must first enable the system to analyze the images shot by the camera.

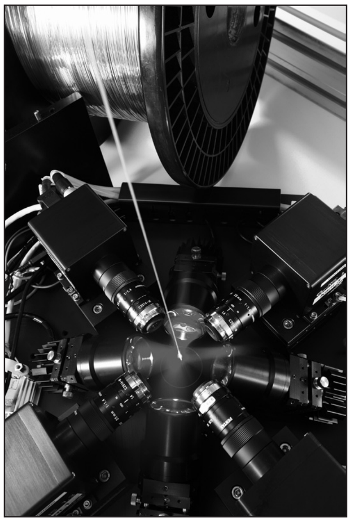
An LED light developed by Carl’s research team puts sharpness into the camera images. Its light shines at a 5 millionth of a second, as bright as 100 suns, and flashes 10,000 times per second. “That is just like normal photographs. The brighter the light and shorter the illumination period, the sharper the images of moving objects. The image does not blur since, in such short periods of time, in principle nothing moves - even at speeds of up to 10 meters per second,” Carl added. The human eye can hardly perceive these very short light times. Therefore, the system is safe for the retina despite the extreme brightness.

Another important element: sturdy housing. Because things can get rough when producing strip products. For example, in the production of wire: The blanks are either rolled or drawn through dies. This can get messy, or the system vibrates. The inspection system, with its sensitive electronic and optical components, is in the middle of the production line. "The workpieces literally go directly through it," describes Carl.

Minor defect, major impact

The drive to develop the sturdy, very fast and precise inspection system came from colleagues at the neighboring Fraunhofer Institute for Mechanics of Materials IWM. "Their job is materials inspection, including that of wires. We noticed that these could have many and very diverse defects if they were produced industrially, but that an inline inspection system would have missed until now," says Carl, in whose group the first prototype was developed. Even the smallest surface defect – not larger than a few micrometers – could have undesired consequences: Either right in production, when the defective wires are processed further – and bring the machinery to a stop. Or as part of the end product, if they disrupt its function. One example is defective wire springs were installed in motorized valves, which could lead to damage to the motor.

The inspection process has matured to the point that the scientists are now offering it to wirepullers. The technology has already been successfully in use for some time now; several additional projects are planned. Anyone who would like to make an image themselves: The IPM researchers are exhibiting their superfast wire inspection at the wire trade show from April 7 to 11, 2014 in Düsseldorf (Hall EN/08), at Control from May 6 to 9, 2014 in Stuttgart (Hall 1, Booth 1502), and at the Wire Industry Convention May 8, 2014 in Iserlohn.



With the WIRE-AOI wire inspection system, four cameras collectively deliver 40,000 analyzed images per second. Thus, a 100% control of the wire surface in real time can also work with very rapid production processes. (© Fraunhofer IPM) | Picture in color and printing quality: www.fraunhofer.de/press

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Mobile robots support airplane manufacturers

The robots move at walking speed along airplane components; in doing so, it applies a sealant against corrosion in equal measure. The mobile assistant is surrounded by technical workers who install, drill, and test. Admittedly this scenario is still a glimpse of the future – but in just a few years, it should be reality for the aerospace manufacturing industry. In the EU project known as VALERI – short for Validation of Advanced, Collaborative Robotics for Industrial Applications – a European consortium is engineering a mobile robot that operates autonomously and moves independently through a production hall, and side-by-side with the engineers and technicians. It is not intended to replace the technician, but instead relieve them of stressful and monotonous duties and take over inspection duties. Airbus DS, FACC AG, IDPSA, Prodintec are involved with the plan, as well as KUKA Laboratories GmbH and Profactor GmbH. The management of this EU project is in the hands of the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg. It is funded by a grant of approximately EUR 3.6 million.

"When we assemble fuselage elements, large quantities of sealant have to be applied to the joints. Mobile robots can take over this work quite well," says José Saenz, head of project at IFF and general coordinator of VALERI. Stationary robots are not suited for the assembly of unwieldy airplane components several meters in length that are worked on over a period of up to two weeks inside one single facility. "For example, the elements of an airplane fuselage are too large for them to be adapted to a conventional production robot. You cannot rotate or turn them so that the system can work on them. So, it has to be the other way around. The robot drives to the desired location in the airplane," say Saenz. Mobile systems are flexible, can be used at various stations, can move forward at various speeds, and are capable of performing delivery services – for example, they could retrieve tools for the technicians from a warehouse.

Touch-sensitive skin prevents collisions

The collaboration between people and equipment only works if collisions can be eliminated or kept to a minimum allowable level. The individual work must be absolutely certain in an environment in which automated assistants are constantly crossing paths with him or her. To guarantee one hundred percent security, Saenz and his team of colleagues outfitted the mobile platform with cameras and touch-sensitive interfaces that possess a cushioning layer. These sensors can be attached to the robot like an artificial skin. Using this technology – in combination with other optical sensors – unintended collisions are sensed and prevented. If a contact occurs again, then the robot stops or moves into another direction.

The mobile colleague is based on a robot from KUKA, the "omniRob." Located on a drivable platform is a multi-extension grip arm; experts call it the manipulator. The complete system possesses 12 degrees of freedom. That means it can move not only forward, backward, up and down, but also move sideways and rotate. "The unique thing about our system is the coordinated movement of all degrees of freedom. While the platform is driving, the manipulator is moving at the same time. There has not yet been a system of this kind with such a large action radius, until now," explains Saenz.

First test drive at year-end

The prototype is scheduled to take its first test drive by the end of this year. Tests under real life conditions are scheduled for October 2015: In a pilot program by Airbus DS, the mobile assistant must move autonomously, identify real airplane elements and solve tasks, without putting people at risk. "These mobile robots will change production processes in the aviation industry by accelerating production processes, making them more flexible, and by relieving technicians of burdensome tasks. With these robots, we are getting one step closer to the factory of the future," says Saenz. These mobile helpers can also help in other industries such as shipbuilding or the production of wind turbines.

The new assistant for the aviation industry, based on "omniRob," a mobile robot by KUKA. (© KUKA) | Picture in color and printing quality: www.fraunhofer.de/press

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Analyzing living cells quickly and accurately

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The Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart can now analyze living cells quickly and accurately with the help of Raman spectroscopy. The non-invasive optical procedure, which recognizes the molecular fingerprint of different materials, has primarily been employed in quality control for medications and pharmaceutical substances. Now biologists and biomedical researchers can also use this technology thanks to the research work at IGB. The technology is suited to investigating living cells without invasive techniques or altering them with dyes. In order to characterize stem cells or identify changes to tissues that are caused by tumors, inflammations, fungi, or bacteria, it is now sufficient to determine the individual cells' Raman spectrum – a specialized energy spectrum having particular analytical capability,

"Under joint projects with universities, industrial partners, and the State of Baden-Württemberg, IGB has developed comprehensive know-how in this area over the last years and has advanced the technology from use in pure research to industrial implementation. We can now investigate not just individual cells in this manner, but entire tissue structures and organs. Next we want to further refine the technology and develop more applications," says Prof. Katja Schenke-Layland from IGB.

The unmistakable Raman spectrum

Cell biologists at IGB use a specially developed Raman spectroscope jointly designed and built with physicists at the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg, Germany. The device is compact and can be conveniently used to investigate a wide range of scientific problems. The scientists are accumulating the spectra they have recorded into a database. "Each cell has a unique, unmistakable Raman spectrum. Doctors are able to compare the sample from their patients' cells with our data base and complete the diagnosis more quickly," says Schenke-Layland.

The technology is already being employed on a practical basis by industrial partners. The scientists are working at present on a rapid test for cancer diagnosis. "Doctors using mobile Raman spectroscopes during an operation could unambiguously say whether the patient has cancer or not simply by comparing the cell sample with the data base," according to Schenke-Layland.

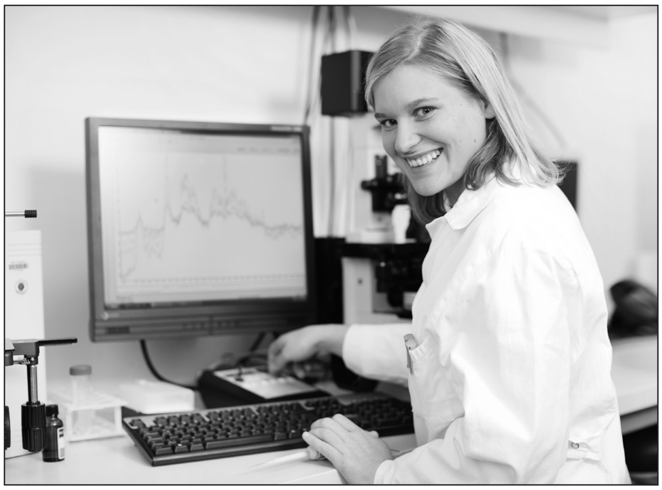
Cancer diagnoses are still complicated and prolonged. After excising the tissue for biopsy, it first must be prepared for further analysis – for example by suitably sectioning or dying it to identify biomarkers. "But this always requires intervention in the specimen and manipulating it in some way," according to Schenke-Layland.

The specimen is then transferred to a pathologist who analyses whether the tissue contains malignant or benign cells. This method is error prone and can lead to the specimen being unusable for other tests in the end. "Human error is reduced by a software-based comparison with our data base," according to Schenke-Layland.

Employment in cancer diagnostics and regenerative medicine

There are numerous additional applications for this non-invasive optical technology – especially in regenerative medicine. Artificially grown tissue may replace diseased cells in patients and thereby help the tissue to heal. To accomplish this, tissue-specific cells from bone marrow, for instance, must be removed and the stem cells extracted. Bone marrow is made up of highly diverse cells and it is complicated to differentiate the adult stem cells from the ordinary tissue cells. In addition, the stem cells must be 100% correctly identified and separated. If this does not happen and other types of cells are cultured into the implant, the body may not react as hoped, causing implant rejection or tumor formation.

Raman spectroscopy is a process to unambiguously identify and differentiate various materials from one another. It is based on the interaction of electromagnetic radiation and matter. If matter is irradiated with light at a precisely defined frequency, some of the photons of this light interact with the molecules of the matter, which thereby shifts the photons' own energy spectrum. This frequency shift of the laser light, also known as inelastic optical scattering, is recorded by the Raman spectroscope. The effect is named after the Indian physicist C. V. Raman, who received the 1930 Nobel Prize in Physics for his work. The frequency shifts are a function of the material and every material possesses an unmistakable spectral fingerprint.



The optical analysis system of IGB: the spectra recorded by the Raman spectroscope (back right) are displayed graphically on a monitor screen. The scientist controls the laser with the small box. (© Fraunhofer IGB) | Picture in color and printing quality: www.fraunhofer.de/press

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Environmental hormones – tiny amounts, big effects

RESEARCH NEWS
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You cannot see, smell, or taste them – and yet, environmental hormones are components of many materials and products. They can be found for example in colorants and dyes, pesticides, cosmetics, plastics, and in pharmaceuticals. Environmental hormones are molecules that behave like hormones, because they resemble them in their structure. It has been suspected that the substances getting into an organism via the air, the skin, through foodstuffs, and through medications influence the human reproductive system and cause a reduction in the quality of spermatozoa, with an associated drop in male fertility. The animal world is affected as well. In addition to other factors, environmental hormones are believed responsible for the reduction in fish populations.

Life cycle studies with freshwater fish

Experts and scientists have been in disagreement for over two decades about whether fish stocks and amphibian populations are actually threatened by any stress from hormonally active substances in bodies of water, because the effects of the environmental hormones actually remain insufficiently understood. Researchers of the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in Schmallenberg, Germany, want to shed light on this question. To investigate the effects of hormonally active substances on fish, the scientists have established and continually refined a model using life cycle studies of the zebrafish (Danio rerio), a freshwater fish. "Using the life cycle test, we can record all of the relevant aspects in the life of fish within a reasonable period of time," says Matthias Teigeler, an engineer in the Ecotoxicology Department at IME. "These include the growth, the embryonic and especially the sexual development, as well as the animals' ability to reproduce. Those are factors that react sensitively to hormonally active substances."

Groups of like-sized fish are exposed to potentially active hormonal substances at differing concentrations while in a flow-through facility. A control group of fish kept in water with no hormone load serves as a comparison with which the possible effects on the subject animals can be discerned. "A life cycle test begins by employing fertilized eggs obtained from unstressed P generation (parental) animals. The fish embryos hatch three days later. We determine the number of surviving animals and record their lengths in the computer. After about three months, the animals are mature enough to be able to reproduce. Their ability to reproduce can be accurately determined from the number of eggs they lay. During the spawning phase, we remove eggs from the experimental aquaria each day and count them. Since they are transparent, you can examine whether they were fertilized or not," explains Teigeler.

The researchers were actually able to determine that zebrafish were no longer able to reproduce – mating and deposition of eggs did not occur – under administration of very low concentrations of ethinyl estradiol, a synthetic estrogen and component of contraceptive pills. They observed negative effects with other substances under test as well. Tests with the synthetic sexual hormone trenbolone led to a masculinization of the animals, for example. The gender ratio shifted considerably. 100% of the fish developed as males following administration of the test substance. This could also be observed for aromatase inhibitors employed as a fungicide for plant protection. As a comparison, researchers would expect a gender ratio of 50 percent male to 50 percent female in the unstressed control group. "Several well-known substances negatively influence the hormone system. However, other factors besides hormonally active substances are under discussion as being responsible for the reduction in fish species, such as poorer constitution of waters and climate change," says Teigeler.

Stricter approval requirements for manufacturers of plant protection products

Manufacturers of chemicals for protecting plants meanwhile anticipate being confronted with a prohibition if it turns out that an active ingredient causes a lasting disruption to the hormone system of humans and animals. Meanwhile, the pharmaceutical industry must likewise present data on the effects of hormone-like substances in bodies of water if they want to bring a new product out on the market in Europe. The testing system of Fraunhofer IME enjoys a high level of acceptance in industry as well as among regulatory authorities. Moreover, IME researchers offer support through their expertise with life cycle experiments, studies, and conclusions to committees of the OECD, the EU and their Member States having to develop guidelines for fish testing and to evaluate of test results. They help find answers to questions dealing with problems of hormonally active substances in the environment.

Flow-through facility at Fraunhofer IME. All test aquaria can handle adult animals as well as those at the larval stage. (© Fraunhofer IME) | Picture in color and printing quality: www.fraunhofer.de/press

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Smaller microchips that keep their cool

RESEARCH NEWS
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An enormous treasure slumbers in the depths of our planet. Temperatures of up to 7000 °Celsius are thought to be present in the Earth's core, while at a depth of four to six kilometers (2.5 to 3.5 miles) it is still 150 °C to over 200 °C. These gigantic reserves of heat can be used as a renewable source of energy for geothermal power. The drill bits and bore hole probes employed are high-tech machines. They are fitted with a range of sensors and control mechanisms for their expedition into the Earth's interior. They are able in this way to be very precisely controlled or autonomously analyze the environmental parameters at depth, and thereby locate suitable – in other words, warm – regions for geothermal production. There is one problem, however: microchips hit their thermal limits when exposed to temperatures over 200 degrees Celsius.

Withstanding temperatures of several hundred degrees Celsius

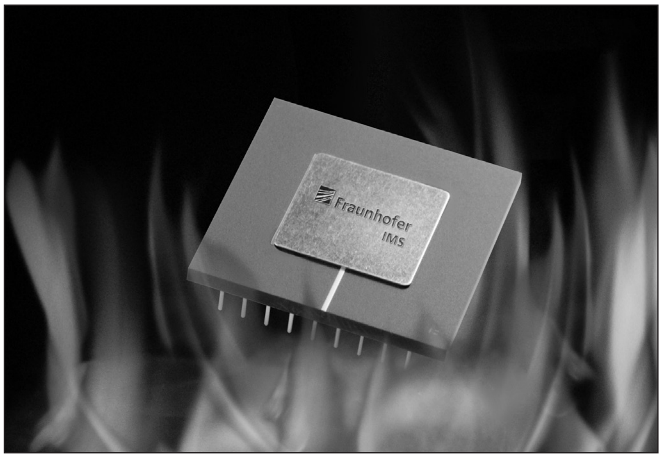
Scientists of the Fraunhofer Institute for Microelectronic Circuits and Systems IMS have now developed a new type of high-temperature process. "It becomes possible with this process to fabricate extremely compact microchips that operate flawlessly even at temperatures of up to 300 degrees Celsius," according to Holger Kappert, head of High-Temperature Electronics at Fraunhofer IMS. It is true that conventional semiconductor chips (CMOS) sometimes tolerate temperatures of up to 250 degrees Celsius, but their performance and reliability fall off rapidly. Frequently, companies must test a large quantity of standard chips using the trial-and-error method before they obtain an acceptable selection – a laborious undertaking.

An additional avenue exists – continuously cooling the heat-sensitive microelectronics, which can hardly be accomplished without extensive additional effort being necessary, however. There are also specialized high-temperature chips on the market already – but with about one micrometer minimal structure size, they are very large. "The solutions available are always associated with certain trade-offs: either they have comparatively large components, or they function with limited performance," Kappert summarizes.

The microchips from IMS are different, though. At a characteristic dimension of 0.35 µm, they are considerably smaller than the high-temperature chips available today. The advantage of these kinds of complex microstructures can be summarized as "more functionality at less size". That is what is necessary to make the chips more capable and more inteligent as well. To fabricate the heat-tolerant mini-chips, the researchers in Duisburg, Germany, use a specialized high-temperature SOI CMOS process. "SOI stands for 'silicon-on-insulator' – that means we introduce a layer that insulates the transistors from one another," explains Kappert. This insulation prevents leakage currents that occur from influencing the operation of the chip. Leakage currents are electrical currents flowing over other than intended paths. They are caused or increased by elevated temperatures in particular. Moreover, the researchers use tungsten metallization for their chips, which is less temperature sensitive than the aluminum usually used. This increases the operating life of the high-temperature chips.

Environmentally friendlier flight

Production of geothermal energy, natural gas, or oil is not the sole area of potential application. The microchips could also prove valuable to aviation, for instance by enabling sensors to be located as close as possible to turbine engines in order to be able to observe the state of their operation. This could permit the turbines to be operated more reliably and efficiently, saving jet fuel and thereby making aviation environmentally friendlier. The first field tests of the new chips have been positive. The researchers want to offer the fabrication process as a service later this year.



Keeping their cool at 300 °C: the especially compact microchips of Fraunhofer IMS. (© Fraunhofer IMS) | Picture in color and printing quality: www.fraunhofer.de/press

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RESEARCH NEWS
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High-performance plastics – developed in kilo quantities

Plastics are everywhere we look – in supermarkets, our cars, and our children's playrooms. To have the properties we need, plastics need additives, such as stabilizers to protect the polymers from premature failure and UV light, and flame retardants to hinder plastics from stoking flames in case of fire. Researchers are developing various additives at the Fraunhofer Institute for Structural Durability and System Reliability LBF in Darmstadt. The additives are expected to improve the material, giving it enhanced performance and greater durability. Additional additives should improve adherence to metals such as light-weight structural components.

The chemists usually work with very little additive to start with, a hundred grams at most. The researchers can establish roughly what properties these have using small, lab-sized quantities. More precise predictions cannot be made, however. This is because the plastics in which the additives were introduced on a small scale often have properties different from when they are produced in larger quantities. Scientists have therefore set up a kilo lab. They test how well the manufacturing process can be scaled up in this lab and how the new additives behave. In this way, the scientists are able to tell their customers precisely what properties the newly developed additives provide to the plastics when they are incorporated under industrial conditions.

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Route-specific load analysis for vehicles

Greater demands are placed on a vehicle and it consumes more fuel along a curving mountainous route or on rough, uneven road surfaces than over the same distance on a flat and well-constructed road. In addition, environmental conditions like heat, cold, and precipitation influence the operating life and dependability of vehicle components.

The Fraunhofer Institute for Industrial Mathematics ITWM in Kaiserslautern, Germany, is supporting manufacturers of automobiles and utility vehicles by enabling them to incorporate these kinds of loading factors in vehicle design and development with its "Virtual Measurement Campaign" (VMC). The researchers have built up a comprehensive data base for this purpose. It provides an overview of the world-wide road network and delivers additional information about the characteristics of each specific route. If an automobile manufacturer would like to develop a new market, for instance, it can construct a sophisticated picture of the conditions in the area. The effect of the various parameters on the individual vehicle components can be analyzed using software developed by ITWM that transforms these data into mathematical algorithms.

In addition, virtual measurement campaigns can usefully supplement real vehicle road testing. They enable selective route planning and provide data in advance about the loading to be expected. This helps reduce the duration and scope of expensive field testing. VMC will be presented by researchers from April 7th to 11th at the joint Fraunhofer booth (Hall 7, Booth B.10) during the Digital Factory trade show in Hanover, Germany.

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Nanostructures – even on curved surfaces

Say sayonara to scrubbing. Dirt slides right off surfaces – referred to as the Lotus effect. Nanostructures make it happen. In addition, they can keep surfaces from fogging up and even add color to faces on Lego figures without the use of dyes or colorants. Plastics with these kinds of structures, which are only about 100 nanometers in size, can be manufactured cost effectively in quantity using injection molding. A metallic insert serves in this case as an inverse mold. The liquid plastic is injected into it, cools, and thus takes on the prescribed shape. The only bad news: nanostructures have only been able to be produced on planar surfaces thus far. On curved parts like the heads of Lego figures, it's game over at about 100 micrometers.

Researchers of the Fraunhofer Institute for Production Technology IPT in Aachen, Germany, want to change this through an EU Project entitled „Plast4Future", coordinated by the Technical University of Denmark. They are developing a new lithographic process with which they can introduce any kind of nanostructure desired on the metallic form – even when it is curved. The researchers have already successfully tested their process on planar surfaces. Now they are transferring their findings to randomly shaped objects. The scientists hope the manufacturing chain could be utilized by industry in about two years.

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