Fraunhofer

RESEARCH NEWS

07 | 2013 ||

1 App security testing tool

Most apps, be they for internet shopping, gaming or social networking, are aimed at private users. But there are hidden risks for businesses. A new test framework will help to uncover gaps in app security and detect malware.

2 Bringing color to solar façades

Until now, designers of buildings have no choice but to use black or bluish-gray colored solar panels. With the help of thin-film technologies, researchers have now been able to turn solar cells into colorful creations.

3 Underwater propulsion from a 3D printer

Nature inspires creativity: in building a silent propulsion system for boats and water sport devices, researchers used the octopus as their role model. The system can be produced at a low cost and in a single step with a 3D printer.

4 Fitness test for corrosion protection coatings

Internal coatings in the different sections of oil treatment plants are subjected to a variety of stresses. By conducting comparative tests, researchers are analyzing which materials are best suited to each individual section.

5 Robots inspect cables

The bearer cables and tethers of bridges, elevators, and cable cars are exposed to high levels of stress. For this reason, their functional reliability must be monitored on a regular basis. A new robot recognizes fissures before they pose a danger

6 Pickling tape for local pre-treatment of aluminum

A new self-adhesive tape simplifies the process of pickling aluminum surfaces. It is safer than existing treatment methods involving pickling pastes, sprays or baths, because there is no rinsing stage and hence no need for complicated wastewater disposal.

7 Using RFID for fiber composites

Antennas that are capable of transmitting radio waves turn components into intelligent objects. Researchers have now found a way to embed these antennas in fiber composites. As a result, the technology also works with carbon and glass fibers.

8 Newsflash

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 66 institutes and independent research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 22,000, who work with an annual research budget totaling 1.9 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 Phone +49 89 1205-1333 l presse@zv.fraunhofer.de | Editorial Staff: Franz Miller, Britta Widmann, Tobias Steinhäußer, Janine van Ackeren, Tina Möbius 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 FORSCHUNG KOMPAKT.

Fraunhofer

App security testing tool

"Please contact the administrator." This error message usually flashes up on the monitor when employees want to install new software on their office computer. The reason is simple. Companies want to protect themselves and their computers against viruses and other malware, and make sure that confidential business information does not go astray. What is standard practice with fixed desktop computers is rather more difficult to implement with mobile smartphones. It is almost impossible to stop employees installing a range of apps on their smartphones, particularly when the handsets belong to them, but operate on the business network. But just how trustworthy are those apps? Are they carrying malware that can steal documents and passwords, or damage machines and servers? What about security? Is important information being transferred without encryption? How are business documents saved? Can unintended viewers get hold of them if somebody happens to lose their smartphone?

Individual test reports

In the future the Appicaptor test framework, developed by researchers at the Fraunhofer Institute for Secure Information Technology SIT in Darmstadt, will provide answers to these questions. The system provides companies with individual reports for every app and operating system. "Our Appicaptor framework consists of different analytic methods and tools," says Dr. Jens Heider, Head of Department at the SIT's Testlab Mobile Security. "It can analyze apps working on both Android and iOS-based smartphones, so it's able to work regardless of platform. It can also be built on to suit special requirements." Appicaptor screens for security gaps and malware automatically, and displays a warning if it finds anything. But a clean bill of health after one scan does not mean everything is fine for the long haul, so the software scans at regular intervals, as apps are modified and reconfigured frequently. Using Appicaptor, companies can put together an app-whitelist - a list of apps that employees are free to install on their smartphones. Or they can draw up a blacklist of apps that are dangerous and that employees must avoid at all costs.

"Appicaptor is not a piece of test software, but a flexible testing platform that brings together different testing tools," Heider says. The scientists put a lot of development work into making results intelligible. At first, only IT specialists were able to interpret Appicaptor's output. Now the software generates warnings that lay users can act on, such as "Security risk: This app is saving data without encryption." Another hurdle the researchers had to overcome was the impenetrability of iOS. Apple is very secretive about the structure of the system. This meant that the scientists had to delve deep to find out how it worked and decide which threats to the platform to screen for.

The framework is already in operation, but it is in constant development and being adapted to work with new operating systems. Researchers are currently testing and

optimizing it with industry partners. This testing phase will continue until fall of this year. One result so far is that businesses often want a bespoke test case. Another requirement is that the system must be compatible with companies' own app stores and mobile device management systems. As a result, the SIT is only offering Appicaptor as a business services product. In spite of this, private users will probably benefit from the results gleaned. "We anticipate that apps will become better as a result of increasing checks, and security gaps will be less and less of a problem."

Not every app is trustworthy. Some install malware, and others steal documents or passwords. These ones are best avoided. (© Fraunhofer SIT) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Secure Information Technology SIT | Rheinstrasse 75 | 64295 Darmstadt | www.sit.fraunhofer.de
Contact: Dr. Jens Heider | Phone +49 6151 869-233 | jens.heider@sit.fraunhofer.de
Press: Oliver Küch | Phone +49 6151 869-213 | oliver.kuech@sit.fraunhofer.de

Fraunhofer

Bringing color to solar façades

Covering a roof or a façade with standard solar cells to generate electricity will change a building's original appearance – and not always for the better. At present only dark solar panels are widely available on the market. "Not enough work has been done so far on combining photovoltaics and design elements to really do the term 'customized photovoltaics' justice," says Kevin Füchsel, project manager at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena.

But things are changing. The IOF physicist has been focusing for the last four years on nanostructured solar cells suitable for mass production as part of a junior research group funded by Germany's Federal Ministry for Education and Research (BMBF). Together with a Fraunhofer team and scientists from the Friedrich-Schiller University in Jena, the group of optics specialists is looking for cost-effective techniques and manufacturing processes to increase both the efficiency of solar panels and the design flexibility they give architects and designers.

Paper-thin silicon wafers give color to solar cells

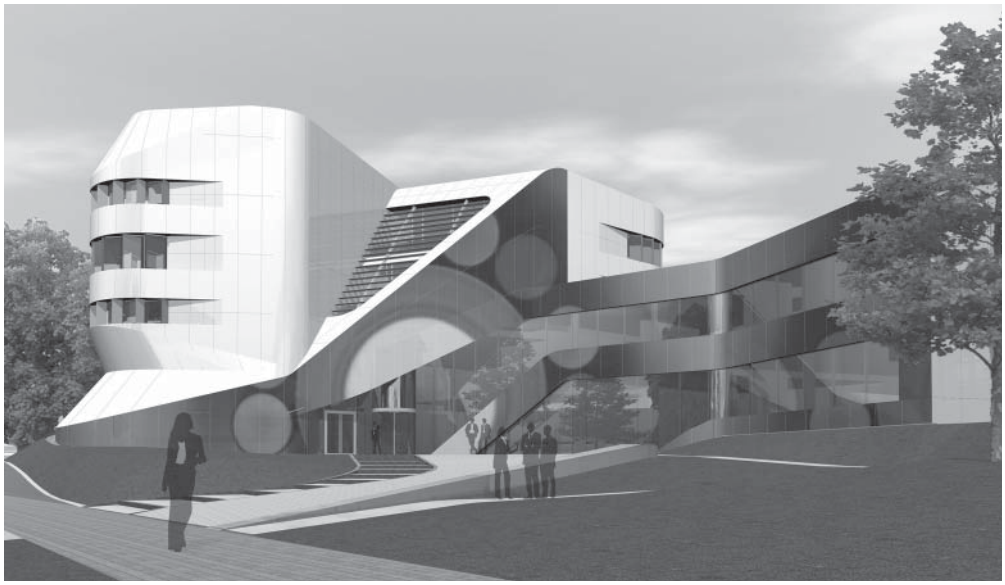
Füchsel is currently working with his "efficient design" team on the fundamentals of how to make colored solar cells from paper-thin silicon wafers. These will be particularly suited to designs for decorative façades and domestic roofs. The silicon semiconductor material, just a few micrometers thick, absorbs light and turns it into electricity. To enable lots of light to reach the silicon substrate, the semiconductor layer is given an optically neutral protective barrier (insulator), onto which a hundred-nanometer-thick oxide layer is applied. This transparent conductive oxide (TCO) conducts electricity, and is there primarily to guide as many light particles as possible to the semiconductor layer below. "TCO has a lower refractive index than silicon, so it works as an anti-reflective coating," Füchsel says.

The simple construction of this SIS (semiconductor-insulator-semiconductor) solar cell, with its transparent outer layer, has a further advantage: Not only does it capture more light, it means solar panels can be made in different colors and shapes. "The color comes from changing the physical thickness of the transparent conductive oxide layer, or modifying its refractive index," Füchsel says. The Jena-based researchers have thus managed to combine wafer-based silicon with processes borrowed from thin-film photovoltaics. They are also pioneering the use of innovative coating materials. Indium tin oxide is the most common material used today, but it is expensive. The IOF laboratory is working on how to use cheaper zinc oxide with added aluminum. New opportunities in façade design are being opened up not just by SIS solar cells, however, but also by dye solar modules and flexible organic solar cells.

But how does color affect the efficiency of these new SIS modules? "Giving solar cells color doesn't really affect their efficiency. The additional transparent TCO layer has barely any impact on the current yield," Füchsel says. Simulations showed that SIS cells could be up to 20 percent efficient. In practice, the efficiency depends on the design of the solar panels and the direction the building faces. But not every color allows you to generate the same amount of electricity. There are restrictions for example with certain blends of red, blue and green.

The possibility of multicolored cells

To connect several solar cells to create a single module the IOF scientist will use laser-based optical welding processes. They enable accurate work at a micrometer scale and do not damage the surrounding material. Researchers are also developing an inkjet printing process to contact the conductive TCO later on the silicon wafer. This will make manufacturing faster and allow additional degrees of flexibility in design. SIS solar cells could even be used to make large billboards that produce their own electricity. Patents already cover the production of colored cells, as well as the ability to integrate design elements into solar panels and whole modules. "This opens up numerous possibilities to use a building to communicate information, displaying the name of a company or even artistic pictures," Füchsel says.



The photomontage shows how the Fraunhofer IAO building in Stuttgart could be fitted with an "efficient design" solar façade. (© Fraunhofer IOF) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Applied Optics and Precision Engineering IOF | Albert-Einstein-Str. 7 | 07745 Jena | www.iof.fraunhofer.de
Contact: Dipl.-Phys.Kevin Füchsel | Phone +49 3641 807-273 | kevin.fuechsel@iof.fraunhofer.de
Press: Dr. Oliver Mauroner | Phone +49 3641 807-371 | oliver.mauroner@iof.fraunhofer.de

Fraunhofer

Underwater propulsion from a 3D printer

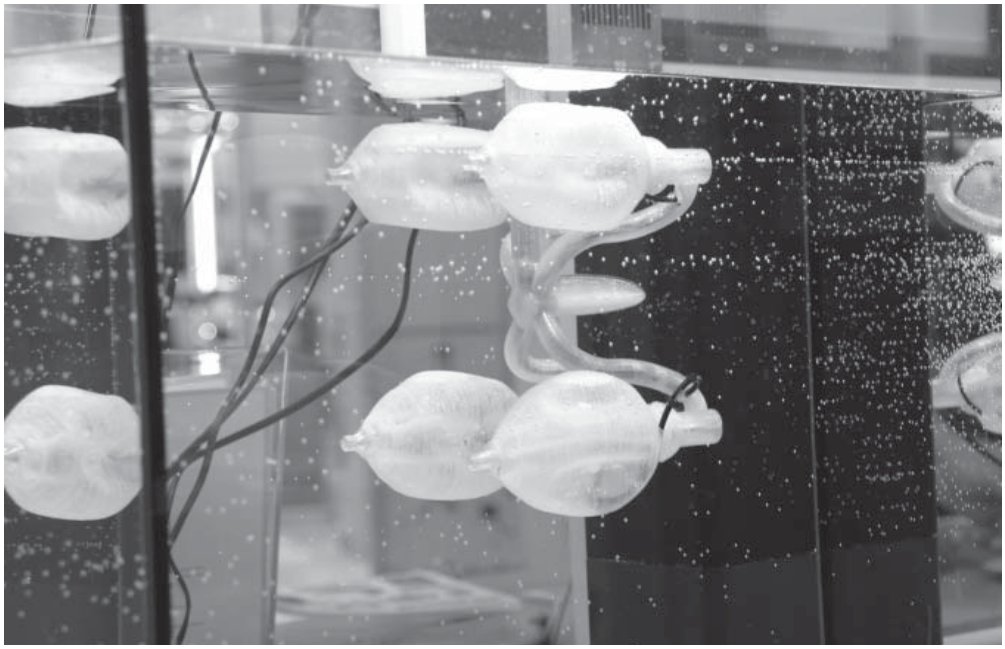
Octopods, which are also known as octopuses or squid, are considered to be the most intelligent invertebrates. In fact, they have been referred to as the "sages of the sea". They are capable of learning; they can open tin cans, and can even tell patterns apart. They are also clever when it comes to protecting themselves from their enemies. While they generally move along the ocean floor with their eight arms, they flee by swimming head-first, in line with the principles of propulsion. When the mollusk does this, water is taken into its mantle, which is then closed by contracting sphincter muscles. The water is then squirted back out at a high pressure through a funnel. The resulting propulsion pushes the octopus forward in the opposite direction. By changing the position of the funnel, the octopus can precisely steer its direction of travel. For researchers at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA, this intelligent propulsion principle served as a role model for the development of an underwater propulsion system. "Squids use this type of movement mainly if they are trying to flee suddenly and quickly. The system is simple, but effective. When they use it, the octopods can speed up considerably over short distances," says Andreas Fischer, an engineer at IPA in Stuttgart. "We have integrated this propulsion principle into our underwater actuators: four elastomer balls with mechanical inner workings create propulsion by pumping water."

Water is sucked into each actuator or elastomer ball through an opening ; a recirculation valve prevents reflux. A hydraulic piston contracts the integrated cable structure like a muscle. In this way, it pushes the water out of the 20 x 6 cm ball. In turn, a motor pump moves the hydraulic piston. "Our underwater actuator is well-suited for maneuvering small boats. It can also be used as a floating aid for water sport devices such as jet skis, surf boards, or scooters that pull divers into deep water. In contrast to ship propellers, it is quiet, and fish cannot get caught in it," the researcher says in explaining the benefits of the system, which has just successfully past initial laboratory tests.

Industrial robots shorten production processes

The best part: the experts can produce the system in a single step with a 3D printer. In order to produce its complex geometry amorphously with soft plastic, the researchers opted for the fused deposition modeling generative production process, or FDM for short. With this approach, the plastics to be processed are heated and liquefied in an extrusion head , and are transformed into a thin filament in the pressure nozzle. This filament is then applied in layers, from bottom to top, to produce a complex 3D component. Fischer and his team used thermoplastics such as polyurethane because of their flexibility. The final product of this process is an underwater propulsion system that can stand extreme levels of pressure without breaking. Even in situations of very high stress, it always returns to its original shape.

Thanks to FDM, the researchers can also scale the actuators. In fact, components of up to two meters in size can be printed three-dimensionally. This can be done with the help of an industrial robot that has been equipped with three extrusion heads. "At the moment, the maximum construction volume of FDM facilities is 91.4 x 61 x 91.4 cm, whereby no more than ten different thermoplastics can be processed in layers. With robot-based FDM, much larger components can be produced, with different combinations of material. By integrating continuous filament into thermoplastics, for example, we can manufacture carbon fiber-reinforced components quickly and at a low cost," says the scientist in explaining the advantages of the melting process. Moreover, the production process can be made much shorter by using several robots that work on a single component simultaneously.



Four elastomer balls pump water and provide the required propulsion. The propulsion system was produced with the fused deposition modeling (FDM) generative production process. (© Fraunhofer IPA) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Manufacturing Engineering and Automation IPA | Nobelstraße 12 | 70569 Stuttgart | www.ipa.fraunhofer.de
Contact: Andreas Fischer | Phone +49 711 970-1280 | andreas.fischer@ipa.fraunhofer.de
Press: Axel Storz | Phone +49 711 970-3660 | axel.storz@ipa.fraunhofer.de

Fraunhofer

Fitness test for corrosion protection coatings

The internal coatings of oil production facilities have to withstand multiple stresses: aggressive chemical substances, high temperatures and pressures, as well as sand and stone particles abrading the walls of tanks and pipelines. Over time, this causes the applied linings to degrade, thus facilitating corrosion of underlying steel structures. This is why the coatings of tanks, separators, and pipelines must be renewed on a regular basis. However, how long the material "holds" depends on the individual levels of stress it is exposed to. A single coating is not necessarily equally well-suited to every application. But until now, there is a lack of systematic analysis of the materials available on the market. Such a comparative analysis would allow plant operators to assess a material's suitability for different types of stress.

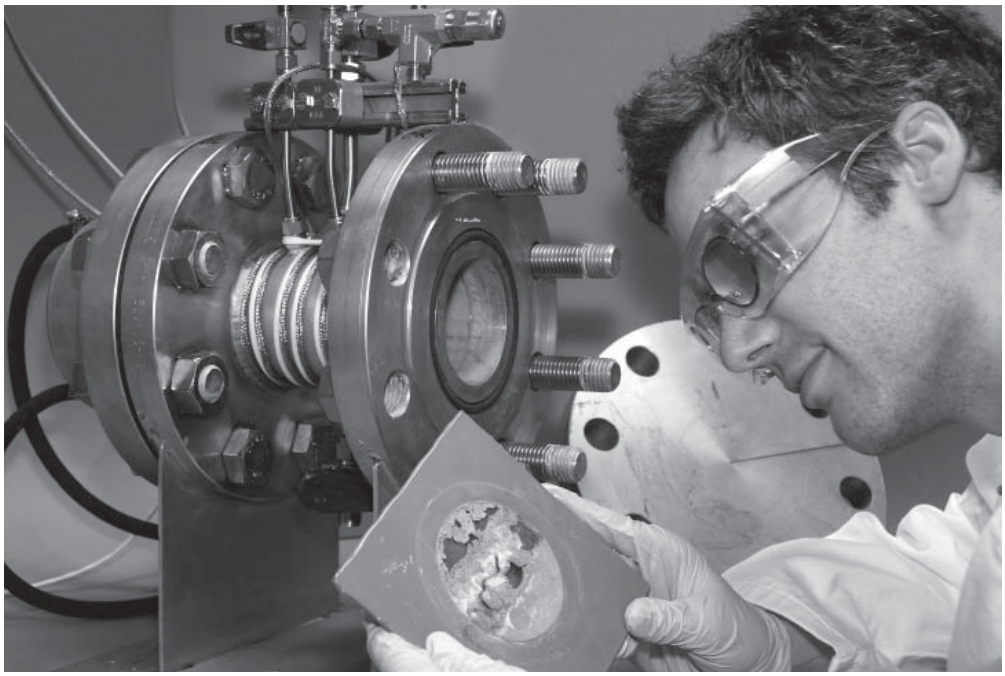
Researchers at the Fraunhofer Institute for Mechanics of Materials IWM are now working to close this gap. In a project sponsored by the DGMK German Society for Petroleum and Coal Science and Technology, researchers in Freiburg have come up with a test program that assesses corrosion resistance in different stress scenarios. The program closely replicates real treatment conditions. "In the different sections of the plant, the coating material is exposed to completely different conditions," says Dr. Matthias Gurr of the IWM. For instance, sand or stone particles are generally present in the extracted mix in the immediate vicinity of the drilling hole. In this part of the plant, it is especially important that the coating is able to withstand the mechanical stress caused by abrasion. However, chemical factors also put the material under stress, among them saline solutions such as the reservoir water that is pumped out of the ground with the crude oil during extraction. To effectively protect the underlying steel surface, coatings that are exposed to this solution require high chemical resistance and a good level of impermeability. "The saline solution is separated from the oil in the separator later on," says Gurr. "For plant sections that are located downstream of the separator, resistance to the saline solution is, in most instances, not as important."

Taking the „cold wall" effect into account

To assess the corrosion resistance of coatings in a laboratory environment, the researchers apply a number of different tests. In the autoclave test, for instance, researchers put a material sample together with a medium – such as an oil-saline mix – in a gas-tight container and expose it to temperatures up to 150 degrees Celsius. For most materials, the critical temperature limit for heightened susceptibility to corrosion is far lower. While the test is state of the art, not all conditions that actually occur in a treatment plant can be simulated. For instance, in containers that do not have additional insulation, thermally induced stress and the effects of condensation (the so-called "cold wall" effect) also have an influence on materials, as there can be stark differences in temperature between the container's exterior and interior walls. To create such a difference in temperature in laboratory conditions, the researchers use special Atlas cells. These

comprise a medium-filled steel cell which is sealed by presssing coated samples onto its open ends. "As a result, the coating becomes part of the container wall," says Gurr. While the medium is heated up on the inside of the cell, the researchers can use a cooling circuit to regulate the ambient temperature downward.

The experts are compiling their results in a comprehensive table. With its help, plant operators will one day be able to find out at a single glance which materials are best suited for specific stress parameters. The researchers aim to test coating materials under real conditions at a treatment plant, and talks are currently underway with several industry partners from the project consortium. Gurr and his team are hoping to have the initial results in about two years. "Correlating our lab tests with the field experiments in this way would form an important basis for concrete forecasts about the life cycle of coating systems in the future," says Gurr.



Fitness test failure! Examining a coating sample after a resistance test has been conducted in the Atlas cell. (© Fraunhofer IWM) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Mechanics of Materials IWM | Wöhlerstr. 11 | 79108 Freiburg | www.iwm.fraunhofer.de
Contact: Dr. Matthias Gurr | Phone +49 761 5142-137 | matthias.gurr@iwm.fraunhofer.de
Press: Katharina Hien | Phone +49 761 5142-154 | katharina.hien@iwm.fraunhofer.de

Fraunhofer

Robots inspect cables

Slowly, very slowly, the robot climbs up the wire cable. As it crawls upward with caterpillar-like movements, it scans the steel surface and detects whether it has any defects. Researchers at the Fraunhofer Institute for Nondestructive Testing IZFP have named the system FluxCrawler. It is designed to monitor the quality of stay cables and wire ropes on a regular basis. Such cables are common features of bridges, elevators, cranes, cable cars, and ski lifts. And these checks are vital, as the tension-induced strain, wear, and corrosion that affect these steel cables mean that they are under enormous stress.

By conducting a magnetic flux leakage test, the robot not only identifies tiny fissures in the cable surface, it also recognizes deeper cracks. This process exposes the cable to a magnetic field that is "disrupted" in the event of a defect. A measurable leakage field is created wherever defects are located. "If such micro-fissures are not discovered in time, the steel can break. This is why material checks are absolutely vital to avoid deadly consequences or even catastrophes", says Dr. Jochen Kurz, an engineer and department head at IZFP in Saarbrücken.

Test system is suitable for many cable sizes

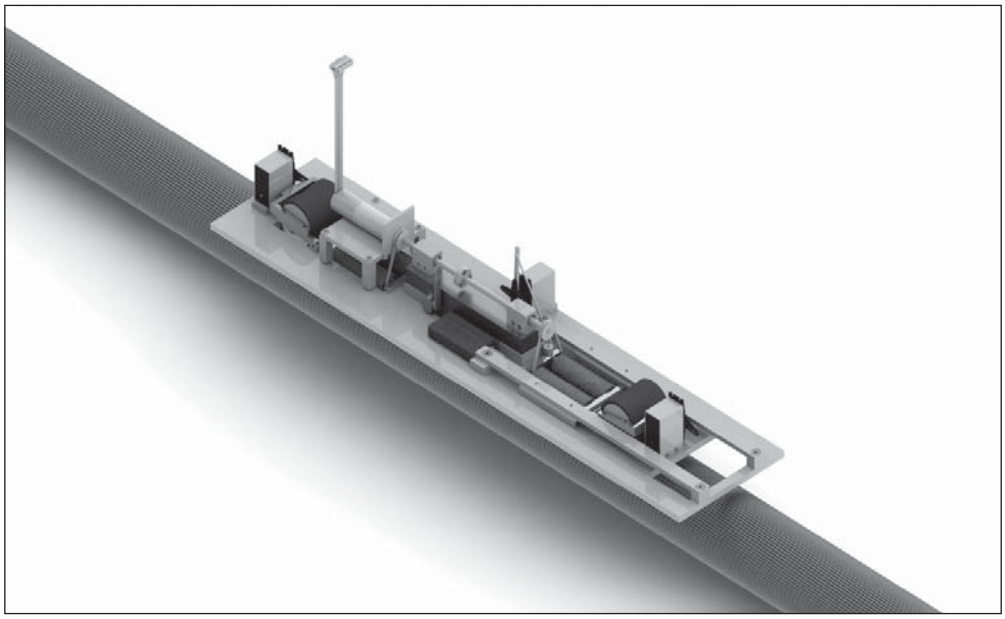
While the testing of steel cables using magnetic flux leakage is already a common approach, until now coils were used that had to clasp the cable. But this posed a problem: since the diameter of steel cables and their jackets vary considerably, the coils' limited diameter range meant that they could only be used in a limited number of instances. Moreover, they were unable to locate the exact angle of a defect. In contrast, FluxCrawler can be applied regardless of a cable's diameter. The robot, which is about seventy centimeters long, scans cylinder-shaped surfaces by revolving around the cable. As a result, there is no need to clasp the cable. A permanent magnet prevents slipping and holds FluxCrawler to the cable. At the same time, it generates the magnetization required to make measurements. Between the two ends of the u-shaped magnet, a line of sensors equipped with several probes is able to rapidly scan the surface. While FluxCrawler moves around the cable, these sensors can identify the exact angle of the defect: they recognize whether defects are on the left, on the right, on the bottom or on top of the cable. The robot can carry out checks on cables with diameters ranging from four to 20 centimeters. The battery-operated platform is controlled with a computer via Bluetooth. An image of the magnetic field on the cable's entire surface appears on the computer, and each conspicuous spot is illustrated in high resolution on the computer screen.

Cooperation with the French Carnot Institute

FluxCrawler is the result of "FilameNDT" project (NDT is short for nondestructive testing). Jochen Kurz and his team from IZFP are cooperating with the French Carnot

Institute VITRES-IFFSTAR to further develop magnetic leakage testing as well as other non-destructive testing methods. These include using Electromagnetic Acoustic Transducers (EMAT) and micromagnetic testing methods, the latter being used for monitoring purposes. "It should be noted that FluxCrawler cannot be used in all situations. For instance, the robot cannot recognize defects in covered areas, for instance in the area where the cable is anchored. To detect defects in such cases, we apply another non-destructive testing method, namely, EMAT," says Kurz. To do this, the researchers create a guided ultrasound wave with a transducer that is placed directly on the cable. The wave penetrates the material and is reflected when it hits a flaw. The signals that are sent back to the computer are used to reconstruct an image. The computer uses this image to analyze the physical changes that the wave perceives in the material, and can thus determine the situation in the material's interior. As a result, the seriousness of even the smallest of flaws can be determined.

A monitoring system is already being tested at a bridge in Mettlach, Germany that is currently undergoing renovation. Kurz and his team are confident that FluxCrawler will soon be used in everyday practice to diagnose defects: the team has already received enquiries from industry. The robot is now patented, and the researchers have already successfully tested cables in the laboratory. In the next step, tests will be conducted at DMT GmbH, a cable testing facility in Bochum that comprises a testing laboratory for non-destructive and destructive testing.



CAD model of the robot inspecting a wire cable. (© Fraunhofer IZFP) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Nondestructive Testing IZFP | Campus E3 1 | 66123 Saarbrücken | www.izfp.fraunhofer.de
Contact: Dr.-Ing. Jochen Kurz | Phone +49 681 9302-3880 | jochen.kurz@izfp.fraunhofer.de
Press: Sabine Burbes | Phone +49 681 9302-3869 | sabine.burbes@izfp.fraunhofer.de

Fraunhofer

Pickling tape for local pre-treatment of aluminum

Aluminum is a light metal used wherever low weight is a prime consideration. Traditionally used in aircraft construction, it is increasingly employed in other sectors such as automotive engineering. But as a base metal, aluminum requires protection against corrosion, which is usually achieved by a special paint or other surface coating. Adhesive bonding is becoming increasingly popular as a means of joining lightweight metal components. But aluminum cannot be coated or bonded without an appropriate pre-treatment to remove undefined deposits of oxides, hydroxides or other contaminations that are almost always found on technical aluminum surfaces. Pickling is one of the most common techniques employed for this purpose. It involves immersion of the components in a solution of chemicals that dissolves the contaminants and provides a perfectly clean metal surface.

The use of a pickling bath is difficult when dealing with large components that only require treatment of part of their surface, or when components are being reworked or repaired. Local pre-treatment methods are increasingly preferred in such cases. Manufacturers mainly use pickling agents in paste or spray form, which are spread or sprayed onto the metal surface manually by trained technicians. The problem is that the chemicals employed are strongly acidic or alkaline. Consequently, the surrounding areas of metal have to be carefully masked off. A subsequent rinsing stage is required to remove the pickling agent, and the corrosive wastewater has to undergo special treatment prior to disposal. "None of the currently available local pre-treatment solutions is entirely satisfactory. That's what led us to the idea of developing a pickling tape that can be easily applied to the areas that require pre-treatment," says Dr. Malte Burchardt of the Adhesion and Interface Research department at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen, describing IFAM's approach.

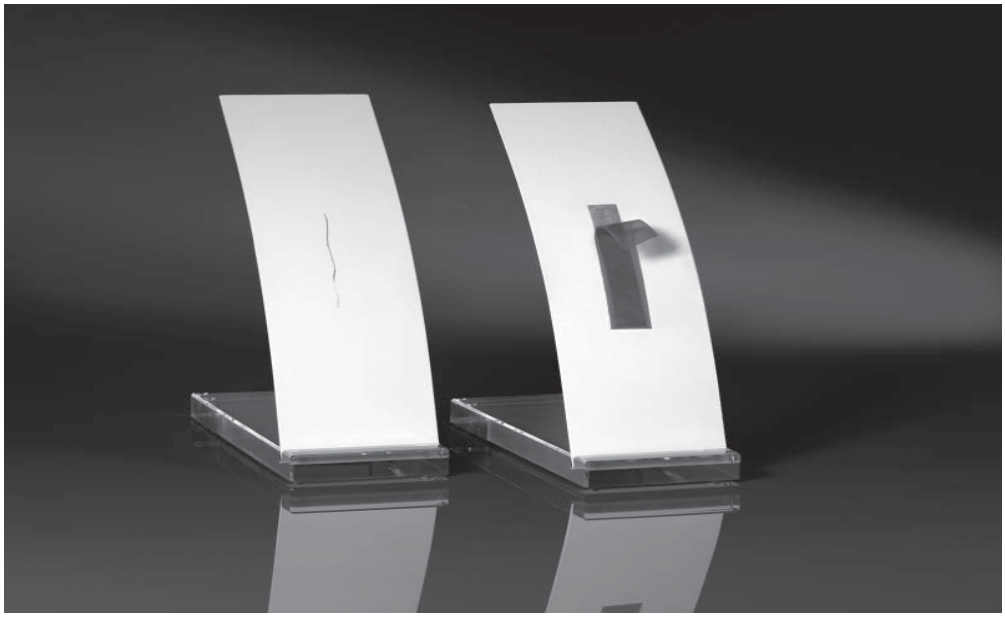
Novel adhesive with high water content

To realize this objective, it was necessary to develop an entirely new adhesive for the pickling tape that would enable it to be applied as easily as any other self-adhesive tape and removed without leaving any residues. Moreover, all of the chemicals required for the pickling process had to be integrated in the adhesive. "An adhesive for pickling applications needs to have a high water content, whereas 95 percent of all conventional adhesives used in self-adhesive tapes are solvent-based. This means they stop working when they come into contact with water," explains Dr. Malte Kleemeier of the IFAM Adhesives and Polymer Chemistry department. The Fraunhofer scientists met this challenge by developing a suitable adhesive formulation based on water-soluble polymers.

Practical tests have demonstrated that the new technology is just as effective as conventional bath pickling and alternative paste or spray methods. And unlike existing techniques, it doesn't produce corrosive wastewater requiring special disposal measures. The treated component merely has to be wiped clean with a damp cloth after the pickling tape is removed. "Our pickling tape is easy to handle, safe, and environmentally friendly," says Kleemeier, summarizing its advantages.

The researchers developed the new self-adhesive tape in collaboration with industrial partners from various sectors including aeronautical and automotive engineering. With their high quality standards, these sectors are the ideal proving ground for the pickling tape. In 2012, its developers received the "SURFAIR Award for Innovation".

In the next step, IFAM and its partners intend to ready the tape technology for production. They will also conduct tests to evaluate the suitability of the pickling tape for use with other materials such as stainless steel.



Application of pickling tape prior to the repair of damaged paint. The paint has been removed by mechanical abrasion and the pickling tape is used for pre-treatment of the metal surface. After removal of the tape and simple cleaning with a damp cloth, the surface is ready to receive a fresh coat of paint. (© Fraunhofer IFAM) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM |
Wiener Str.12 | 28359 Bremen | Germany | www.ifam.fraunhofer.de
Contact: Dr. Malte Burchardt | Phone +49 421 2246-498 | malte.burchardt@ifam.fraunhofer.de
Contact: Dr. Malte Kleemeier | Phone +49 421 2246-483 | malte.kleemeier@ifam.fraunhofer.de
Press: Anne-Grete Becker | Phone +49 421 2246-568 | anne-grete.becker@ifam.fraunhofer.de

Fraunhofer

Using RFID for fiber composites

It is barely visible to the naked eye: the work pieces in the production hall look normal. But the first impression is deceiving. The airplane components are "intelligent" and can communicate with the skilled workers in their vicinity. Not only can they tell them what they are, they can also provide information on who has worked on them as well as on the next work step. A radio frequency identification chip (RFID) transmits the information. It measures just a few square millimeters and transmits details about the component quickly, efficiently, and consistently to a receiver via radio waves. Until now, only a handful of companies use the technology for documentation purposes in production processes. Most often, RFID is used for access control purposes, or to record time, for instance on employee smart cards.

How well an RFID transponder works depends mainly on the material that surrounds it. The material can have a negative influence on the transponder antenna's range, as well as on the quality of data transmission. Researchers at the Fraunhofer Institute for Integrated Circuits IIS in Nuremburg have now developed an RFID transponder whose antenna works reliably on fiber composites as well. Components such as glass or carbon fibers are both lightweight and robust, and are thus used increasingly in airplane and vehicle production. However, these fibers have a particularly strong influence on frequencies. Until now, their exact behavior with regard to RFID has not been well known on the wireless system, and this is why production steps are still documented with a pencil and paper.

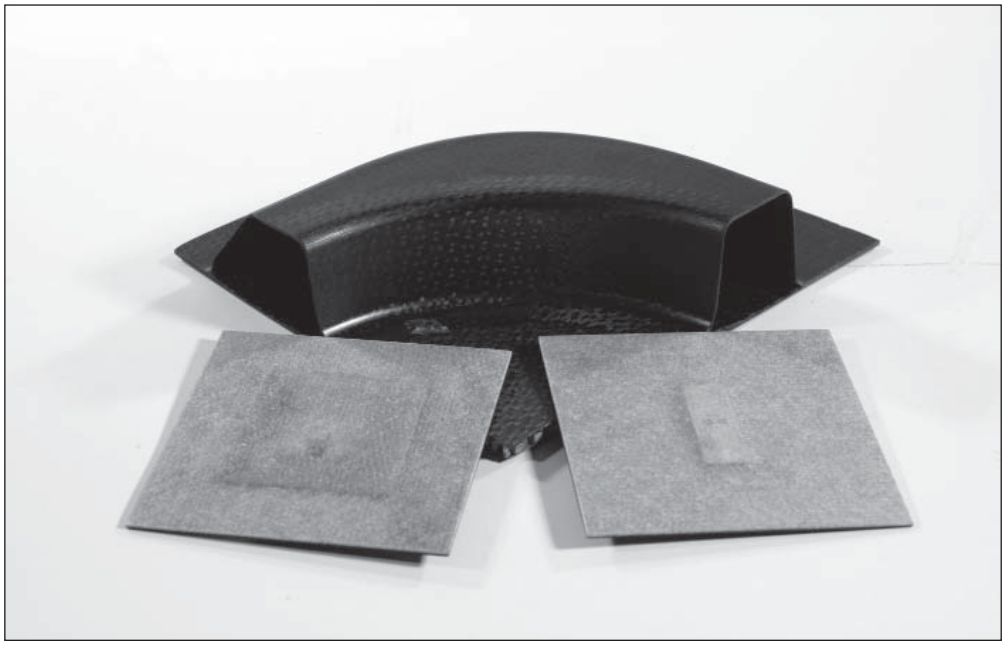
Carbon fibers compromise the performance of RFID chips

"We took a close look at the frequencies relevant to RFID technology: 125 kHz (LF: low frequency), 13.56 MHz (HF: high frequency), and 868 MHz (UHF: ultra high frequency). We measured the extent to which glass and carbon fibers affect the reliability of the transponder," says Tobias Dräger, an engineer, in describing the work of the IIS team. The result: while LF, HF, and UHF work well with glass fibers, they showed weaknesses with carbon fibers. The high frequencies in particular compromised the performance of the RFID chip significantly. "Carbon fibers are, similarly to metal, conductive. As a result, they dampen radio signals considerably– especially at 868 MHz," says Dräger's colleague Dr. Iker Mayordomo.

But thanks to their relatively large range of up to 15 meters, UHF frequencies are very well suited to applications in logistics and production. In the past, if RFID was used with incompatible materials such as metals, a very expensive transponder was required to reach this level of performance. "The antennas and transponders required make these customized systems very large. At the same time, integrating them into fiber composites is difficult," says Dräger in discussing the initial situation. Together with partners from the aviation industry and research, his team has successfully developed a trans-

ponder that can operate reliably within conducting components, which are also subject to physical stress. The scientists have designed an ultra-thin antenna that can be embedded in materials underneath a protective glass fiber layer. Together with Schreiner LogiData, a manufacturer of RFID transponders, IIS has already developed the first test series.

According to Eurostat, the statistics office of the European Union, about six percent of German companies were using RFID in 2011. In Europe, the figure was four percent. Maximilian Roth, an engineer and RFID expert at the Center for Intelligent Objects ZIO of the IIS in Nuremberg, is convinced that this is about to change. "New applications in the area of fiber composites, which is booming, will further increase the relevance of RFID for industry. There are currently a number of other pilot projects underway in the market that are conducting major tests for the use of RFID in logistics, traffic, and production." Fraunhofer IIS is already working on its next project in parallel, the EU-sponsored "SmartFiber" initiative. Researchers working on the project are using RFID technology to transmit energy and data to sensors that are embedded in fiber materials. This makes it possible, for instance, to monitor the entire structure of wind turbines.



To embed RFID tags in fiber composites, ultra-thin antennas are needed (right: UHF, left: HF transponder). (©TUM-IWB / Fraunhofer IIS) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Integrated Circuits IIS, Standort Nürnberg | Nordostpark 93 | 90411 Nürnberg | www.iis.fraunhofer.de
Contact: Dipl.-Ing. Tobias Dräger **|** Phone +49 911 58061-3211 | tobias.draeger@iis.fraunhofer.de
Press: Lina Scheu | Phone +49 911 58061-9545 | lina.scheu@iis.fraunhofer.de

Spotting plagiarism and breaches of warrantee

In Germany industry, product piracy leads to billions of euros in losses each year. The mechanical engineering sector is particularly affected by the efforts of counterfeiters, whose strategies are increasingly deceitful. While they copy almost everything, components are most often faked, followed by whole machines or replacement parts. Textile and plastics machines are most often affected, as are compressors as well as printing and paper technologies. Researchers at the Fraunhofer Institute for Production Systems and Design Technology IPK in Berlin aim to make idea theft more difficult with a new solution to prevent component assemblies from being copied or tampered with. Since the system functions equally well under extreme conditions, even the pumps and compressors employed by the natural gas industry – located in ice and snow, in deserts, and in the tropics – can be protected against the use of fake components.

The plagiarism protection system comprises a newly developed seal that contains a labeling powder embedded in hardened enamel. This powder serves as proof of the component's authenticity. Once they have been built in, the original components are fixed in place with the filled seal. This seal can be placed in a component with the appropriate tools, and this can also be done on site at the operator's installation. When called upon to carry out maintenance or repairs, the service technician first ascertains the seal's integrity and authenticity with a mobile device. To reach the protected component module, the technician must break the seal, which is replaced once his work is complete.

Fraunhofer Institute for Production Systems and Design Technology IPK | Pascalstraße 8-9 | 10587 Berlin | www.ipk.fraunhofer.de
Contact: Dr. Roberto Feitscher | Phone +49 30 39006-130 | roberto.feitscher@ipk.fraunhofer.de
Press: Steffen Pospischil | Phone +49 30 39006-140 | steffen.pospischil@ipk.fraunhofer.de

X-ray vision for the walls of buildings

Purchasing an older house can be full of surprises when it comes to electrical wiring and water pipes. The buyer does not know when the wiring and pipes were last maintained, and whether repair work has already been carried out. In most cases, buyers rely on previous owner's good will and memory. The question of where exactly the pipes run also often leaves people guessing. In the future, an app will ensure that such information does not get lost. It will document all of the renovations, maintenance work, and repairs that have been done over the course of a buildings entire life cycle. The program with x-ray vision was developed by researchers at the Fraunhofer Institute for Computer Graphics Research IGD in Darmstadt in cooperation with their French colleagues from the Centre scientifique et technique du Bâtiment CSTB. To find out where pipes and cables run, for instance, all a buyer needs to do is grab their smart

phone, turn on the integrated camera, and point it towards the wall. The smart phone uses Augmented Reality to show where the plumbing and electrical installations are located, simply by superimposing the information on the picture the camera has taken. And that's not all the app is capable of: the technology is just as helpful when a building is being built. If architects use the app to archive 3D CAD data of a new building, they can always go back to the stored data to see where changes subsequently became necessary, which could be a useful reference for comparable projects later on. Customers in the facility management sector are currently testing the software, which is almost ready for market. Once these tests are completed, NewMedia Yuppies GmbH plans to turn the app into a product.

Fraunhofer Institute for Computer Graphics Research IGD | Fraunhoferstr. 5 | 64283 Darmstadt | www.igd.fraunhofer.de
Contact: Holger Graf | Phone +49 6151 155-471| holger.graf@igd.fraunhofer.de
Press: Dr. Konrad Baier | Phone +49 6151 155-146 | konrad.baier@igd.fraunhofer.de

Extracting subsea natural gas and storing CO_2

The dilemma is well known: the world's energy needs continue to rise, but we are slowly running out of energy sources. While an increasing number of wind and solar energy parks try to overcome the problem, finding unconventional sources of energy is another option. Gas hydrates are one of these sources. The ice-like compounds comprising gas and water can be found mainly beneath the sea floor. According to estimates, the amount of carbon stored within these compounds is larger than that within conventional deposits of natural gas, oil, and coal. Not only could subsea gas hydrates supply natural gas in the form of methane, they could also be used to store CO_2. Under favorable conditions, artificially injected CO_2 can turn into a solid structure that is stored safely under impermeable sedimentary layers.

Scientific experiments have already shown that the two gases can be exchanged in subsea sediments, but that this is an extremely time-consuming process. Researchers at the Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT in Oberhausen are currently conducting laboratory experiments and simulations to speed up the process. Their mathematical simulation model takes important variables into account, including temperature, pressure, and the distribution of the substances in question. The model can be used to determine production rates based on the properties of the deposit and the method of exploitation.

Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT | Osterfelder Straße 3 | 46047 Oberhausen | www.umsicht.fraunhofer.de
Contact: Dipl.-Ing. Georg Janicki | Phone +49 208 8598-1420 | georg.janicki@umsicht.fraunhofer.de
Press: Iris Kumpmann | Phone +49 208 8598-1200 | iris.kumpmann@umsicht.fraunhofer.de