Fraunhofer

RESEARCH NEWS – SPECIAL ISSUE

05 | 2014 ||

Research awards in brief

Four science prizes will be presented at this year's annual conference of the Fraunhofer-Gesellschaft in Freiburg. The first, the Stifterverband Science Prize, is awarded for scientific excellence in collaborative applied research projects. The Joseph von Fraunhofer Prize will be awarded to three teams of researchers in recognition of outstanding scientific work leading to the solution of application-oriented problems.

1 Liquid crystal as lubricant

Thanks to a new lubricant, small gears can run with virtually no friction. Made from liquid crystalline fluid, these lubricants drastically reduce friction and wear.

2 Inspecting letters with terahertz waves

Is it a harmless parcel or a bomb, an innocent letter or a drug shipment? A new terahertz scanner is capable of detecting illicit drugs and explosives sent by post without having to open suspicious packages or envelopes..

3 The digital film reel

Instead of heavy rolls of film, digital film copies are sent to movie theaters these days. With the easyDCP software, these digital packages can be easily created in the required standard so that the digital film can run in any theater.

4 Adhesive bonding with pre-applied adhesives

In industrial production, bonding plays an increasingly important role. Researchers have now succeeded in separating the processes of applying the adhesive and the actual joining, which opens up a new world of applications.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 67 Fraunhofer Institutes and research units at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 23,000, who work with an annual research budget totaling 2 billion euros. More than 70 percent of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the Americas 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: Beate Koch, Birgit Niesing 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

The prizes

Stifterverband Science Prize

Stifterverband is a joint initiative by members of the business community that aims to sustainably improve the quality of higher education and research in Germany. Formed in 1920 in response to the need for research funding expressed by German academic societies, universities, and scientific institutions, Stifterverband has continued to this day to promote cooperation between industry and science. True to its vocation of making higher education more accessible in order to create knowledge and drive innovation, its activities include providing support to universities and research institutes, developing talent, analyzing the science and education system, and recommending appropriate political and economic measures.

For more than ten years, Stifterverband has supported the Fraunhofer-Gesellschaft through its Science Prize, endowed with prize money of 50,000 euros. This prize is awarded for scientific excellence in applied research projects conducted by Fraunhofer Institutes in collaboration with industry and/or other research organizations (topic 1)

Joseph von Fraunhofer prize – research for practical applications

This prize has been awarded by the Fraunhofer-Gesellschaft every year since 1978, in recognition of outstanding scientific work by members of its staff leading to the solution of application-oriented problems. To date, more than 200 researchers have received this honor. This year, four prizes each worth 50,000 euros will be awarded. The prize-winners also receive a silver lapel pin bearing the face of the man for whom the award is named, as illustrated in the logo included in topics 2, 3 and 4.

The award for Human-Centered Technology is funded by former Executive Board members and institute directors of the Fraunhofer-Gesellschaft and outside sponsors associated with them. This prize is awarded every two years – alternating with the Donors' Association Prize – to those employees whose research and development work makes a significant contribution to improving people's quality of life and maintaining their active participation in daily life into old age (topic 1). The prize of 50,000 euros will be awarded on June 10 at the Fraunhofer-Gesellschaft's annual conference in Hannover.

RESEARCH NEWS
SPECIAL ISSUE
05 | 2014 || Topic 1

Liquid crystal as lubricant

Lubricants are used in motors, axels, ventilators and manufacturing machines. Although lubricants are widely used, there have been almost no fundamental innovations for this product in the last twenty years. Together with a consortium, the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg has developed an entirely new class of substance that could change everything: liquid crystalline lubricant. Its chemical makeup sets it apart; although it is a liquid, the molecules display directional properties like crystals do. When two surfaces move in opposite directions, the liquid crystal molecules between the two surfaces align themselves so that the frictional resistance is extremely low. This enables nearly frictionless sliding.

Liquid crystals are known for its use in liquid crystal displays (LCDs) in TV screens, mobile phones or touchscreens. The unusual idea to use them as a lubricant was proposed by Nematel GmbH, which then turned to Fraunhofer IWM to see if it would work. There, Dr. Tobias Amann applied the lubricant made from liquid crystal between two metal workpieces. "Even in the first test, we measured extremely low friction coefficients," remembers Amann.

Match-shaped molecules form a liquid crystalline structure

The researchers at Fraunhofer IWM discovered that liquid crystal is well suited for lubricants because its molecules are long and thin. "When used as a lubricant between two surfaces that slide past each other, the molecules become aligned in parallel to each other in ordered boundary layers," explains Dr. Andreas Kailer, acting director for the Tribology business unit at Fraunhofer IWM. These layers are very stable but slide easily over each other, keeping friction and wear to a minimum.

Still, much was missing before a liquid crystal lubricant suitable for practical applications could be developed. Fraunhofer IWM launched a project along with Nematel GmbH and the lubricant experts at Dr. Tillwich GmbH in 2010, sponsored by the German Federal Ministry of Education and Research (BMBF).. Susanne Beyer-Faiß, a chemist at Tillwich, improved the liquid crystal's stability with help from additives. At the same time, her colleague, Werner Stehr, built a special test unit that uses laser technology to enable contact-free measurement of the extremely low friction coefficients. At Fraunhofer IWM, Tobias Amann tested different liquid crystals manufactured by Dr. Holger Kretzschmann at Nematel; among other things, Amann conducted friction experiments with various materials, including iron, copper and ceramic. He also examined the chemical mechanisms displayed during friction and the effects of mixing different liquid crystal molecules. Tobias Amann deciphered the mechanisms that are responsible for these ultra-low frictional coefficients and discovered how to further optimize the new lubricants in specific ways. He also examined the chemical mechanisms displayed during friction and the effects of mixing different liquid crystal molecu-

les. When the project came to an end, the partners had produced a liquid crystalline lubricant prototype that performed best in sliding bearings made of iron. For this pioneering work, Dr. Tobias Amann, Dr. Andreas Kailer, Susanne Beyer-Faiß, Werner Stehr and Dr. Holger Kretzschmann received the Stifterverband Science Prize, which is awarded every two years for scientific excellence in applied research projects.

Currently, the award winners are developing innovative sliding bearings lubricated with liquid crystal for small electric motors for use in the automobile industry, for instance in alternators or windshield wiper motors.

The Stifteverband Science Prize for scientific excellence in Germany was awarded to: Dr. Holger Kretzschmann (Nematel), Werner Stehr and Susanne Beyer-Faiß (Dr. Tillwich GmbH), Dr. Andreas Kailer and Dr. Tobias Amann (Fraunhofer IWM). (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Physical Measurement Techniques IPM | Wöhlerstr. 11 | 79108 Freiburg | www.iwm.fraunhofer.de
Contact: Dr. Andreas Kailer | Phone +49 761 5142-247 | andreas.kailer@iwm.fraunhofer.de
Dr. Tobias Amann | Phone +49 761 5142-208 | tobias.amann@iwm.fraunhofer.de
Press: Thomas Götz | Phone +49 761 5142-153 | thomas.goetz@iwm.fraunhofer.de
Nematel GmbH & Co. KG | Galileo-Galilei-Straße 28 | 55129 Mainz
Contact: Dr. Holger Kretzschmann | Phone +49 6131 507992 | info@nematel.de
Dr. Tillwich GmbH Werner Stehr | Murber Steige 26 | 72160 Horb-Ahldorf
Contact: Susanne Beyer-Faiß | Phone +49 7451 5386-30 | susanne.beyer.faiss@tillwich-stehr.com
Werner Stehr | Phone +49 7451 5386-20 | werner.stehr@tillwich-stehr.com

Fraunhofer

RESEARCH NEWS
SPECIAL ISSUE
05 | 2014 || Topic 2

Inspecting letters with terahertz waves

Alert at Schloss Bellevue. A suspicious letter addressed to German President Joachim Gauck has been detected, which might contain a bomb. Not willing to take any risks, the bomb squad is called out to destroy the package. Later investigations revealed that the envelope did not contain any explosives, but better safe than sorry. A year ago, this event created turmoil in the mail sorting office in Berlin, because at the time there was no safe and simple way of reliably detecting the presence of explosives or drugs in letters and small packets. A new solution is offered by the terahertz scanner developed by researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM in Kaiserslautern in collaboration with Hübner GmbH & Co. KG in Kassel. Their T-COGNITION system is capable of detecting and identifying the hidden content of suspicious packages or envelopes without having to open them. One of this year's Joseph von Fraunhofer prizes was awarded to Prof. Dr. René Beigang of Fraunhofer IPM and Dipl.-Ing. Thorsten Sprenger, Head of Public Security and Photonics at Hübner, for their work on the terahertz scanner for the secure identification of hazardous materials and illicit drugs in postal consignments.

But why did the scientists choose to use terahertz waves for this application? Professor René Beigang explains: "The terahertz range lies midway between microwave and infrared in the electromagnetic spectrum, and thus combines the advantages of both." Like microwaves, these low-energy frequencies can easily penetrate paper, wood, lightweight fabrics, plastics, and ceramics. Moreover, terahertz waves generate characteristic spectra depending on the type of material they travel through, which can be analyzed quickly using intelligent software. A further significant advantage is that terahertz waves are non-ionizing and therefore safe to use in an unprotected environment, unlike X-rays. This makes the technology an interesting option for use in mail scanners.

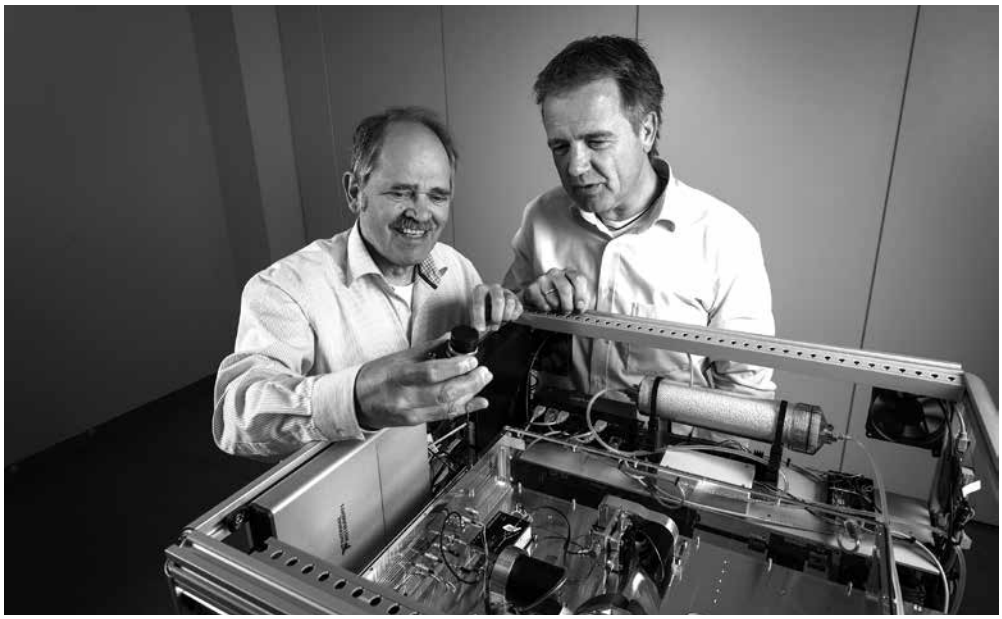
Scaling up terahertz technology for industrial applications

Terahertz technology is still in its infancy, and until now it has found relatively few applications. The department of Material Characterization and Testing at the University of Kaiserslautern, sponsored jointly by Fraunhofer IPM and the Land of Rheinland-Pfalz, hopes to change this situation. "Our goal is to scale up terahertz technology and extend its range of use to include security applications," says Beigang. The engineers at Hübner were among the first to recognize the potential of the Fraunhofer researchers' work. The company's traditional line of business is manufacturing key components for the transportation industry (e.g. rail vehicles, buses, airport technology, automotive). A new division for public security was added in 2006, when the company first started to look for cooperation partners. The mail scanner project was launched four years later, based on previous joint development projects. In the meantime, the company has brought its T-COGNITION solution onto the market.

This is how the mail scanner works. Suspicious envelopes and packages are fed into the scanner on a retractable tray. They are then exposed to terahertz waves which are absorbed at different frequencies within the spectral range depending on the substance they travel through (characteristic absorption properties). Detectors at the output of the scanner record the transmitted wavelengths. "Within a few seconds, T-COGNITION produces a spectroscopic fingerprint that allows the detected hazardous material to be compared with database samples and definitively identified," says Thorsten Sprenger. The system triggers an alarm if the consignment contains explosives or illicit drugs.

The system is capable of examining the content of postal items up to C4 format with a thickness of up to two centimeters. Sprenger says: "It is the ideal mailroom solution for prisons, customs offices, government agencies, company headquarters, and embassies or consulates, because it helps to improve security and protect human lives."

T-COGNITION recently received the PrismAward, the equivalent of an Oscar in the photonics world, at the Photonics West 2014 international congress in San Francisco.



The prize-winning team presents terahertz scanner for the secure identification: Professor René Beigang and Thorsten Sprenger (from left to right). (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Physical Measurement Techniques IPM | Kaiserslautern branch | Department Materials Characterization and Testing
Building 56 | Erwin-Schrödinger-Straße | 67663 Kaiserslautern | www.ipmfraunhofer.de
Contact: Prof. Dr. René Beigang | Phone +49 631-205 5201 | rene.beigang@ipm.fraunhofer.de
Press: Holger Kock | Phone +49 761 8857-29, | holger.kock@ipm.fraunhofer.de | www.ipm.fraunhofer.de
Hübner GmbH & Co. KG | Heinrich-Hertz-Str. 2 | 34123 Kassel | www.hubner-germany.com
Contact: Thorsten Sprenger | Phone +49 561 998 2085 | thorsten.sprenger@hubner-germany.com

Fraunhofer

3 The digital film reel

For more than a hundred years, analog technology dominated the cinema. Moving pictures were captured on film made from celluloid or polyester, and uniform standards applied worldwide. Each film strip was 35 millimeters wide and perforated along the outside edges. This way, it could be shown in any theater. Distribution of digital movies has changed all that: instead of sending analog reels of film, movie theaters receive DCPs (Digital Cinema Packages) via hard drive or satellite that include not only the encoded digital video and audio data but also subtitles in multiple languages.

Digital cinema needs universal standards too. Only then can digital films be shown in any cinema worldwide; In 2005, the six largest Hollywood studios defined the DCI standards, the technical specifications for digital cinema. At the studios' request, researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen have created international test procedures for compliance with the specifications of the DCI standards. In order to ensure that digital film copies meet these standards, the experts at Fraunhofer IIS have developed a software for creating DCPs suitable for all playback devices that work reliably on all cinema systems.

Simple and clear operation

"While developing easyDCP, we really concentrated on keeping operation simple and clear," says Dr. Siegfried Foessel, director of the Moving Picture Technologies department at Fraunhofer IIS. That's a concept that users found persuasive. In very little time easyDCP became the market leader; more than 1000 customers already use the software. Meanwhile large companies have started integrating easyDCP software into their products including Quantel, Drastic, and Blackmagic Design.

"We've tested easyDCP-created cinema packages on any number of playback devices and continuously improved the software," explains Heiko Sparenberg, head of the Digital Cinema group at Fraunhofer IIS. As for why the software has established itself so successfully on the market, "Feedback from our users has played an important role," he explains. The software enables not only the largest studios, but also smaller, independent producers and film makers to create their own digital cinema packages. Post-production companies, film producers, distributors and film festivals - all profit from the comprehensive software functions, such as the adding of subtitles and audio tracks in different languages or the support of 3D formats or 4K resolution. At the Berlin International Film Festival, the software is used to test the quality of digital film copies from around the world, so that flawed cinema packages can be quickly identified andprepared and validated for proper screening.

For their work on the topic "Digital cinema conquers the world – software for creating digital cinema packages enables digital cinema's breakthrough" Dipl.-Inf. Heiko Sparenberg and Dr.-Ing. Siegfried Foessel received this year's Joseph von Fraunhofer Prize.

Dr.-Ing. Siegfried Foessel and Heiko Sparenberg developed a software for creating digital cinema packages. (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Integrated Circuits IIS | Am Wolfsmantel 33 | 91058 Erlangen | www.iis.fraunhofer.de
Contact: Dr. Siegfried Foessel | Phone +49 9131 776-5140 | siegfried.foessel@iis.fraunhofer.de
Dipl.-Inf. Heiko Sparenberg | Phone +49 9131 776-5143 | siegfried.foessel@iis.fraunhofer.de
Press: Angela Raguse | Phone +49 9131 776-5105 | angela.raguse@iis.fraunhofer.de
Thoralf Dietz | Phone +49 9131 776-1630 | thoralf.dietz@iis.fraunhofer.de

Fraunhofer

4 Adhesive bonding with pre-applied adhesives

RESEARCH NEWS
SPECIAL ISSUE
05 | 2014 || Topic 4

Adhesive bonding technology is an effective and inexpensive means of seamlessly joining two parts, even two made of different materials. Especially in lightweight construction, adhesive bonding is the preferred technique because many of the materials used can hardly be joined otherwise. However, since liquid adhesives need time to cure, they cannot be applied in every production step. In hopes of finding a way to eliminate the need for regularly applying liquid adhesive while joining fasteners, the automotive supplier STANLEY Engineered Fastening - Tucker GmbH in Gießen turned to the researchers at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen. Their solution was a two-step process in which adhesive is initially deposited on one of the parts and then dried to form a non-sticky layer. During a subsequent production step, the adhesive is hardened and the two parts are bonded together.

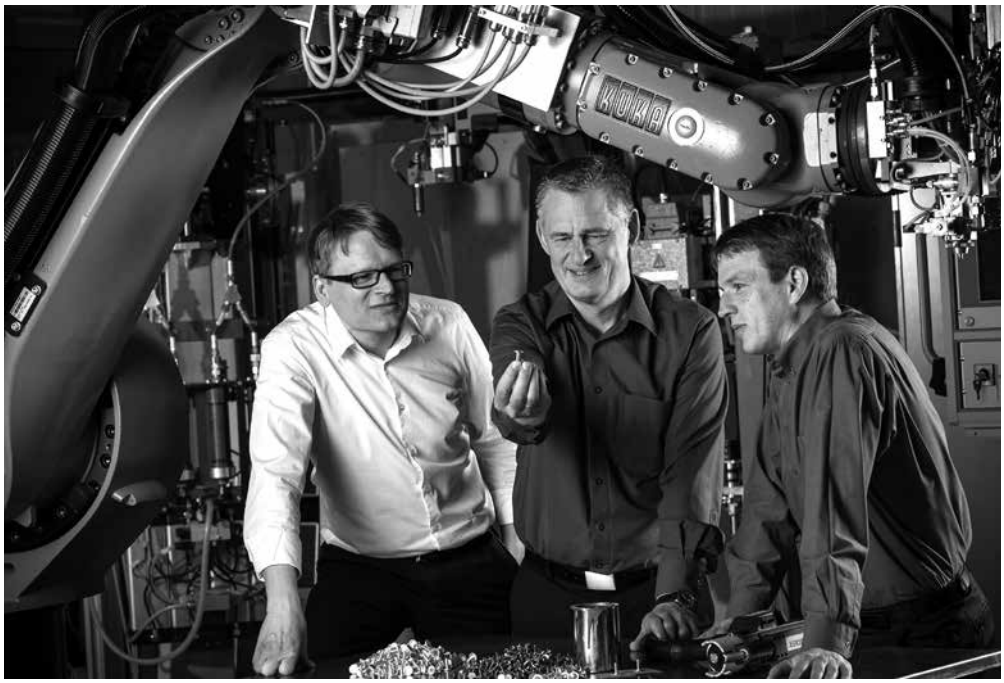
Although two-step bonding techniques aren't new – early postage stamps were coated with an adhesive that would only stick to envelopes once moistened – using them for industry is. Fraunhofer IFAM researchers have successfully developed the technique to allow for a high-strength adhesive bond suitable for industrial use – no easy task, since the adhesives must fulfill different and sometimes contradictory requirements. "Once the adhesive is applied, it can't be tacky and it has to withstand long storage times," explains chemical engineer Andreas Lühring from Fraunhofer IFAM. But the adhesive has to do more than that. "The adhesive also has to be very reactive and harden quickly during joining." The researchers' concept combines resins and hardening agents that melt at different temperatures. "We use micro-dispersion to finely distribute hardening agents with considerably higher melting points throughout the resin base," adds Professor Andreas Hartwig.

The resulting reactive, hot melt adhesive is used in the manufacture of fastening bolts, for instance. First the material is heated and then applied onto the fastener. After it cools, it solidifies again. The fastener can then be transported and stored without difficulty. To harden the actual adhesive, it must be heated to more than 150 degrees Celcius in a controlled way. "Only then is the actual hardening agent melted and the adhesive activated," explains Lühring. In this way, two parts can be bonded to each other within seconds.

"There is one disadvantage to reactive adhesives like these – they can be stored for a long time, but not indefinitely," says Dr. Matthias Popp, group manager at Fraunhofer IFAM. That's why the researchers had added an additional, visual means of monitoring the adhesive – if the substance has lost its functionality, it changes color.

These pre-applicable structural adhesives (PASA®) are also suitable for other applications, including a variable "construction kit" that offers adhesives based on different materials and hardening principles.

The IFAM experts have altered the composition of the adhesives so that they yield the best possible productivity and characteristics for a wide variety of applications. For this development, Andreas Lühring, Andreas Hartwig and Matthias Popp received one of this year's Joseph von Fraunhofer prizes.



The prize-winning team: Dr. Matthias Popp, Prof. Dr. Andreas Hartwig and Andreas Lühring. (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM | Wiener Str. 21| 28359 Bremen
Contact: Professor Andreas Hartwig | Phone +49 4212246-470 | andreas.hartwig@ifam.fraunhofer.de
Andreas Lühring | Phone +49 4212246-494 | andreas.luehring@ifam.fraunhofer.de
Dr. Matthias Popp | Phone +49 4212246-650 | matthias.popp@ifam.fraunhofer.de
Press: Martina Ohle | Phone +49 4212246-256 | martina.ohle@ifam.fraunhofer.de