Fraunhofer

RESEARCH NEWS – SPECIAL ISSUE

06 | 2015 ||

Research awards in brief

At this year's Fraunhofer-Gesellschaft annual conference in Wiesbaden, three Joseph von Fraunhofer prizes (topics 2 through 4) and the Fraunhofer prize for Human-Centered Technology were awarded (topic 1).

1 Plasma makes wounds heal quicker

Many people suffer from skin disorders. Open wounds are a particularly acute problem, especially among the elderly. PlasmaDerm, a new medical technology solution, uses plasma to facilitate faster healing of wounds.

2 Natural rubber from dandelions

Dandelions are modest plants that are an excellent alternative source for a raw material of high demand: natural rubber, the fundamental ingredient in rubber products. Fraunhofer researchers have established the basis for the large-scale production of high quality rubber with Russian dandelion.

3 A concert hall for on the move

Researchers have developed new audio software that creates a natural three-dimensional sound. Whether you're listening on your smartphone or in the car, it feels like you're right there in the concert hall.

4 Diamond-like coatings save fuel

Coating engine components with hard carbon reduces friction to almost zero – a development that could save billions of liters of fuel worldwide every year. Now researchers have developed a new laser method to apply the coating on the production line.

Further information, podcasts and videos about the research awards are available online at www.fraunhofer.de/presse

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 66 Fraunhofer Institutes and research units at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 24,000, who work with an annual research budget totaling 2 billion euros. About 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.

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Research awards in brief

Fraunhofer Prize for Human-Centered Technology
The prize for Human-Centered Technology is funded by former Executive Board members and institute directors and the Excellence Foundation of the Fraunhofer-Gesellschaft. This prize is awarded every two years to employees whose research and development work makes a significant contribution to improving people's quality of life and helps them actively participate in daily life into old age. The prizewinner receives a sum of 50,000 euros (topic 1).

Joseph von Fraunhofer Prize
Since 1978, the Fraunhofer-Gesellschaft has awarded prizes every year in recognition of outstanding scientific work by members of its staff that solve application-oriented problems. To date, over 200 researchers have seen their work honored in this way. This year, three of these prizes will be awarded, each worth 50,000 euros (topics 2 through 4).

The prizewinners also receive a silver lapel pin bearing the face of the man for whom the award was named, as illustrated in the logo of the topics.

Juries for the Fraunhofer Prize for Human-Centered Technology and the Joseph von Fraunhofer Prize in 2015

Dr. Reinhold E. Achatz, ThyssenKrupp AG
Prof. Dr. Frank Fabian Bier, Fraunhofer Institute for Biomedical Engineering IBMT
Dr. Gerd Deuster, representative of former executive board members and institute directors
Prof. Dr. Michael Dröscher, Evonik Degussa GmbH
Prof. Dr. Jörg Eberspächer, Technische Universität München
Prof. Waldemar Hermel, representative of former executive board members and institute directors
Prof. Dr. Hartmut Hoffmann, Technische Universität München
Dr. Monika Kursawe, Merck KGaA
Dr. Gyula Meleghy, Meleghy Automotive GmbH & Co. KG
Prof. Dr. Erich R. Reinhardt, Medical Valley Europäische Metropolregion Nürnberg e.V.
Prof. Dr. Paul Schönsleben, ETH Zürich
Dr. Frank Stietz, Carl Zeiss AG
Prof. Dr. Marion Weissenberger-Eibl, Fraunhofer Institute for Systems and Innovation Research ISI

The jury evaluated submissions in the following categories:

Fraunhofer Prize for Human-Centered Technology
- Importance of the work for humanity and society
- Novelty of the approach / knowledge process
- Market situation
- Implementation of the results in applications

Joseph von Fraunhofer Prize
- Originality of the scientific methodology
- Scientific advancement
- Implementation / ease of application / economic success
- Setting of international standards

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Plasma makes wounds heal quicker

Skin disorders are a common problem in this part of the world. Atopic dermatitis, psoriasis and chronic venous leg ulcers – typically caused by diabetes or varicose veins – can cause patients years of suffering. Working in collaboration with the company Cinogy and the Department of Dermatology, Venereology and Allergology at the University Medical Center Göttingen, the Fraunhofer Institute for Surface Engineering and Thin Films IST has successfully developed a new medical technology solution for treating wounds and skin disorders known as "PlasmaDerm". Plasma promotes wound healing when it is generated directly on the skin.

"All you feel is a slight tingling sensation," says Prof. Wolfgang Viöl from Fraunhofer IST, moving a device approximately the size and shape of a pocket flashlight in small circles over the back of his hand. Holding the device just over the skin, a faint purple mist can just barely be seen at the device's tip. That's plasma, he explains – an ionized gas.

PlasmaDerm – which was developed by a team consisting of medical professionals, biologists, physicists and engineers – is a novel solution. For the first time, the device generates a non-thermal or "cold" plasma directly on the skin at atmospheric pressure. The patented method involves placing the electrode of the device close to the skin, with the skin itself acting as the second electrode. A high voltage is then applied across the gap, and the resulting electric fields convert the area between the electrode and the skin into non-thermal plasma.

PlasmaDerm is safe and painless

Since cold plasma has not been used on human beings before, the top priority of the Fraunhofer IST was to evaluate the safety of the solution. "We carried out a risk-benefit analysis to evaluate all the chemical and physical parameters and concluded that there is no reason to be concerned about using plasma on people," says Dr. Andreas Helmke, describing how Fraunhofer IST went about the process.

A clinical study conducted by Prof. Steffen Emmert at the Department of Dermatology, Venereology and Allergology at the University Medical Center Göttingen revealed an antiseptic effect and improved wound healing. But Prof. Emmert explains that the greatest benefit of the application is the fact that "non-thermal plasma actually combines the mechanisms of different therapies. UV, ozone and electrotherapy are already available, but plasma achieves a better effect in a shorter period of time." Plasma reduces the bacteria count on the skin's surface, while the electric field simultaneously boosts the skin's microcirculation by allowing more oxygen to be delivered. These are both decisive factors in improving wound healing.

To enable the new method to be applied more flexibly, the researchers needed to develop a portable device. To do this, the Fraunhofer IST worked together with the company Cinogy. "We had to develop a device that was small but capable of generating high voltages. The result is only about the size of a laptop and can be plugged into a normal socket between 100 and 230 V," says Dr. Dirk Wandke, managing director of Cinogy, describing how they tackled the project's biggest challenge. PlasmaDerm is now available all over Europe.

For Prof. Viöl, PlasmaDerm has inspired a vision. But the researcher has an even more ambitious vision. "I anticipate that in the future, a child who falls off a skateboard could be treated at home. Parents could care for the wound using a small PlasmaDerm stick instead of iodine. And I could even imagine the device itself being able to measure what's wrong with somebody's skin and then adjust the dose accordingly and start the physical treatment."

Prof. Wolfgang Viöl, Dr. Andreas Helmke, Prof. Steffen Emmert and Dr. Dirk Wandke jointly accepted a Fraunhofer Prize in the Human-Centered Technology category for their development of PlasmaDerm.

From left to right: Dr. Andreas Helmke, Dr. Dirk Wandke (Cinogy GmbH), Prof. Wolfgang Viöl and Prof. Steffen Emmert (University Medical Center Göttingen) developed the PlasmaDerm medical technology solution that makes wounds heal faster. (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

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Natural rubber from dandelions

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Approximately 40,000 products of everyday life contain natural rubber. It's the material that provides extreme elasticity, tensile strength and low-temperature flexibility in products from mattresses and gloves to adhesive tape and tires. As yet, it has no artificial replacement. However, researchers from the Fraunhofer Institute for Molecular Biology and Applied Ecology IME were able to identify a cost-effective and eco-friendly alternative to the natural rubber tree: the dandelion.

Currently, all our natural rubber comes from Hevea brasiliensis, a tree that grows under subtropical climate. Increasing demands and potential problems with a devestating fungus have made natural rubber into a valuable resource. Southeast Asia accounts for 95% of global production. In order to meet growing demands, producers turn rainforest into agricultural land. Now Professor Dirk Prüfer and his colleague Dr. Christian Schulze Gronover from Fraunhofer IME in Münster are developing Taraxacum koksaghyz, also known as Russian dandelion, as an efficient replacement for the natural rubber tree. "The plant is extremely resilient, able to grow in moderate climates and even in soil that is not or just barely suited for the cultivation of food and feed crops," explains Christian Schulze Gronover. "Dandelions also have the advantage of growing anually. The natural rubber tree takes between seven and ten years to deliver the first harvest."

Dirk Prüfer decided to investigate the dandelion after a sudden insight on a day out. "I was sitting in a meadow in the Sauerland region in Germany, and it was absolutely covered with dandelions. Having plucked the flower off one of them, I was wondering if the expelling white latex contains rubber." However, Germany's native dandelions don't produce sufficient quantities of rubber for being industrially viable. That's why the researchers subsequently turned their attention to the Russian dandelion, which produces large amounts of natural rubber.

No genetic modification

With the help of precision breeding, the researchers were quickly able to double the amount of natural rubber in the Russian dandelion. This was achieved without genetic modification; instead, Dirk Prüfer and Christian Schulze Gronover analyzed the dandelion's genome and identified suitable DNA markers. These genetic tools could tell already in a very early stage of plant development if a given plant will possess an efficient rubber production.

Extraction of natural rubber from the plant was another challenge. To this end, the scientists developed an eco-friendly technique whereby only the roots are pulverized because the leaves contain very little rubber. At the end of the process, water is used to separate the resource from the other substances.

New natural rubber successfully undergoes practical testing

The performance of tires made of dandelion natural rubber has already proven in action, and manufacturer Continental has tested a first version. "The dandelion natural rubber has ideal material properties. The tires are equivalent to those made from Hevea natural rubber," says Dr. Carla Recker of Continental.

Since natural rubber is critical to the quality of many rubber products, industrialized nations in particular regard it as a strategically important resource. Natural rubber obtained from dandelions could reduce the dependence on imports from Asia. However, if the entire world production will be based on dandelion rubber, one would need the size of Austria for its cultivation. Thus, Dirk Prüfer points out that rubber from dandelion will not replace the actual source, but will compensate the additional demand in the future.

For their work on the Russian dandelion and its application as a source of natural rubber, Dirk Prüfer, Christian Schulze Gronover and Carla Recker are recipients of the 2015 Joseph von Fraunhofer Prize.

Left to right: Dr. Christian Schulze Gronover, Dr. Carla Recker (Continental Reifen Deutschland GmbH) and Prof. Dirk Prüfer make use of the Russian dandelion to obtain natural rubber for subsequent use in the manufacture of car tires. (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

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A concert hall for on the move

Optimum playback of digitized music requires superior software solutions. The Fraunhofer Institute for Integrated Circuits IIS has developed intelligent algorithms known as Cingo and Symphoria that produce a natural and immersive 3D audio experience. So you get to feel like you're at a live concert – even when you're actually listening on a mobile device or in the car.

People often listen to music in far from ideal conditions. For example, the quality of the speakers used in smartphones, tablets and headphones is not always the best, and the speaker positions and passenger compartment acoustics can cause difficulties in the automotive environment. But people still expect premium audio quality. The software solutions Cingo and Symphoria compensate for hardware weaknesses while simultaneously reproducing the musician's intended sound image with the utmost precision – regardless of which speakers or headphones the listener is using.

"In a concert hall, the music doesn't just come directly from the stage. We also hear the sound that bounces off the walls and ceiling. It's the overall combination that gives us the impression of three-dimensional sound," says Symphoria project manager Oliver Hellmuth. Cingo and Symphoria analyze which elements of a recording are direct sound and which are reflected sound. They then join them together to create natural three-dimensional sound.

Close collaboration with sound engineers

However, it's not enough to rely on signal analysis of the music to create an optimum listening experience using Cingo on mobile devices and Symphoria in vehicles. The key is to get engineers and sound technicians working together. "The engineers know how to develop the tool, and the sound technicians know how to make the best use of it," explains Jan Plogsties, project manager for Cingo. That's why the sound technicians at Fraunhofer IIS were involved in making adjustments to the sound reproduction at an early stage in tandem with the technical analysis. Since no audio benchmark is available to judge the quality of these kinds of audio algorithms, the experts' subjective opinions were crucial.

The IIS researchers have worked closely with their customers at every stage of the development process. That's because the sound has to be tailored to the particular speakers of each individual device. "When a manufacturer chooses to implement our software, we configure the sound separately for each model. It's a tuning process – and that's why we need the expertise of our sound technicians," says Oliver Hellmuth.

Right from the start, Cingo and Symphoria were developed with the idea of launching them as products. "We asked the same question we always ask ourselves: if it ends up

working well, who could benefit from it? Our preliminary discussions soon revealed that a number of companies were very interested in good 3D surround sound solutions," says Harald Popp, who is in charge of marketing the applications.

Since 2013 Google has included Cingo in all its Nexus devices, and Samsung launched the software as part of its virtual reality glasses. Audi is using Symphoria to create 3D and surround sound effects in its TT, Q7 and R8 models.

For the development and market launch of Cingo and Symphoria, Oliver Hellmuth, Jan Plogsties and Harald Popp are recipients of the 2015 Joseph von Fraunhofer Prize.

Left to right: Developed by Harald Popp, Oliver Hellmuth and Jan Plogsties, the software solutions Cingo and Symphoria create 3D surround sound in vehicles and on mobile devices. (© Dirk Mahler/ Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

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Diamond-like coatings save fuel

Scientists already know how to coat components with diamond-like carbon to minimize friction. But now Fraunhofer researchers have developed a laser arc method with which layers of carbon almost as hard as diamond can be applied on an industrial scale at high coating rates and with high thicknesses. By applying carbon coatings to engine components such as piston rings and pins, fuel consumption can be reduced. "Systematic application of our new method could save more than 100 billion liters of fuel each year over the next ten years," says Prof. Andreas Leson from the Fraunhofer Institute for Material and Beam Technology IWS in Dresden, referencing a study that was published in the journal Tribology International in 2012.

Carbon-based coatings are already used in volume production. But now the team of IWS researchers led by Prof. Leson, Dr. Hans-Joachim Scheibe and Dr. Volker Weihnacht has succeeded in producing hydrogen-free ta-C coatings on an industrial scale at a consistent level of quality. These tetrahedral amorphous carbon coatings are significantly harder and thus more resistant to wear than conventional diamond-like coatings. "Unfortunately, you can't just scrape off diamond dust and press it onto the component. So we had to look for a different method," says Dr. Scheibe, who has spent over 30 years investigating carbon's friction-reducing properties.

A pulsed laser controls the light arc

In a similar style to old-fashioned film projectors, the laser arc method generates an arc between an anode and a cathode (the carbon) in a vacuum. The arc is initiated by a laser pulse on the carbon target. This produces a plasma consisting of carbon ions, which is deposited as a coating on the workpiece in the vacuum. To run this process on an industrial scale, a pulsed laser is vertically scanned across a rotating graphite cylinder as a means of controlling the arc. The cylinder is converted evenly into plasma thanks to the scanning motion and rotation. To ensure a consistently smooth coating, a magnetic field guides the plasma and filters out any particles of dirt.

The laser arc method can be used to deposit very thick ta-C coatings of up to 20 micrometers at high coating rates. "High coating thicknesses are crucial for certain applications – especially in the auto industry, where components are exposed to enormous loads over long periods of time," says Dr. Weihnacht.

The automotive and motorcycle manufacturer BMW is working intensively on the industrial-scale implementation of ta-C engine components in its various vehicle models with the aim of reducing their fuel consumption. Prof. Leson sees this as the first major step in using the laser arc method to save resources. And as a motorcycle aficionado himself, he also sees another positive effect stemming from this development: "The fact that our research is helping to make motorcycling more environmentally friendly

eases my conscience every time I go for a ride," he says, unable to suppress a smile. Andreas Leson, Hans-Joachim Scheibe and Volker Weihnacht received the 2015 Joseph von Fraunhofer Prize for the development of the laser arc method and the application of ta-C coatings in volume production.

Dr. Volker Weihnacht, Prof. Andreas Leson and Dr. Hans-Joachim Scheibe (left to right) successfully developed a laser arc method of depositing friction-reducing, wear-resistant coatings on components. (© Dirk Mahler/Fraunhofer) | Picture in color and printing quality: www.fraunhofer.de/press

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