Fraunhofer MIKROELEKTRONIK

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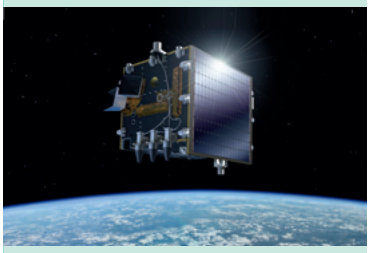
Energy-efficient data transport via light

Major data centers and supercomputers will soon be more cost- and energy efficient – and at the same time even more powerful. Fraunhofer scientists and 17 partners from business and research in the European Union have set themselves this ambitious goal in the "PhoxTroT" project. The key is optical data transmission. »» page 3

Photo: Fraunhofer-Gesellschaft



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Race car with electric drive

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Events

Date	Event / WWW	Location	Group institutes involved
09/03 – 09/05	SISPAD 2013 www.sispad2013.org	Glasgow, Scotland	IISB
09/04 – 09/06	EEE SOCC - System on Chip Conference www.ieee-socc.org	Erlangen, Germany	IIS
09/04 – 09/06	SEMICON Taiwan 2013 www.semicontaiwan.org	Taiwan, China	IIS
09/06 – 09/11	IFA 2013 www.ifa-berlin.de	Berlin, Germany	HHI,IIS
09/09 – 09/13	TNT 2013 www.tntconf.org	Sevilla, Spain	IAF
09/12 – 09/22	IAA Cars 2013 – International Motor Show www.iaa.de	Frankfurt a.M., Germany	IZFP-D
09/13 – 09/17	IBC 2013 www.ibc.org	Amsterdam, Netherlands	HHI, IDMT, IIS
09/17 – 09/19	Composites Europe www.composites-europe.com	Stuttgart, Germany	IZFP-D
09/17 – 09/19	CoSeRa 2013 – 2nd Int. Workshop on Compressed Sensing applied to Radar www.fhr.fraunhofer.de	Bonn, Germany	FHR
09/17 – 09/19	The Battery Show 2013 www.thebatteryshow.com	Detroit, USA	ISIT
09/26 – 09/27	ISCDG – International Semiconductor Conference Dresden-Grenoble www.iscdg.org	Dresden, Germany	ENAS
09/30 – 10/05	8th International Workshop on Bulk Nitride Semiconductors 2013 www.iwbns2013.iisb.fraunhofer.de	Seeon, Germany	IISB
10/06 – 10/11	European Microwave Week 2013 www.eumweek.com	Nuremberg, Germany	IAF
10/08 – 10/10	SEMICON Europe 2013 www.semiconeuropa.org	Dresden, Germany	Group Institutes
10/15 – 10/17	MATERIALICA 2013 www.materialica.de	Munich, Germany	ENAS
11/13 – 11/15	5th International Symposium on NDT in Aerospace www.ndt-aerospace.com	Singapore, Singapore	IZFP-D
11/20 – 11/23	MEDICA 2013 www.medica.de	Düsseldorf, Germany	EMFT, HHI, IDMT, IIS, IPMS, ISIT

Photo: pixelio.de / Markus Klaus

Energy-efficient data transport via light

Major data centers and supercomputers will soon be more cost- and energy efficient – and at the same time even more powerful. Fraunhofer scientists and 17 partners from business and research in the European Union have set themselves this ambitious goal in the "PhoxTroT" project. The key is optical data transmission.

The project partners
Fraunhofer IZM • Fraunhofer HHI • Vertilas GmbH • Xyratex Technology Ltd. • ams AG • Meadville Aspocomp International Limited • AMO GmbH • National Technical University of Athens • DAS Photonics SL • Phoenix B.V. • Centre for Research and Technology Hellas • Compass Electro Optical Systems Ltd. • Bright Photonics BV • Computer Technology Institute and Press – "Diophantus" • Centre National de la Recherche Scientifique • Karlsruhe Institute of Technology • University of Southern Denmark • Universitat Politècnica de València • Interuniversitair Micro-Elektronica Centrum vzw.

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The gigantic data centers of cloud providers consume energy at an extraordinary rate. For example, Google's server farms process many petabytes of data and they consume 260 mill. W – enough power for a city of 200,000 households. The need to save energy is equally powerful. These facts led the European Union to initiate the PhoxTroT project, coordinated by the Fraunhofer Institute for Reliability and Microintegration IZM in Berlin. The goal is to cut energy consumption by at least 50 %, while simultaneously doubling the capacity of data connections to 2 Tb/s.

Trying to square the circle

Light could show us the way: this is because data transmission using light consumes only a fraction of the energy that conventional methods need. The technologies for photonic transmission already exist and have been thoroughly researched. "The novelty of the PhoxTroT project is that we are now researching the synergies between the various technology components and are combining them with each other in a new research plan based on the 'mix-and-match' principle," explains project coordinator Dr. Tolga Tekin from Fraunhofer IZM. But that is not all: by the end of the project, entirely new technologies are expected to emerge that can guarantee a photonic data connection that remains constant across hundreds of kilometers. For this purpose, the project partners are developing three prototypes for various hierarchy levels. They will realize and investigate the optical transmission on a printed circuit board ("on-board"), between boards ("board-to-board"), and from one server rack to the next ("rack-to-rack"). By combining these interfaces, it will also be possible to bridge longer distances within the foreseeable future. In a further step, the project partners will engineer single-mode solutions that integrate optical chips onto one circuit board. This allows for signal transmission via one optical path, instead of multiple paths as before. Thus, these technologies are particularly well suited to the transmission of extremely high data rates across long distances.

Ability to dance an advantage

The European Union is providing 9 mill. € in funding for the four-year research project, which began in October 2012. Eighteen companies and scientific installations from all over Europe are involved. This makes coordination at Fraunhofer IZM a mammoth task in itself. The whole thing is a little like dancing, which requires coordination, creativity, and stamina, according to project manager Dr. Tekin, referring to the name of the project.

Optical data transmission could reduce the energy consumption of large server farms by 50 %.
Photo: Fraunhofer IZB

TV satellites: precise positioning in space

Receiving a constant signal for TV transmissions during the Champions League final or the morning radio news is something we take for granted. In order to be able to receive these signals reliably, the satellites must always maintain their position relative to Earth. From time to time, however, their orbits require correction. Fraunhofer IIS / EAS and SES ASTRA have come up with a new type of technical solution to optimize these correction maneuvers.

Digital network operations room for the monitoring of the transmission function of TV satellites. Photo: SES

Factors such as the sun, the moon, or the surface of the Earth disturb the orbit of a geostationary satellite of the type used for broadcasting radio and television. They orbit with an angular velocity of one Earth rotation per day, meaning that ideally, they are always situated above the same point on the equator. If this position can no longer be maintained, rocket motors on board the satellite have to be ignited temporarily. But each of these maneuvers uses fuel, which shortens the life of the satellite. To determine when a correction is really necessary, and how large it needs to be, the satellites in space need to be located precisely. Until now, this positioning has been performed using various technically complex measuring processes, some of which require expensive special antennas. Now the Design Automation Division EAS of the Fraunhofer Institute for Integrated Circuits IIS and SES ASTRA have come up with a method called "Passive Correlation Ranging" (PaCoRa), a new high-accuracy method of determining the position of geostationary satellites. The measuring system is not only more cost-effective and reliable; it is also a relatively simple method of minimizing fuel consumption.

Assistance via a digital time stamp

Unlike the sending of special locating signals, the PaCoRa method takes advantage of the processing of conventional digital signals for satellite radio and television. These are recorded at different locations on the Earth and given a digital time stamp. The locally recorded arrival times allow a central station to use the time lapse between signals to calculate the exact position of a satellite. As the locations of the receiving devices are known precisely, the central station can take correlation formulas and high-precision computer models as the basis for determining – and even predicting – a satellite's exact orbit. Within the joint project, Fraunhofer IIS / EAS developed the technology for decentralized, precisely timed signal recording and central signal processing. SES was responsible for system specification and the overall system development.

Research results for decades

The process is so precise that the number of geostationary satellites in orbit – some of which come within a few kilometers of one another – can be increased further without risking any damage to these artificial celestial bodies. SES is currently using the PaCoRa system at five locations in Europe for the positioning of TV satellites.

Geostationary satellites orbit the Earth once a day along the equator. Photo: SES

This practical test has shown that the measurements are considerably more exact than those used in existing positioning methods. This allows the rocket motors on the satellites to be controlled with more precision, lengthening their potential service life. The system is also extremely flexible. It can be used on various satellite systems and orbital positions and with future signal transmission standards, meaning that it can remain in use for decades to come. The project partners were supported by the European Space Agency (ESA).

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Barely larger than a washing machine: the mini-satellite Proba-V will send pictures of the vegetation on Earth from space.
Poto: ESA / P. Carril

New semiconductor technology flies into space

May 7th at 02:06 a.m. GMT: the Proba-V satellite took off into space on a mission to observe the Earth. For the first time, a satellite was carrying a European device based on the semiconductor gallium nitride. More robust, more compact, and lighter than previous solutions, an amplifier developed by Fraunhofer IAF promises to improve communication electronics in space travel considerably.

About the project
The European Space Agency (ESA) founded the initiative Great² ("GaN Reliability Enhancement and Technology Transfer Initiative") in order to exploit the potential of gallium nitride technology for aeronautics. Together with industrial partners, renowned research institutes in the field of III-V semiconductors, such as Fraunhofer IAF, develop high quality gallium nitride-based devices under the project leadership of Tesat-Spacecom, thus strengthening the competitiveness of the European aerospace industry.

The satellite that the European Space Agency (ESA) has launched into space for Earth observation weighs about 140 kg and is roughly the size of a washing machine. The Proba-V mini-satellite is covered in solar cells and observes the Earth's vegetation. Every other day, the environmental satellite sends pictures from a distance of about 820 km. Rain forest destruction, pollution of the seas, and soil erosion are made visible by pictures taken in various spectral ranges.

Revolution in data transmission

The Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg has developed an amplifier circuit for the frequency range of 8–8.5 GHz (X-band) for the Proba-V communication system. "Gallium nitride has the potential to revolutionize communication in space. We expect signal strength and data transmission to improve five- or tenfold," says Andrew Barnes, who is responsible for the project at ESA. "We are eagerly awaiting the results of the first practical test in space." Tesat-Spacecom in Backnang, in cooperation with SCHOTT Electronic Packaging, packaged the gallium nitride amplifier together with further components into a hermetically sealed housing suitable for space travel.

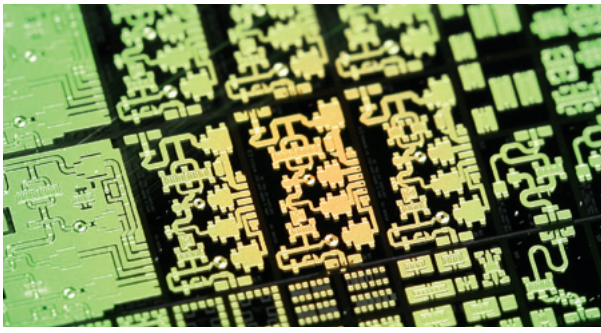
Gallium nitride in stress tests: robust and reliable

Gallium nitride devices can be operated under much higher voltages and temperatures than traditional silicon or gallium arsenide components. The circuits are more compact, smaller, and lighter than other solutions. They might even replace the electron tubes currently used for amplification. This would significantly reduce weight and transport costs, which can amount to 30,000 €/kg of payload.

Due to the long lifetime and radiation hardness of the semiconductor material, such electronic devices are ideally suited for the extreme conditions posed by aerospace. Before being admitted for space travel, however, the gallium nitride device had to prove its resilience. The device was exposed to cold and heat, strong vibration and motion as well as radiation. "Accelerated lifetime tests, conducted together with Tesat-Spacecom, have shown that our gallium nitride amplifier will live for at least 20 years," says Dr. Patrick Waltereit, project leader at Fraunhofer IAF. "The approval of our device for flight into space is an important milestone for the further development of gallium nitride technology, as well as for other areas of application."

Due to its exceptional physical properties, gallium nitride is ideally suited to applications in power electronics. This makes compact and energy-efficient gallium nitride devices of interest not only for applications in aeronautics, but also for voltage converters for the batteries of electric cars, solar panels, or household appliances. As such, these devices offer high potential especially for applications that demand high performance and a long lifetime even in harsh environmental conditions. This is where silicon technology meets its limits.

Processed X-band amplifier circuits based on the semiconductor gallium nitride. The circuit for Proba-V measures a mere 2 x 3.5 mm².
Photo: Fraunhofer IAF



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A breath of fresh air

Stuffy conference rooms, difficulty concentrating, and heavy eyelids – situations that everyone has experienced at work. They are caused by high concentrations of CO_2. For a long time, only heat insulation was a significant factor in building planning, but researchers at Fraunhofer IMS have now come up with a solution that makes constant ventilation by means of opening windows and doors a thing of the past: an intelligent door seal system.

Heated debates and no agreement in sight: the eight employees sitting in a small conference room have come together to get an important project moving. But after an hour, some of them have trouble focusing on the discussion, while others are becoming drowsy. No wonder: the air in the conference room is stuffy and stale, and increased levels of carbon dioxide (CO_2) are making the participants tired and robbing them of their concentration.

There's only one solution: to air out the room. Or else to rely on the intelligent door seal system that has now been developed by researchers at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in cooperation with the Athmer Company. Users of the system not only spare themselves the effort of regular airing; the door seal is also cold air's worst enemy, insulating to provide a perfect indoor climate.

CO_2 sensors to regulate the air in an office

The secret of the electronically controlled door seal designed by the IMS engineers – which opens or closes depending on the quantity of CO_2 in a room – is a CO_2 sensor, designed to register the concentration of CO_2 in the air. If this value exceeds a certain threshold, a tiny motor moves a spring to open the door seal at the bottom of the door leaf. The seal rises to permit an exchange of air inside the room. At the same time, the system uses building-based measurement and control technology to activate the ventilation system and extract stale air from the room.

At the beginning of a meeting, the air in the meeting room is usually still fresh.
Photo: MEV Verlag

It was Max von Pettenkofer who investigated indoor air quality in the middle of the previous century and identified the CO_2 value that, if met or exceeded, makes people begin to feel unwell indoors. Today's rules and guidelines based on DIN for the workplace set 1,500 ppm as the upper limit and recommend a CO_2 concentration of 1,000 ppm. "We can achieve this with the aid of the intelligent door seal – without having to open doors or windows," Hans-Jürgen Schliepkorte, group manager at Fraunhofer IMS in Duisburg, reassures us. The door seal system is electronically coupled with building measurement and control systems. If a ventilation system or, for that matter, a heat recovery system has been installed, they can additionally be activated based on indoor CO_2 concentrations and temperatures. "The system always calculates the best compromise between good indoor air and optimal utilization of energy efficiency," Schliepkorte says.

Improvements at home

Beginning in June of this year, the door seal will be used in the Fraunhofer-inHaus-Center in Duisburg, an innovation workshop for application-oriented and market-based research for systems in rooms and buildings.

Indeed, Fraunhofer researchers have already set their sights on further applications: in the future, the door seal may well also help regulate humidity in residential and commercial buildings. This may soon make mold in the home and dry eyes in the office a thing of the past.

On display at the Fraunhofer-in-Haus-Center in Duisburg since June: the door seal system from Fraunhofer IMS.
Photo: Fraunhofer IMS

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Sensor pigments.
Photo: Fraunhofer EMFT / Bernd Müller

Glove warns about hazardous substances

Handling substances that can be harmful to health is an everyday occurrence for laboratory staff. Fraunhofer researchers have developed a practical and cost-effective method of protecting employees from dangerous substances: a glove that changes color when it comes into contact with toxic materials.

Employees in chemical production, the semiconductor industry, or in laboratories are frequently exposed to harmful substances. The problem: many of these aggressive substances are imperceptible to human senses, which makes handling them so risky. That's why there is a broad range of solutions that employers can use to protect their staff from hazardous substances – from highly sensitive measuring equipment to heat imaging cameras. Researchers at the Fraunhofer Research Institution for Modular Solid State Technologies EMFT in Regensburg have now developed a practical and easy-to-use solution that does not even require electricity: a glove that detects whether certain toxic, corrosive, or irritant substances are in the vicinity and indicates their presence by changing color. As part of employees' personal protective equipment, it warns them immediately about the danger.

Sensor dyes detect certain substances

The warning signal is triggered by an indicator dye integrated into the glove that reacts to the presence of analytes: in this case, the toxic substances. "By synthesizing the adapted color sensor materials, we can detect gases such as carbon monoxide or hydrogen sulfide," explains Dr. Sabine Trupp, head of the Fraunhofer EMFT Sensor Materials group. The challenge: a tailor-made sensor dye must be developed for every substance. Only when the dye molecules detect a special analyte in a targeted manner does a chemical reaction take place. The scientists use different techniques to equip textiles with sensor-active dyes. The sensor dyes are applied to the clothing using standard dyeing and printing processes, e.g. by fixing them in an immersion bath. Beforehand, the researchers adapt the dye molecules to the fiber properties of the textile by means of targeted chemical modification. Alternatively, the textiles can also be coated with sensor particles that have been impregnated with sensor dyes. To this end, the scientists either integrate the dye molecules in commercial pigments or they create them fully synthetically. The pigments are then processed using conventional textile finishing methods, such as screen printing.

Further potential in food monitoring

The experts already have new ideas about how the solution could be developed further. For example, a miniaturized sensor module, integrated into textiles, could record toxic substances, store the measurement data, and even transmit them to a main unit. This way, one could document how frequently an individual within a hazardous environment was exposed to toxic concentrations over a longer period of time. The researchers also envision other potential applications in the foodstuffs industry: in the future, color indicator systems integrated into foils or bottle closures are intended to make the quality status of the packaged foods visible. Because the sell-by date is no guarantee.

The sensor glove turns blue in the presence of hazardous substances.
Photo: Fraunhofer EMFT / Bernd Müller

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“Information ethics can give a new impetus”

Technological progress opens up new opportunities for action that make our lives safer and more comfortable – as long as we take advantage of it responsibly. VµE spoke to the commercial computer scientist and author Prof. Oliver Bendel about the ethical dimension of research, and current issues.

What are information and machine ethics about?

Bendel: Information ethics studies the morality of and in our information society. It investigates how we behave – or should behave – as both suppliers and users of information and communication technologies and digital media from a moral point of view. But information ethics is not interested in just turning everything into a problem. It is also concerned with the improved quality of life offered by these technologies. Machine ethics deal with the morality of machines, particularly of (semi-)autonomous systems such as agents, robots, drones, computers in automated trading, and self-driving cars.

Even “well-meaning” technology may be abused or used to negative ends. The Internet, for example: being linked globally is all well and good, but, on the other hand, cases of cyber-bullying among young people are on the rise, and some have had tragic consequences. Does every technology have its dark side?

Bendel: Bullying has been around forever – but cyber-bullying takes it to new heights. In the worst-case scenario, the texts and images involved can be distributed around the world. Young people used to be able to move to a different school, but nowadays, in some cases, they would need to move to a different planet! Information and communication technologies offer profitable and enriching opportunities, but they also support totalitarian structures. That’s the dark side, and it’s very dark and cold indeed.

In what ways can researchers impact on the ethical effect of their developments?

Bendel: First of all, scientists can follow moral codes and use safety mechanisms – up to and including whistle-blowing platforms. But platforms like that only make sense if there are scientists who use them, who remain critical, and who are willing to go public. Research institutions and universities can also play an important part by motivating their scientists to contribute their own ideas and to question things. The next generation of scientists can be an important impetus, because young researchers often work more closely with this topic than professors do.

Debates certainly take place in Germany about the pros and cons of technology – even if they are often quite emotionally driven, like the recent discussion of stem-cell research. One often has the impression that neither side understands the other. Why is that the case?

Bendel: In Germany, the churches get heavily involved in these kinds of debates. Theological ethics – the view the churches hold – has little to do with philosophical ethics, however. They both deal with the same subject, but have completely different approaches. While one is based on dogmatic principles and assumptions, the other uses observation and reasoning and applies scientific methods to reach its conclusions. And by the way, this philosophical approach is not a modern invention; it goes right back to Plato and Aristotle. It is therefore an older tradition than Christian ethics. All the same, the latter still dominates discussions today, even on the German Ethics Council. I think this one-sided approach in the discourse about the opportunities and risks posed by technology to be extremely problematic. I think we would be well advised to give more space to philosophical ethics.

Prof. Oliver Bendel.
Photo: private collection

About Oliver Bendel:
Oliver Bendel obtained his doctorate in commercial computer science from the University of St. Gallen. He has worked in Germany and Switzerland and, among other positions, managed the E-Learning Competence Center at the University of St. Gallen, the Business Communication working group at Fraunhofer ISST in Dortmund, and the Center for Innovation, Media and Technology at the University of Education Weingarten. During his time at Fraunhofer from 2003 to 2004 he designed a food-related mobile information system for diabetics, people with allergies, and vegetarians. In April 2009, he was named a professor by the School of Business based in Basel, Olten, and Brugg. Oliver Bendel is an expert in the areas of e-learning, knowledge management, social media, mobile business, avatars and agents, information ethics, and machine ethics. Since 2000 he has developed oft-quoted and used e-learning definitions and in 2001, at the University of St. Gallen, he founded a newsletter about e-learning that is still in existence and which is now managed by Prof. Dr. Andrea Back. Since 1998, he has been published over 130 times, including various books and contributions to books, as well as articles in specialist journals.

Long tradition: philosophical ethics has its roots in the work of great thinkers such as Aristotle.
Photo: pixelio.de / Templermeister

ECG and respiratory rate of firefighters are detected by the t-shirt and transmitted in real time via radio, for example, to a smartphone or directly into the command center. Photo: Fraunhofer IIS

To make the debate more factual and constructive?

Bendel: It would certainly be more constructive – simply because the scientific approach would give it a certain basis where arguments could be exchanged. This exchange could also provide research with new impetus. Because, as I mentioned at the start, a primary purpose of information ethics is not to criticize, but rather to be able to shape our lives with new technologies.

One research topic at Fraunhofer is telemedicine. It allows older people to live an independent life for longer. The "price" is, to put it simply, continuous monitoring of patients. How does information ethics view this question?

The future of residential living is being developed in the "inHaus." Photo: Fraunhofer IMS

Bendel: Surveillance of patients using information and communication technologies has many facets. It could be a "smart watch" worn on the wrist – its sinister equivalent would be an electronic hand or foot tag. It could be a camera pointed at the patient accompanied by a monitor showing a care provider asking questions and giving instructions. Some of the challenges from an information ethics point of view include: How can patients' autonomy be protected in the information society? How reliable are third-party decision makers in the virtual space? The patient must know about the data being exchanged, must give his consent, if possible, and must be able to opt out of the monitoring. An electronic tag on the hand or foot loses its terror if you can take it off. I would also find it very important to be able to decide in advance – as part of a living will, for example – whether one would like this kind of monitoring or not.

I hardly need to lift a finger in the "smart" house of today: the heating and lighting register whether I'm at home and can regulate themselves automatically. Sensors warn me that a window is open and the fridge reminds me that I'm out of yogurt. Is this convenience, or paternalism?

Bendel: It's both. It's great to be able to leave the house without having to worry, because a system will remind us in time that the iron is still switched on or a window is open. It's even better if we can switch off the iron and close the window when we're away via our cell phones. A fridge that reminded me to buy yogurt would probably annoy me, but it's not about me. If people like that, that's OK. The owner of a fridge like that should watch out what happens to his data, however. If he's constantly running out of beer and the fridge lets this slip to his health insurance company, there could be costly consequences. A really smart house would be one that didn't cause me any trouble.

Professor Bendel, thank you very much for talking to us.

Professor Bendel was talking to
Tina Möbius.

Devices (headband and chest band) for measuring a patient's vital parameters with a screen display of the data being monitored in the background. Photo: Fraunhofer IPMS

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Photo: MEV Verlag

Race car with electric drive

Electric cars are commonly held to be environmentally friendly, but sedate. Fraunhofer researchers have now put paid to that prejudice. Together with an industry partner, they have developed new battery management and power sensor solutions for an electric race car that can rival a Porsche in terms of acceleration.

From 0 to 100 km/h in 3.6 s – we're not talking about the rapid acceleration of a Porsche Carrera or Ferrari Scaglietti, but of EVE, a race car with a very quiet engine. EVE is powered by two electric motors, one for each rear wheel. With a maximum output of 60 kW, they get the e-racer going at 4,500 rpm. The sprinter can reach a top speed of 140 km/h, and has a range of 22 km thanks to two lithium polymer batteries, with a combined capacity of 8 kWh. Electrical engineering students from the e-racing team at Esslingen University of Applied Sciences designed the 300 kg car as a voluntary project supplementary to their studies. Scientists from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen developed the entire electronic sensor system in close collaboration with Seuffer GmbH & Co.KG.

Electronic sensors determine charge state of the battery

The two electronic sensors attached at the sides of the batteries use 3D magnetic-field sensor technology developed by Fraunhofer IIS to measure the magnetic field generated by the flow of electrical current and thus to determine the battery's level of charge. What's special about this is that the contactless sensors measure both the current that flows from the battery to the engine and the current that flows back again when the vehicle brakes. The integrated sensor system is able to eliminate disturbances and foreign magnetic fields, thus guaranteeing very precise measurements. A further advantage is that the system is also able to measure other aspects of the battery such as its voltage and temperature. The data is collected and sent to the power control unit (PCU) and the battery management system (BMS), which controls the charging and discharging processes.

Intelligent battery management system extends battery life

Battery running times and battery life are limiting factors for all electric vehicles. The BMS developed by Fraunhofer IIS in Nuremberg tackles this problem by determining the impedance spectrum of all battery cells and constantly testing whether the cells are functioning properly. This allows cell condition, current capacity, and potential service life to be ascertained and running times to be predicted more accurately. As individual battery cells age, they are able to store less and less energy. The challenge lies in optimizing cell utilization. "Until now, a battery system was able to provide only as much energy as was available in its weakest cell. The energy stored in other cells remained unused. Our BMS has an active cell balancing system that moves energy between stronger and weaker cells. This means that all cells share the load equally, allowing the maximum capacity of the battery as a whole to be utilized," explains Dr. Peter Spies, group manager at Fraunhofer IIS in Nuremberg. Actively balancing out the cells during the charging and discharging process extends the battery's service life and range. "EVE's current BMS is a system developed in-house by "E.Stall," but our solution could take its place," says Spies.

The scientists are convinced that EVE's innovative technology will allow the vehicle to perform very well while demonstrating excellent environmental awareness. And the "E.Stall" student team will soon have a chance to prove it: this year EVE will be in the lineup for the Formula Student Race in Italy, Spain, and the Czech Republic. The researchers are right on trend, as even FIA, the governing body for world motor sport, federation of the world's leading motoring organizations, and organizer of Formula 1, is planning a racing series for electric vehicles.

The race car from the "E.Stall" of Esslingen University of Applied Sciences races silently around the track. It's driven by an electric motor.
Photo: E.Stall, Esslingen University of Applied Sciences

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In the future, a smart home may be as widespread as phones or the Internet. All functions can be operated conveniently from a smartphone or tablet – if necessary, even when you're away. Photo: EnOcean GmbH / BSC-Computer GmbH

In the right light

Sight is a human's most important sense: we receive about 80 % of our information about our surroundings through our eyes. Because we spend increasing amounts of time indoors, the right lighting is very important in ensuring that we feel comfortable when living and working. Fraunhofer IIS / EAS is therefore working on "EnKonSens," a research project to develop a new type of intuitive system for electronic light control.

EnKonSens:
In addition to Fraunhofer IIS / EAS, the following partners are involved in the project: University of Kassel • Telefunken GmbH • EnOcean GmbH • BSC Computer GmbH

Artificial illumination of rooms is often not ideally adapted to the individual needs of the people inside. While illumination at work is intended to support concentration in an efficient manner, lighting within your own home is supposed to increase your well-being. Older people, in particular, require special light concepts to ensure that distracting shadows on stairways and thresholds do not put them at unnecessary risk. This is where the researchers at the Fraunhofer Institute for Integrated Circuits IIS, Design Automation Division EAS, come in, in collaboration with partners from industry and science: together, and as part of the EnKonSens project (the name is derived from the German for "Energy-self-sufficient Mobility for Context-sensitive Building Automation"), they are developing an automatic solution that creates adapted light situations for different scenarios.

Photo: EnOcean GmbH

Energy-efficient and reliable

At the core of the system are energy-independent sensors: these automatically detect which lighting situation is currently required for a room in order to generate the needed light as efficiently as possible. The radio sensors do not need batteries and obtain the power they need from energy harvesting, as it is known. This is when energy is obtained from the environment, e.g. from motion. This allows the project partners to create systems that are almost maintenance-free and that automatically switch on lamps for your working area or your sofa with the appropriate lighting strength and light spectrum. If no one is in the room, the light is switched off. These measures alone can result in significant energy savings and increase the life cycle of light sources. Even LED lights age as their usage time increases, and they may use up to 20 % more energy than when they were new. The scientists also want to reduce the energy used to a minimum by means of particularly efficient light switches and related switch concepts.

Easy to operate

The researchers also aim to develop a particularly user-friendly interface for the controls: an intuitive operating concept, such as for a remote control or a smartphone, provides the user with a transparent overview of the system's current status and additional control options. Intelligent sensors also allow the system to restrict the information it displays to that which is relevant to the user in the current situation. Someone in the bedroom, for example, will not be shown the operating options for the living room. This intuitive controllability will come into its own in an aging society, and will allow as many people as possible to use the systems.

Germany's Federal Ministry of Education and Research will support EnKonSens to the tune of 2.4 mill. € over the next three years.

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From photonics and energy efficiency to medical engineering

Photos: Andrea Grützner (5)

For four days, 150 scientists and decision-makers in industry and government from over 15 countries came together in Berlin at the INC9 conference to discuss the opportunities and challenges presented by nanotechnology. The focal point of INC9 was the exchange of views on nanoelectronics and their areas of application.

Which potential applications will research offer for the new "miracle material" of graphene in the future? How can nano applications in biology and medicine contribute to improving our personal health? These were the type of questions that researchers from Europe, Japan, and the USA talked about during the recent Ninth International Nanotechnology Conference on Communication and Cooperation (INC9). Other intensely discussed issues were the potential contribution to be made by nanoelectronics to energy-efficient and environmentally friendly products as well as the possibility that nanophotonics might become a key technology in the area of optical communications.

There was also a poster session in which young scientists from ten countries presented the results of their nanotechnology research. A jury selected three winners from the regions of Europe, Japan, and the USA from among 63 posters.

The issue of "more women in research" was raised, and participants talked about the obstacles facing female scientists in research, and how these can be overcome. The result of the discussions was clear: although many initiatives by both companies and government have resulted in a small rise in the number of women in research over the last few years, there is still a lot to be done; combining a career with raising a family remains a great challenge, particularly for female scientists.

INC10 will take place from May 13–16, 2014, in Gaithersburg, Maryland.

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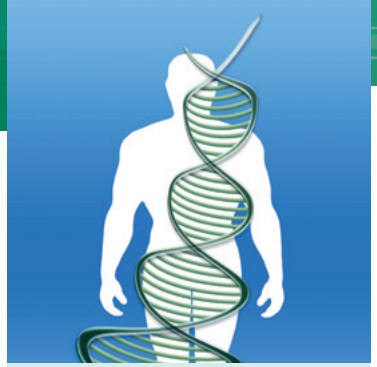
"The real challenge is 'interoperability.' INC is an opportunity to interconnect regional strengths."
David Seiler (NIST)

"Nano is cross-fertilizing industry along the whole value chain from design to product. Nano is the basis for an infinite number of extended products and new applications."
Hubert Lakner (Fraunhofer IPMS)

"Besides high performance – an issue that remains highly topical – new technological directions will focus on low power and energy efficiency. The barriers towards new applications have to be overcome." Toshiro Hiramoto (Tokyo University)

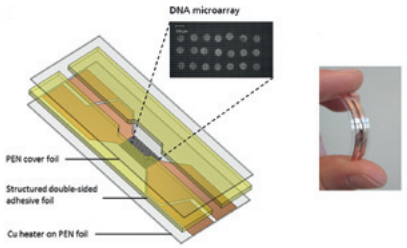
"What will happen beyond 2020? Nanoelectronics is at a turning point. Nanosystems and their application will require a complete redesign of scientific research."
Dirk Beernaert (European Commission)



DNA analyses provide valuable information contributing to better treatments and increased chances of cure.
Photo: pixelio.de / Gerd Altmann

A laboratory on a foil

Thanks to molecular genetics, many diseases can be diagnosed early on. At the moment, however, this requires complex laboratory analyses. Scientists at Fraunhofer EMFT and the KTH Royal Institute of Technology are working on cost-effective mini-laboratories fabricated on foil, which shall allow fast on-site diagnosis in the future.



Chip with DNA micro-array.
Fig.: Fraunhofer EMFT

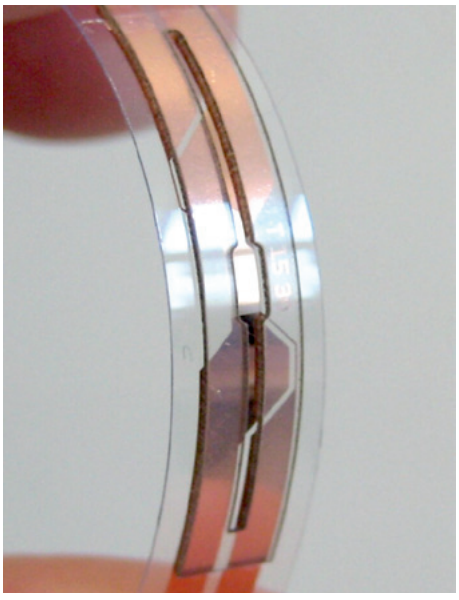
The earlier a disease is diagnosed, the better the treatment options and chances of recovery. Molecular genetics offers great potential: for example, certain SNPs – changes to individual base pairs of our DNA – indicate the presence of certain diseases. These include diabetes and particular types of cancer. Additionally, new possibilities in the fight against dangerous infectious diseases such as malaria arise. Viruses and bacteria are generally detected by means of antibodies in the patient's blood. Searching directly for the DNA of the infectious agent, however, makes early detection of the infection possible. Moreover, the specific subtype of the agent can also be precisely determined. To investigate DNA, it must first be isolated from a blood sample. In the second step, the relevant DNA sections are copied using the polymerase chain reaction (PCR). During the melting curve analysis that follows, these double-stranded segments are slowly heated. A DNA double strand with mutations is less stable than a normal double strand, meaning that it opens up at lower temperatures and can thus be identified. So far, these complex diagnostic methods have only been possible in well-equipped central laboratories, which make them time-consuming and expensive.

Heating included

Scientists at the Clinical Microfluidics Lab at the KTH Royal Institute of Technology in Stockholm and the Fraunhofer Research Institution for Modular Solid State Technologies EMFT in Munich have developed a foil-based measuring system for the melting curve analysis, not much bigger than a matchbox. In addition to microfluidics and micro-array technology, they have also integrated the heating elements into polymer foils. The heating elements are constructed on a thin polyethylene naphthalate (PEN) foil using Photolithography. The heating rods are arranged in a grid structure, enabling a more even heat distribution than conventional meander shaped heating elements. A 50 µm thin double-sided adhesive foil is then laminated onto this PEN foil. The researchers cut a channel-shaped structure out of this layer – thus creating the microfluidic element into which the samples are introduced. Another PEN foil then serves as the "cover".

Fast on-site analysis

This development holds great potential: polymer foils can be manufactured in a roll-to-roll process and are significantly more cost-effective than microarrays made of glass or silicone. Furthermore, unlike stationary equipment, the system does not require a power connection; a 2 V battery is sufficient as energy supply. These features predestine the development for on-site diagnosis, where small, simple analytical systems with disposable cartridges are commonly used. This allows doctors to carry out tests in their premises without having to send the samples to the lab, resulting in a significant reduction of both costs and waiting times. These mini-labs could also improve medical services in remote areas or in developing countries.



Disposable cartridge for melting curve analysis on foil with integrated heating element.
Photo: Fraunhofer EMFT

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New: Fraunhofer Institute for Embedded Systems and Communication Technologies ESK in Munich

On July 1, 2013, Fraunhofer ESK became the "Fraunhofer Institute for Embedded Systems and Communication Technologies ESK." Its approximately 80 scientists are experts in wide-ranging areas of communication technology, including fixed-line transmission technology, local radio networks, and Ethernet / IP communication. Furthermore, they also carry out research into model-based software design and software securing, as well as the development of reliable embedded multicore software and adaptive systems.

Founded in 1999 as the independent Fraunhofer Institute for Communication Systems ESK and directed by Prof. Ruge, the institute's initial focus was on the telecommunications sector. When the directorship passed to Prof. Dr. Rudi Knorr in 2003, the second business area – Automotive – was founded. In the years that followed, the institute expanded consistently, including with the foundation of the Industrial Communication business area in 2008.

Today, Fraunhofer ESK and its 80 employees design reliable, flexible, and resource-efficient ICT systems that are increasingly multi-centered, heterogeneous, and linked. That is the only way that these systems can contribute to product improvement in the areas of automobiles, transport, energy supply, automation, building and security/safety technology, and telecommunications. The aims of the institute include expanding technological expertise and making an active contribution to shaping Munich as a location for research.

The Fraunhofer ESK building. Photo: Fraunhofer ESK

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Journeying into the brain aboard the EU flagship

The European Commission has selected two flagship projects from six fields of research. The projects are intended to move the development of new technologies in Europe forwards. One of these is the Human Brain Project, which will receive funding of approximately one billion euros over the next ten years. More than 80 international research teams, including the scientists from Fraunhofer IZM, have set themselves the goal of researching the human brain and simulating its functions on a computer in full for the first time. The results should help us to develop new technologies that can be used in neuroscience, medicine, and computer technology. A subproject is dedicated to developing hardware that can process information at several sites simultaneously. The inspiration came from the brain, which has no problem processing images from the eye at the same time as acoustic and tactile stimuli. To build a computer that works in a similarly parallel manner, whole wafers must be linked together – Fraunhofer IZM's scientists will develop the necessary wiring technology.

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Photo: pixelio.de / hldg

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The Fraunhofer Group for Microelectronics (German abbreviation: VµE), founded in 1996, combines the expertise of 15 Fraunhofer institutes, with a total of more than 3,000 employees. Its main focus is the preparation and coordination of interdisciplinary research projects, conducting studies and to assist in the process of identifying strategies.

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The business office of Fraunhofer VµE is located directly at the River Spree in the heart of Berlin. Photo: Fraunhofer VµE / Kracheel

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The last word …

… comes from Gudrun Feix

Ms. Feix, what are you working on at the moment?

First of all there's the upcoming PCIM trade fair, for which we need to write texts, create images, compile exhibits, and plan our booth. In my scientific work, I am currently working on a project involving double-sided cooling of power modules with two DCBs for electric or hybrid cars, as well as on an electrically insulated chip-scale package for power semiconductors for SMD assembly.

What excites you about applied research?

I'm excited by the direct connection it has to its application, as the name implies, and the opportunity we have to see the device in action. In the next few years, a project to manufacture solar inverters may go into series production, and another project will be tested in a wind tunnel in the USA. So we don't do work only to then leave it lying in a drawer.

Imagine that you receive a visit from some nice colleagues and would like to show them something of Berlin after work, apart from the usual tourist sights. Do you have an insider tip?

The restaurant / café / bar "Uferlos" in the district of Wedding. It's not the kind of thing you expect to find in that area. Just a few meters away are the old transport sheds, the "BVG-Hallen," where you can now find arts and theater.

If a first-grader on your street asked you what power electronics is, how would you explain it?

Power electronics turn electrical energy – such as the AC voltage that comes out of your outlet – into the low DC voltage that's needed to charge cell phones or Nintendo consoles. Power electronics ensures that cell phone and computer chargers remain small and light and that energy generated from wind and the sun can be brought to our outlets. It is a major contributing factor in making electric cars, bikes, and trains go.

What invention would you not like to do without in daily life?

With two small children, that would have to be the washing machine. Closely followed by the dishwasher! The stove is also pretty useful – I really like to cook.

What do you wish you could learn overnight?

Languages. I like to read books in their original language, and whenever I'm in a country where I don't speak the language, I wish I did.

You have two young sons – how do you manage to combine career with raising a family?

Flexible working hours; the ability to work from home; an understanding working environment where I can bring my children if need be; and, in particular, a partner who takes his paternal rights seriously. He has just started seven months of parental leave for our youngest son, something he already did for the eldest. His mother thinks that two children are too much for one man to handle, so I guess that's her take on gender roles and discrimination.

Let's look into the future. What would you like to have achieved in 5 or 10 years' time?

I would like to have finished my doctorate and still be managing to juggle career and family.

What song belongs to the "soundtrack" of your life?

I don't have a song that I connect to a particular event, but I had Quincy Coleman's CD "Come Closer" on repeat for hour after hour when my first son was being born.

Last, but not least: Can you tell us what motto you live by?

The man who moved the mountain started by taking away small rocks.

Buses and street cars were repaired at the BVG workshops in the Berlin district of Wedding until 2006 – now they are home to a large cultural center.
Photo: Heinrich Hermes

Photo: private collection

About Gudrun Feix:
Gudrun Feix was born in Nordhausen in 1980. She studied electrical engineering at TU Berlin, concentrating on power electronics and electrical energy technology. She received her bachelor's degree in 2007 and her master's in 2008. Since 2009, she has been integrated in Fraunhofer IZM's research operations as a TU Berlin employee, and in that time has been working on package and system development for power electronic systems and components.

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