Harnessing the sun better worldwide

Whether desert, rain forest or mountains: Austrian researchers in the Infinity lead project are working on photovoltaic systems for different climate zones.
Research leads to innovation

Only if you research will you survive in the long term. Many local companies are also aware of this and trust in innovation and expertise for staying on the ball. Cooperative research can support them and often helps to bring about innovation faster.

On pages 4 and 5 you can find out about the Infinity photovoltaic programme, an Austrian lead project. Lead projects are strategic research and development programmes dedicated to promoting cooperation along the value chain and therefore advancing the technological feasibility of system solutions with long-term growth prospects.

Page 3 reports on the positive results of the now completed project focusing on SAW sensors that are suitable for use at high temperatures. They include a miniaturised high-temperature sensor for mobile emissions analysis developed together with NanoTec-Center Weiz and industrial partners AVL List and Ebner Industrieofenbau.

Other research projects in the field of electronic components and systems as well as production for the future are scheduled to start in the coming months. They were initiated together with industry and will receive funding under European and Austrian research programmes.

All these future projects and the research work presented in this issue go to show that we are reliable partners to industry, especially when it comes to leveraging research in order to drive innovative developments.

[ Scientific Awards ]

Three awards for CTR scientists

Two researchers from CTR recently took home prizes from scientific events. Lukas Neumaier received the Best Poster Presentation Award at the Austrian Photovoltaics Conference in Schwaz (Tyrol). He is exploring metallisation patterns for solar cells inspired by Nature (see ZOOM OUT on page 8).

In New Zealand Michael Ortner (see page 6) was presented with the Runner-Up Poster Award. His special field is developing magnetic sensor systems and his achievements were honoured at the International Conference on Sensing Technology (ICST). In addition, CTR’s team of researchers together with research partner PCCL Leoben also won a poster prize at Europe’s largest PV Solar Energy Conference. Here they are working on increasing the efficiency of photovoltaic back sheets.

[ Certification ]

Successful TÜV certification to EN ISO 9001:2008

CTR was certified to TÜV EN ISO 9001:2008 in 2003 and has been reviewed regularly ever since. TÜV Austria has just performed a successful re-audit. Recognised globally, the EN ISO 9001 standard takes a process and system approach to quality management and continual improvement. It is designed to help organisations ensure they meet customer needs and product requirements, increase process performance and effectiveness with the focus on continual improvement. [ www.tuev.at ]

[ Network Meeting ]

Networking in Villach

Cooperate and create synergies – this was the aim of the meeting between the Photovoltaics technology platform and Photonics Austria platform at CTR in February 2016. The idea behind the event is to forge closer ties and together define new, collaborative research areas. On the two-day agenda were intensive talks and work meetings to exploit both platforms’ strengths for an alternative energy future.
Reducing harmful emissions is not only of great interest for combustion processes in engines, but also for thermal plants used in industry. What is required in both applications are small, reliable sensor systems that can ideally be integrated in order to record the actual emissions from vehicles or industrial burners. The systems currently available on the market are however large and relatively costly. In a research project – led by CTR – project partner NanoTecCenter Weiz (NTC) and industrial partners AVL List and Ebner Industrieofenbau therefore worked on delivering improvements. “We concentrated on sensor solutions that can be miniaturised, are durable and enable measurements to be taken near the combustion location,” explains Gudrun Bruckner, CTR project manager. “This means that the sensors are suitable for use at high temperatures and can withstand ranges from 350 to 500 degrees Celsius,” adds Bruckner.

**SENSORS CAPABLE OF BEING INTEGRATED**

To achieve their goal, the researchers selected such principles as resistance testing and surface acoustic wave (SAW) sensors in combination with functional layers based on metal oxide. If suitable materials are chosen, both principles can withstand extreme temperatures and have the potential to allow very small sensor systems to be built in large numbers and therefore manufactured very cost effectively. In addition, SAW sensors also enable wireless readouts. The research work proved that this sensor is extremely sensitive to nitrogen oxide and hydrogen. Legal limits are often so stringent that sample analysis has to show the existence of a few molecules out of a million gas molecules. “During the project, we tested various manufacturing processes, analysing and evaluating more than 60 layers and layer combinations using a total of 11 different materials in order to find the best possible option,” says Andreas Klug who was responsible for the project at NTC. The SAW sensors developed with CTR are 1 x 5 mm in size and in addition to being sensitive, also display temperature stability up to a maximum of 800°C.

The project ran from March 2013 until August 2015, was funded by Production for the Future, a Research Technology Innovation (FTI) initiative, and managed by the Austrian Research Promotion Agency (FFG).
Harnessing the sun better worldwide

In Infinity, an Austrian lead project, researchers are working on a new generation of photovoltaic systems. Their aim is to adapt the entire system to the requirements in different climates and regions.

Research and development are important strategic factors in driving the expansion of renewable energies and achieving global climate protection goals. Austrian solar technologies are in demand on the global market. The Infinity project will therefore help to develop this strong position.

The demand for photovoltaic (PV) systems has increased over the past few years, not just in our part of the world. Future growth markets outside the temperate zones, for example desert, (sub)tropical or alpine regions, also intend to use solar to a greater extent for generating electricity. However, there is currently only one standardised PV system for all climate zones. No options are available that can be adapted to different climate or grid conditions in specific applications.

**NEW GENERATION OF PHOTOVOLTAIC SYSTEMS**

Developing such application-specific options is the objective of the research in the Infinity project where five scientific partners and nine leading partners in industry have joined forces. The project is subsidised by the Climate and Energy Fund.

“What we want to achieve in the Austrian lead project is to create the basis for the next generation of PV materials, components and systems. Our research is therefore into adapting both the materials and the whole PV system to different climate conditions and special regional features. Here we also take such factors into account as extreme temperatures, snow, sand or instable electrical grids,” says project manager Christina Hirschl from the research centre CTR Carinthian Tech Research.

“If we are to achieve the energy transition, we need smart systems that are long lasting, energy-efficient and also affordable. The project is also aimed at improving climate protection and making companies more competitive at an international level.”
ADAPTIVE SYSTEMS DELIVER HIGHER YIELD

The team of researchers will start off by conducting an in-depth error analysis to identify the mechanisms affecting how various materials, modules and inverters react in different climate zones both individually and as an overall system. They will then use the results gained to take a different approach to designing new, improved, climate-specific PV energy generation systems. “A feature that makes the project so special is the holistic research method employed along the entire PV value chain – from the materials and components to module manufacture, system installation and maintenance. The scientific findings will be used to develop further process, service and maintenance strategies. Our goal is to create new energy-efficient products and also new services,” Hirschl goes on to explain. Research is aimed at prolonging service life, reducing system costs and ultimately also delivering more electricity.

Lead scientist Michael Schwark from AIT adds: “The various inputs along the value chain will significantly improve the quality of the mathematical-physical models, enabling climate-related aging predictions to be given for all parts of a PV system. Apart from optimising the system, these models will also lead to approval and maintenance recommendations for individual climate zones.”

As a whole, it will give the Austrian and European photovoltaics industry the opportunity to secure a competitive edge on the global market in terms of quality and above all establish sustainable research structures with scientific experts.

PROJECT APPLICATION FACTS & FIGURES

Title: INFINITY – Climate sensitive - longtime reliability of photovoltaics

Lead management: research centre CTR Carinthian Tech Research AG

Scientific management: AIT Austrian Institute of Technology

Industrial partners: ENcome Energy Performance, Fronius International, Infineon Technologies Austria, Isovoltaic, KIOTO Photovoltaics, Polytech PT, PVI, PVSV, Ulbrich of Austria

Scientific partners: AIT Austrian Institute of Technology, CTR Carinthian Tech Research, Vienna University of Applied Sciences, OFI Austrian Research Institute for Chemistry and Technology, PCCL Polymer Competence Center Leoben

Duration: 3 years starting on 1 November 2015

Research volume: € 5.5 million

This project will be subsidised by Austria’s Climate and Energy Fund and carried out as part of its energy research programme.
IN person

Magnetic researcher

NAME

Michael Ortner

MY EDUCATION

Degree in theoretical physics at Vienna University of Technology, then PhD in quantum optics with the focus on molecular quantum computing in Innsbruck. I have been working in electrodynamics at CTR for nearly four years now, concentrating on position and orientation detection with magnetic field sensors.

WHAT I AM CURRENTLY RESEARCHING AT CTR

The focus is on magnetic field modelling with the aim of developing and improving position and orientation systems for 3D Hall sensors used in automotive applications in particular. However, I basically work on everything to do with magnetism: magnetic materials, all kinds of sensors, magnetic field dynamics and eddy currents. A fascinating area that I am also exploring on the side is the mathematical description of eddy currents in laminated materials and their feedback to the environment.

WHERE I RECHARGE MY BATTERIES …

At home with my family, at work in the break room and outdoors in the mountains, whether biking, skiing, rock climbing or other sports.

WHAT STILL NEEDS TO BE INVENTED …

My wish list would be quite long, but apart from alternative energies, electric vehicles and space technology, I think that research and development in cybernetics and human-machine interfaces is particularly important and holds a great deal of potential in the medium term.

PARTNER PROFILES

ENcome Energy Performance GmbH
Maximum energy utilisation

Renewables are the future in meeting the growing global demand for energy. ENcome Energy has set itself the goal of maximising mutual benefits for generators and consumers. Renewable energy power plants must be managed professionally in order to make their electricity generation costs competitive compared with traditional energy sources. This requires a holistic approach, both in plant operation and maintenance. ENcome Energy Performance provides all the requisite services from a single source: from technical and economic assessment of acquisitions, complete plant operation, including optimisation and repowering, to sale or dismantling.

Highly qualified engineers ensure the best possible yield for every renewable energy plant in any grid environment. ENcome’s flexible and scalable monitoring system with a custom user interface optimises both the user experience for the customer and plant efficiency for the operator. Together with international partners, ENcome is a one stop shop delivering all the services required over the power plant’s entire life cycle. In addition to its headquarters in Klagenfurt (Lakeside Park), ENcome Energy also has subsidiaries in Italy, Germany, the UK, France and Spain and partners in Turkey and Japan. ENcome cooperates with CTR on the Infinity project (see pages 4 and 5).

NanoTecCenter Weiz Forschungsgesellschaft mbH
Nano analytics in the spotlight

NTC Weiz GmbH was founded in 2006 as a subsidiary of Graz University of Technology and Joanneum Research Forschungsgesellschaft mbH. Since then, the company has worked successfully as a non-profit, non-academic research institute for nano technology, printed electronics, rapid prototyping, smart systems integration and sensor technologies, also gaining a reputation outside the region. Success factors include a highly motivated team and the state-of-the-art R&D facilities available. The company’s primary objective is to advance scientific, technological and industrial applications in the fields of sensors, photovoltaics and optoelectronics by developing and combining electroactive materials using appropriate structuring and processing methods. At the end of 2015 Joanneum Research (JR) acquired all the shares in the company, thus giving Weiz as a research location together with the JR Institute of Materials a leading role across Europe in the research area of printing and structuring technologies in the micro and nano range. NTC Weiz cooperates with CTR in the field of gas sensors (see page 3).
Magnetic position and motion sensors

Networking and sharing knowledge with other scientists is an important part of everyday research life. The recent Coffee Journal Club (CJC) organised by CTR saw the research work in the area of magnetic position and motion sensors being presented.

Here the focus of the presentation was on position and orientation detection with magnetic sensors. The researchers moved a magnet relative to a magnetic field sensor and by measuring the magnetic field were able to draw conclusions on the state of the magnet. Readouts provide information on its position, orientation and motion.

Today’s magnetic field sensors are manufactured as microchips and contain complex electronics for direct signal processing. This requires several sensitive components to be integrated, not only to compensate for stray fields, temperature and pressure but also reduce noise.

To enable a rapid test setup and consequently prototypes, a CTR researcher has developed an environment where new sensors and magnets can be integrated quickly and - with the help of a four-axis precision robot arm - moved accurately relative to one another. The latest project examines how a joystick movement can be modelled magnetically with a view to replacing the complicated mechanics and electronics with simple magnetic field detection. As part of a dissertation, a joystick application was replicated and modelled magnetically with the help of RAMSRS.

A new 3D Hall effect sensor was used for detection, which enables a particularly stable analysis of the joystick position. The positive results impressively demonstrate the magnetic joystick application’s stray field tolerance. They were presented and discussed at the CJC.

Calculations of the distortion from external stray fields, such as the Earth’s magnetic field, explain errors.
SAVE the date

Smart Systems Integration
9-10 MARCH 2016, MUNICH, GERMANY

Hosted by EpoSS, the European Technology Platform on Smart Systems Integration, this conference is one of the most important events in Europe in the field of smart systems. CTR staff will be giving technical papers.

Future Jobs 2016
17 MARCH 2016, TECHNOLOGY PARK AND HIGH TECH CAMPUS, VILLACH

Helping young people appreciate technology better is the aim of the Future Jobs Campus at Villach’s Technology Park. Some 150 pupils from the secondary schools in Villach and Feldkirchen will be visiting CTR to develop a micro power sweeper together.

MEET & MATCH – job fair
14. APRIL 2016, FH KÄRNTEN, VILLACH

Companies, students and graduates in the areas of business, technology, health and social services can meet at the job fair. CTR will be giving a company presentation.

Long Night of Research
22 APRIL 2016, KLAGENFURT
UNIVERSITY & LAKESIDE PARK, KLAGENFURT

Where can you get in free and go home smarter? The Long Night of Research invites you to explore, experiment and experience. CTR will be there with two stands. Find out when you should eat an apple if you want it to taste best and how strong a laser has to be before it will ignite rocket motors.

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Innovative safety switch for lithium-ion batteries

Batteries are to be found in all kinds of everyday devices like mobile phones, cameras and tablets. However, they have one drawback: if they overheat, they can catch fire or even explode. To prevent this, commercial lithium-ion batteries often have sensors designed to shut down the battery immediately in the event of overheating. Unfortunately, this stops it from functioning normally afterwards. An integral safety device could now make lithium-ion batteries safer without compromising their functionality or performance. Researchers at Stanford University have developed a composite material, which acts as a thermo-responsive polymer switch (TRPS). It consists of nickel nano particles with a graphene-coated spiky surface structure. The researchers attached this composite film to a lithium-ion battery’s cathode on top of the normal current collector. When the battery operates under normal conditions, the conductive nano particles lie close together and electric current can flow to the collector. If the battery starts to heat up abnormally, the polymer switch responds immediately: “Once the critical temperature of 70°C is reached, the film’s conductivity decreases within one second by seven to eight orders of magnitude,” the researchers report. In addition, this system offers 1,000 to 10,000 times higher sensitivity and also responds much faster than previous safety devices.

When silicon solar cells are modelled on Nature

One of the current research issues in photovoltaics focuses on optimising finger metallisation for solar cells and improving overall efficiency. The solar cell metallisation process used today produces a homogeneous pattern, consisting of straight, evenly distributed grid fingers. A dissertation at CTR therefore explored alternative metallisation patterns inspired by Nature. The most important research goals here were reducing the shading caused by front metallisation of the solar cell and increasing power output. To produce an alternative metallisation structure, research work investigated designs inspired by Nature and evaluated their suitability for solar cells. Sources of inspiration were typical patterns seen in Nature, such as the vein systems in leaves, tributary branches in river deltas or spider’s webs. Based on them, a randomly branching structure was developed, consisting of a minimum spanning tree. To optimise this Nature-inspired pattern, an evolutionary algorithm was applied to improve the spatial distribution of the pattern. The result was a bionic solar cell design, which enables both the amount of metal used to be reduced and the front shading to be minimised.