INTERNATIONAL

New organic solar cells

A research team from Nuremberg and Erlangen has set a new record for the power conversion efficiency of organic photovoltaic modules (OPV). The scientists from Friedrich-Alexander Universität Erlangen-Nürnberg (FAU), the Bavarian Center for Applied Energy Research (ZAE), and the Helmholtz Institute Erlangen-Nürnberg for Renewable Energy (HI ERN), a branch of Forschungszentrum Jülich, in cooperation with the South China University of Technology (SCUT), designed an OPV module with an efficiency of 12.6 percent over an area of 26 square centimeters. The former world record of 9.7 percent was exceeded by 30 percent.

This is the highest efficiency value ever reported for an organic photovoltaic module. It was confirmed by a certified calibrated measurement under standard testing conditions by the independent certification laboratory of Fraunhofer ISE (Freiburg) in September 2019. The multicell module was developed at the Solar Factory of the Future at the Energie Campus Nürnberg (EnCN) in a coating laboratory with a unique megawatt pilot line for thin-film photovoltaics, which was designed and implemented with financial support by the Bavarian Ministry of Economic Affairs.

Organic solar cells usually consist of two different organic components, possessing the necessary semiconductor properties. In contrast to conventionally used silicon, which is manufactured by energy-intensive melting processes, organic materials can be applied directly from solutions onto a carrier film or glass carrier. On the one hand, this reduces manufacturing costs, on the other hand, the use of flexible, lightweight materials allows for new applications, such as mobile devices or clothing, even if the efficiency is not yet comparable to that of traditional silicon solar cells.

"This milestone in organic semiconductor research shows that the latest performance developments with certified cell efficiencies of over 16 percent are not limited to the laboratory scale, but ready to be scaled up to the level of prototype modules," explains Prof. Christoph Brabec from FAU, director at HI ERN, and scientific director of the Solar Factory of the Future, a research group of ZAE Bayern.

Due to their design, the efficiency of complete photovoltaic modules is always slightly lower than that of individual cells. A part of the module area, for example, is always inactive since it is used for the interconnection of the individual cells. With an increasing module area, the losses caused by the electrodes' electrical resistance increase as well.

The record module consists of twelve serially connected cells and has a geometric fill factor of over 95 percent. This part of the module area actively contributes to the power generation. With respect to its active area, the module even achieves an efficiency of 13.2 percent. The minimization of inactive areas was achieved through high-resolution laser structuring, as developed and optimized in recent years at the "Solar Factory of the Future."

https://scitechdaily.com

ASIA-PACIFIC

CHINA

Efficient perovskite solar module

Chinese perovskite cell maker Microquanta Semiconductor says its research team achieved a 14.24% conversion efficiency record for a large-area (200x800cm^2) perovskite solar module. The device has reportedly passed testing by the European Solar Test Installation agency. The latest record comes just two months after Microquanta achieved an 11.98% landmark for a large module.

Hangzhou-based Microquanta was established in 2015 by three students returning from periods abroad. Chief executive Jizhong Yao graduated from Zhejiang University and the University of New South Wales before gaining his PhD at Imperial College, London. The business has focused on perovskite cell and module R&D from day one. In June last year, Microquanta achieved a lab conversion efficiency record of 17.9% (17.3% stable rate) with its perovskite solar module, and the company then turned to large-area devices.

Yao and his team initially secured private funding for the business and were then helped by their local government and China's key R&D funding program. In April, state-owned energy company the China Three Gorges Corporation made a strategic investment in Microquanta aimed at perovskite technology research and commercializing perovskite solar.

https://www.pv-magazine.com

Giant offshore wind turbine

China has developed a giant offshore wind turbine with a 210-meter rotor diameter, which will be put into production soon, according to the science and technology bureau of southwest China's Chongqing Municipality. The wind turbine, coded H210-10MW, has a unit capacity of 10 megawatts and is China's first to have a rotor diameter of more than 200 meters. It was developed by HZ Windpower, a subsidiary of the state-owned China Shipbuilding Industry Corporation.

Han Huali, director of the research institute at HZ Windpower, said once put into operation, each H210-10MW turbine unit could generate about 40 million kWh of electricity annually, double the unit energy production of 5-MW turbines currently in use. The turbines will be installed at wind farms in the coastal provinces of Fujian and Guangdong after rolling off the production line.

The institute now aims at R&D of wind turbines with larger rotor diameters of up to 230 meters, Huang added, noting they are expected to be used in the eastern provinces of Jiangsu and Zhejiang, where average wind velocity is lower.

http://www.xinhuanet.com

INDIA

Process to improve solar cell efficiency

A novel process to improve the performance of Dye-Sensitised Solar Cells (DSSC)

has been developed by researchers at the Indian Institute of Technology (IIT) Hyderabad. Dye-sensitised solar cells hold a lot of promise because of possible cost and environmental benefits. But, they have low light-to-power conversion efficiency. The new process, published in the journal *Solar Energy*, promises to enhance the efficiency. "A dye molecule absorbs the light energy in DSSC and causes electrons in the dye to jump to titania and then to the external circuit, which causes a flow of electrons, leading to a current," said Jammalamadaka Suryanarayana, who led the research team.

The first-generation silicon-based cells with energy harvesting efficiency of about 26 per cent continue to be costly. Second-generation thin film solar cells based on semiconductors like cadmium-telluride and cadmium-selenide have comparable efficiencies, and not much lower cost. The third generation of dye-sensitised solar cells can significantly lower costs of solar cells while being environment-friendly. But, their efficiencies need improvement to translate to practical products.

In the study, the researchers initially tried introducing holmium oxide, a powerful paramagnetic material, into the anode of the cell and by applying external magnetic fields. The experiment showed an enhancement in efficiency. However, application of external magnetic field can be power-consuming because electromagnets themselves require energy for their functioning. The team consequently replaced holmium oxide with iron oxide magnetic nanoparticles since it produced a magnetic field internally. The result was as good.

https://www.downtoearth.org.in

Solar technology for indoor

As the conventional solar technologies may not be a suitable choice for indoor environments in near future owing to the high costs involved, researchers from a Central lab, based in Kerala, have developed an indigenous semi-automatic fabrication unit for manufacturing dye-sensitized solar cell (DSC) based modules.

DSCs contain synthetic dyes and harvests light by mimicking photsysthesis and are an efficient third generation indoor light harvesting technology, said researchers from the National Institute of Interdisciplinary Science and Technology (NIIST) which has developed the equipment. NIIST is one of the labs of the Council of Scientific and Industrial Research under the Union Science and Technology Ministry.

By developing indoor light harvesting photovoltaic cells, self-powered sensors can be realised and the battery life can be extended, pointed out an official from the Ministry. Their advantage lies in their ability to generate power from low levels of exposure to light including indoor lights like CFl, LED etc. Installed at CSIR-NIIST lab, the equipment has been selected on the Prime Minister Office's high priority implementation category, he said.

The indigenous unit has been developed with the support of the Department of Science and Technology (DST) under the Ministry. The entire equipment which was developed by the CSIR-NIIST partnering with Elixir Technologies, Bangalore has helped reduce cost of fabrication equipments to more than 60 per cent leading to true import substitution, said the researchers. They said the fabrication process, molecules and materials were optimised keeping in mind end user requirements and applications thereby developing international competency in this photovoltaic sector.

The cell can be used in powering internet of things (IoT) smart devices, smart meters, water and energy management, smart parking, self-powered sensors, portable devices like those integrated in phones, tablets, mobile charging stations, backpack, in clothes and also solar power windows or aesthetically beautiful power producing glass windows.

https://www.dailypioneer.com

EUROPE

SPAIN

Radiative cooling of solar panels

Spanish scientists claim to have created a new, two-dimensional material which can reduce heat in electronic devices which suffer critical heating during operation, such as solar modules.

The paper *A Self-Assembled 2D Thermofunctional Material for Radiative Cooling,* published in *Small*, describes the material as an inexpensive solution made of a single layer of silica microspheres self-assembled on a soda-lime glass. The material, developed by researchers from the Catalan Institute of Nanoscience and Nanotechnology and the Instituto de Ciencia de Materiales de Madrid, is said to significantly reduce heat as it cools the surface on which it is placed. The cooling occurs, the scientists say, without energy consumption or gas emissions.

The researchers claim their translucent thermal emitter has enabled them to reduce the daytime temperature of a silicon wafer by around 14 degrees Celsius and added, the reduction can reach 19 degrees Celsius if the structure of the material is backed with a silver layer. According to the scientists, the emissivity of the single-layer colloidal structure of the material, and its radiative cooling power, can also be increased by using an f-SiO2 (silicon dioxide) bulk substrate.

Without the new material, such cooling tops out at 5 degrees Celsius, according to the scientists who developed it. "The cooling power of this simple radiative cooler under direct sunlight is found to be 350 W/m^{-2} when applied to hot surfaces with relative temperatures of 50 K above the ambient," states the paper.

Radiative cooling is the principle all objects on Earth tend to emit part of the heat they receive from the sun's infrared radiation. The atmosphere pushes that heat back to Earth, except for infrared wavelengths, which can escape the atmosphere. What the scientists claim to have created is a material that emits infrared wavelengths. "The sand grains in deserts are among the major contributors to this phenomenon, which keeps the average temperature of our planet stable as long as we do not consider human activities," the Spanish team said.

Research into radiative cooling of solar cells has increased in recent years. A recent

study on the matter stated investigating the effect of enhanced radiative cooling on solar cells used in commercial PV was imperative.

https://www.pv-magazine-india.com

UK

Biofuels from seawater bacteria

Researchers from the University of Manchester are using synthetic biology to explore a more efficient way to produce the next generation of biobased jet fuels—partly made from a type of bacteria that grows in seawater. The Manchester research group, led by Professor Nigel Scrutton, director of the Manchester Institute of Biotechnology (MIB) and supported by the prestigious US-based international maritime research agency Office of Naval Research Global (ONR), is using synthetic biology to help identify a more efficient and sustainable method to make biofuel than the one currently used.

Scientists have discovered that the bacteria species called *Halomonas*, which grows in seawater, provides a viable "microbial chassis" that can be engineered to make high value compounds. This in turn means products like bio-based jet fuel could be made economically using production methods similar to those in the brewery industry and using renewable resources such as seawater and sugar.

The breakthrough behind this approach is the ability to re-engineer the microbe's genome so to change its metabolism and create different types of high value chemical compounds which could be renewable alternatives to crude oil. Benjamin Harvey and his team of researchers at the world-leading Naval research facilities in China Lake, California, USA, have pioneered this exciting work on converting biological precursors to relevant jet fuels.

Following on from this research, Professor Nigel Scrutton explained, "Effective biofuels strategies require the economic production of fuels derived from a robust microbial host on a very large scale—usually cultivated on renewable waste biomass or industrial waste streams—but also with minimal downstream processing and avoids use of fresh water. With *Halomonas* these requirements can be met, so minimizing capital and operational costs in the production of these next generation biofuels."

http://biomassmagazine.com

Renewable energy storage device

Researchers have developed a new dielectric capacitor -- a device that stores energy like a battery -- taking inspiration from how the French pastry, croissant, is made by folding multiple layers of dough. The researchers, including those from Queen Mary institute of London in the UK, found that by pressing and folding a polymer film capacitor (a capacitor with an insulating plastic film), they were able to store 30 times more energy than the best-performing commercially available dielectric capacitor.

According to the study, published in the journal *Nature Communications*, this is the highest energy density ever reported in a polymer film capacitor -- an advance that may pave the way for efficient, low-cost, and environment friendly electric energy storage systems for wind and solar sources.

"Storing energy can be surprisingly tricky and expensive and this is problematic with renewable energy sources which are not constant and rely on nature. With this technique we can store large amounts of renewable energy to be used when the sun is not shining and it is not windy," said Emiliano Bilotti, lead researcher of the study from the Queen Mary University of London in the UK.

The study noted that dielectric capacitors generally have ultrahigh power density making them suitable for technologies such as motor drives, and space vehicle power systems which require accumulating energy over a period of time and then releasing it very quickly.

"This finding promises to have a significant impact on the field of pulse power applications and could produce a step-change in the field of dielectric capacitors, so far limited by their low energy storage density," Mike Reece, co-author of the study from the Queen Mary University of London. The researchers said that the newly developed technique of processing, pressing and folding layers to make the dielectric capacitors is unique for its simplicity, record-high energy density, and the potential to be adopted by industries.

https://www.indiatoday.in

NORTH AMERICA

USA

Novel solar energy system

UCLA researchers looked to nature to develop a new material that could capture more solar energy than previous technology. Ximin He, a materials science and engineering assistant professor at UCLA, has spent more than three years working on SunBOTs, which bend toward the sun to harvest solar energy, similar to sunflowers. She and her team's research was published in November in Nature Nanotechnology.

SunBOTs have the potential to harvest double the amount of energy that a stationary solar panel could harvest, He said. "We found, on a day like (a) spring and autumn day, we know where the sun is shining on the earth at Los Angeles' latitude, we (could) harvest double the sunlight for LA," He said. When sunlight shines at oblique or indirect angles, solar energy capture is almost fourfold in SunBOTs compared to solar panels, He added. For example, when sunlight shines 75 degrees away from a perpendicular line to the surface, SunBOTs harvest 90% of its energy whereas solar panels just receive 24%, He said.

Some current solar panels are mechanically repositioned toward the sun throughout the day. However, this requires additional machinery and energy, He said. A mechanical system would also not work for mobile surfaces like cars because they would be constantly changing direction, she added.

He and her team took on the challenge of creating an intelligent synthetic material

that could independently detect light and orient toward it, using nature for the answer, specifically phototropism. "Phototropism means the plants are able to detect where the light comes from and autonomously … move their head or their leaves toward light (in) real time," she said. "This inspired us to try to create similar intelligence in man-made material."

Todd Lynch, a principal project planner for UCLA Capital Programs, works on integrating solar power in campus buildings. Lynch said one of the challenges with solar energy is that a large surface area is required to capture a small amount of energy, and solar panels have to be positioned at just the right angle in order to harvest energy efficiently.

SunBOTs' unique abilities come from their structure and material, He said. Their symmetric shape mimics a plant's stem, which allows for light to be captured at any area of the SunBOT and makes it easier for the SunBOT to orient itself toward a light source, He added. SunBOTs are composed of hydrogel and photoabsorbers. Hydrogels, cross-linked polymers similar to Jell-O, are used in household products such as diapers and contact lenses, He said.

https://www.eletimes.com

Highly efficient solar cells

A new type of material for next-generation solar cells eliminates the need to use lead, which has been a major roadblock for this technology. Now a team of scientists and engineers led by Letian Dou, assistant professor of chemical engineering at Purdue University, have developed a sandwich-like material incorporating organic and inorganic materials to form a hybrid structure that doesn't use lead and has much improved stability.

"These structures are very exciting," Dou said. "The sandwich structures are like semiconductor quantum wells that are widely used today in many electronic and optoelectronic devices, but they are much easier to produce and more tolerant to defects," The research was published in the journal *Nature Chemistry*.

In a paper published in the *Journal of the American Chemical Society* in September, the scientists had incorporated the material into an essential component of many electronic devices, a field effect transistor. Yao Gao, lead author of both research papers and a postdoctoral fellow in Dou's research group, said the new organic-inorganic hybrid perovskite materials are cheaper and perform better than a traditional inorganic semiconductor. Also, Gao said, the new material's design strategy could serve as a blueprint for many other functional hybrid materials.

https://www.sciencedaily.com

Breakthrough in perovskite solar cells

Rice University scientists believe they've overcome a major hurdle keeping perovskite-based solar cells from achieving mainstream use. Through the strategic use of the element indium to replace some of the lead in perovskites, Rice materials scientist Jun Lou and his colleagues at the Brown School of Engineering say they're better able to engineer the defects in cesium-lead-iodide solar cells that affect the compound's band gap, a critical property in solar cell efficiency.

As a side benefit, the lab's newly formulated cells can be made in open air and last for months rather than days with a solar conversion efficiency slightly above 12%. The Rice team's results were published in *Advanced Materials* , November 4, 2019.

Rice postdoctoral researcher and lead author Jia Liang and his team built and tested perovskite solar cells of inorganic cesium, lead, and iodide, the very cells that tend to fail quickly due to defects. But by adding bromine and indium, the researchers were able to quash defects in the material, raising the efficiency above 12% and the voltage to 1.20 volts.

As a bonus, the material proved to be exceptionally stable. The cells were prepared in ambient conditions, standing up to Houston's high humidity, and encapsulated cells remained stable in air for more than two months, far better than the few days that plain cesium-lead-iodide cells lasted.

https://scitechdaily.com

Hydrogen from seawater

A new study could help solve that problem by showing how hydrogen can be extracted from seawater using an electric current. The study, which was published in the journal *Nature Communications*, explains that water-splitting technologies have come a long way when it comes to getting hydrogen from freshwater, but producing the same results with seawater has presented a greater challenge.

The study was conducted by researchers at the University of Houston. They applied electric currents to water, using a process called electrolysis, with a device made of "non-noble metal nitrides." The problem with splitting seawater to extract hydrogen has been that this kind of device would typically free compounds like chlorine, calcium and sodium in the water while you're trying to get the hydrogen out. Once these compounds are freed, they attach themselves to the device and make it unusable.

To solve this problem, the researchers had to make sure the electrode was at a voltage that was high enough to separate the hydrogen but not high enough to release a compound like chlorine, which requires a voltage that is closest to the amount required to separate hydrogen. This meant keeping the voltage above 1.23 volts and below 1.73 volts, which is a bit of a challenge.

The researchers were able to do this successfully on a consistent basis and believe their methods could be used to change the hydrogen production space, since there's a lot more seawater on the planet than freshwater.

https://www.inverse.com