ASIA-PACIFIC

CHINA

Perovskite solar cells

Chinese researchers have developed a type of perovskite solar cell (PSC) with high power conversion efficiency. Perovskite solar cells have been considered one of the most promising photovoltaic technologies for low-cost power generation and high efficiency. Since the world is experiencing climate change, the United Nations has set carbon reduction goals to offset its long-term effects.

PSCs can be generally classified into two categories:n-i-p devices and inverted p-i-n devices. The p-i-n PSCs can be produced at low temperature with good stability. They are compatible with crystal silicon cellsand so are considered indispensable for achieving the development of laminated cells, according to Fang Junfeng, a Professor at the East China Normal University (ECNU).

At present, the efficiency of n-i-p perovskite cells has reached 25 percent, while the maximum efficiency of inverted p-i-n devices remains at 22 to 23 percent. The new inverted p-i-n PSCs achieve a power conversion efficiency higher than 24 percent. During illuminated operation for 1,000 hours at 55 degrees Celsius and after dark aging at 85 degrees Celsius for 2,200 hours, the p-i-n devices maintain more than 90 percent of this efficiency, according to a research article recently published in the journal *Science*.The new PSCs are developed by researchers from the ECNU and the Ningbo Institute of Materials Technology and Engineering under the Chinese Academy of Sciences.

https://news.cgtn.com

INDIA

Clean hydrogen

A group of scientists from the CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, have designed a hybrid material to simulate capturing carbon dioxidefrom non-fuel grade bioethanol in-situ (onsite) and converting it into clean hydrogen. The research details were published in the scientific journal *Chemical Engineering and Processing*.

In a first for India, the scientists developed a fluidized bed reactor (FBR) facility in Hyderabad to perform sorption enhanced steam methane reforming (SESMR) to achieve clean hydrogen in its purest form. The facility was commissioned at CSIR-IICT in January this year.The facility was commissioned under a Mission Innovation Project supported by the Department of Science and Technology, Government of India.

The FBR system measures the performance of dual-functional materials for SESMR. This method results in certain advantages for onsite carbon dioxide removal through sorbents. Itthere by over comes the equilibrium restrictions of steam reforming, leading to clean hydrogen production.The researchers conducted a thermodynamic investigation using Aspen plus models (imperative programming language to study scientific computation), which led to the discovery of two methods by which high purity hydrogen could be produced from non-fuel grade bioethanol.

The two schemes are based on the sorption process where a gas or vapor (sorbate) is captured or fixated by a substance in a condensed state (solid or liquid) called sorbent. The methods studied by the team are the chemical looping combustion (CLC) integrated process, sorption enhanced steam reforming (CLC-SESR) and sorption enhanced chemical looping reforming (CLC-SECLR).

The two schemes are energy-wise self-sustainable. The heat and power demands in the two processes are met by integrating them with heat recovery, steam generation, and power generation mechanisms. The efficiency of carbon capture achieved by the IICT scientists were99.13% and 99.58% respectively. The purity level of hydrogen obtained in the process were 99.15% and 99.71% respectively, with an energy efficiency of 39.47% and 37.30% respectively.The optimal hydrogen yield achieved by the team were97.38%, and 82.45%,demonstrating the efficacy of the above two schemes in facilitating low temperature reforming of partially distilled bioethanol of 14 mole % (34.5% by volume), with the concentration maintained at 550 degrees and 500 degrees Celsius respectively.

Earlier this year, scientists at the Indian Institute of Science Education and Research (IISER), Kolkata demonstrated a strategy to synthesize novel solid absorbents to capture and utilize carbon specifically. The group discovered particular types of nanoparticles which capture carbon dioxide in their micro and mesoporous voids.

Many research institutes across the globe are focused on studies to capture carbon and control or reduce carbon emissions. Earlier this month, a U.S.-based electric public utility company, Cleco Power, announced an allocation of $12 million to develop a carbon capture facility in Lousiana's Brame Energy Center.

https://mercomindia.com

Smart solar stove

Researchers at the Department of Electrical Engineering at the National Institute of Technology-Calicut (NITC) have designed and developed an eco-friendly smart solar stove with zero operating cost for domestic and roadside eateries.An excellent alternative cooking system, especially when prices of domestic cooking gas are rising, the smart solar stove with multiple versions has been tested for practical feasibility and is ready to be launched in the market at an affordable price, a press release stated here on Tuesday. The Department of Biotechnology of the Union Ministry of Science and Technology had funded the project. NITC Director Prasad Krishna launched the product on the campus. One of the product versions that can be used directly under the sun has a single and double stove suitable for domestic cooking. Another model, which can be employed for all types of cooking purposes, has a provision to connect an LED lamp.

The sufficient illumination will help vendors to extend their business operating

hours during night hours. Besides, this model, having a foldable solar panel, can be used by travelers and tourists. Another model has a battery with a control unit for extending the cooking time during overcast weather. V. Karthikeyan, Assistant Professor, Department of Electrical Engineering, NITC, said that the smart stove was similar to a user- friendly induction cooker. It had no thermal or electromagnetic wave radiation. Multiple safety features were added to the product, he said. S. Ashok, Chairman, Centre for Innovation and Entrepreneurship, NITC, said that a number of industries had expressed interest in securing the technology for commercial manufacture of the smart solar stove.

https://www.thehindu.com

Technology to convert diesel to alternative fuel

The Indian Institute of Technology (IIT) Delhi researchers have developed a technology which enables a diesel-powered automotive vehicle to run in flex fuel mode — the other fuel being the environment-friendly Dimethyl Ether (DME). The technology enables the transition of diesel trucks from conventional diesel to DME as an alternative fuel. The project was funded by the Department of Science and Technology (DST), Government of India.

Dimethyl Ether (DME) is one of the alternative fuels for compression ignition engines and vehicles. It can be produced from biomass, coal, industrial wastes, municipal solid wastes, black liquor (a by-product of pulp) through gasification and the Fisher-Tropsch synthesis process. It can also be produced via catalytic dehydration of methanol. DME is generally stored in liquid form, and phase change from liquid to vapor or gas could easily occur at the ambient temperature and pressure.

The technology has been developed by the researchers of the institute's Department of Energy Science and Engineering (DESE), Indian Oil Corporation (IOC)'s R&D Department, and the auto major Ashok Leyland Ltd. They have converted a diesel-powered automotive vehicle into a flex fuel vehicle on a pilot basis.

The technology produces less/negligible smoke, soot and PM emission. It has lower noise with smoother engine and overall vehicle operation. Further, it helps in the improvement in transient engine performance and enhancement of energy security, and creates a sustainable environment as there is substantial reduction in greenhouse gas emissions.

The flex fuel technology-based vehicle named DOST was jointly flagged off on April 8 at IIT Delhi by Dr Srivari Chandrasekhar, Secretary, DST;Prof Rangan Banerjee, Director, IIT Delhi; Dr SSV Ramakumar, Director (R&D), Indian Oil; Krishnan Sadagopan, Senior Vice President, Ashok Leyland; Prof. Sunil Kumar Khare, Dean R&D, IIT Delhi; and Prof KA Subramanian, Head, DESE, IIT Delhi, in the presence of other senior officials from IIT Delhi, IOC R&D Department, and Ashok Leyland.

https://www.news18.com

JAPAN

Glass-integrated BIPV module

Japan's AGC Group has developed a BIPV module consisting of laminated safety glass with embedded solar cells. The press release by the Groupstated thatthe "Sun-Joule" panel can be adapted to different building requirements. SunJoule is available with either monofacial or bifacial cells and the cell arrangement can be customized according to a client's need, the manufacturer said. The spaces between the cells can be customized from 6 mm to 30 mm.

Customers can choose between simple laminated glass and laminated insulating glass. The glass composition is determined by the manufacturer after calculations considering wind load, glass size, and the chosen support method.An interlayer film is placed between the solar cells and the glass. Each module can have a maximum size of 2,400 mm x 1,800 mm.

The product was recently used for the 3D-shaped entrance canopy of the Global Zero Emission Research Center of the National Institute of Advanced Industrial Science and Technology in Tokyo. The PV system has a power output of 6.7 kW.AGC said the solar cells embedded in the glass can effectively reduce heat transmission, as they block sunlight while harvesting solar energy. The PV devices are also said to create a comfortable space with natural light through the spaces between the cells "like sunbeams through the leaves of trees."The company said the BIPV glass has already been deployed at 215 sites since its launch in 2000.

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

NEPAL

Eco-friendly electric scooter

Nepal Academy of Science and Technology has developed an electric scooter in collaboration with the government of Lumbini province of Nepal. The preliminary version of the eco-friendly two-wheeler was launched by Pampha Bhusal, Minister of Energy, Water Resources and Irrigation, during an official event.

The innovation is viewed as significant at a time when the entire world is searching for alternatives to fossil fuels, bearing in mind their negative implications on the environment, depleting reserves and skyrocketing prices. The innovation is claimed to be appropriate in terms of the roadways in Nepal and its topography.

On the occasion, Ms. Bhusal urged NAST to seek response from the government whether the country needs to introduce internationally available technology or develop a homegrown technology for the automotive industry.

https://thehimalayantimes.com

REPUBLIC OF KOREA

Photovoltaics on railroad noise barriers

Land-scarce South Korea is currently hosting a series of initiatives aimed at deploying solar on unused surfaces. The latest development comes from the city of

Suncheon, which will test several photovoltaic railroad noise barriers based on bifacial PV modules.The project will be developed with the support of the Korea Railroad Corporation (Korail) and other government entities.

Suncheon City has been selected by the Korean Ministry of Trade, Industry and Energy (MOTIE) to host the Railway-suitable Solar Power Demonstrator for Noise Reduction project. It is a KRW 6 billion (US$4.8 million) initiative aimed at testing the deployment photovoltaic panels on railroad noise barriers.

The project will be developed with the support of the Korea Railroad Corporation (Korail) and other government entities.The installations will rely on bifacial solar modules and will be applied to noise barriers in high-speed and conventional railroads as well as on bridges. The solar modules will be adapted to the aesthetics of each side and should be resistant to pollution, the city government said in a press release.

"The foundation has been laid for the development of solar power generation on railroad sound barriers, and if the technology will become viable it will contribute to the creation of an energy-independent and carbon-neutral city," the statement read.

Scientists from the Korea Institute of Energy Research (KIER) developed last year a photovoltaic-thermal noise barrier that could be used to replace conventional soundproof walls to reduce traffic noise. Korea Hydro and Nuclear Power Co. (KHNP), a unit of Korea Electric Power Corp. (Kepco), also recently signed a memorandum of understanding with Hanmaeum Energy, a Singapore-based private equity firm owned by Affirma Capital and Duham Partners to deploy 100 MW of solar capacity on idle areas close to highways in South Korea.

In the future, the country may host one of the world's largest floating PV projects – a 2.1 GW floating solar complex - that the South Korean government is developing near the Saemangeum tidal flats, on the coast of the Yellow Sea.

https://www.pv-magazine.com

Zinc-air batteries get solar energy makeover

Researchers at the Korea Institute of Science and Technology (KIST) developed a technology to improve the electrochemical performance of zinc-air batteries by utilizing solar energy.Zinc-air batteries, which produce electricity through a chemical reaction between oxygen in the atmosphere and zinc, are considered to be the next-generation candidatesrather than lithium-ion batteries to meet the explosive demand for electric vehicles. The devices theoretically meet all required characteristics for next-generation secondary batteries, such as high energy density, low risk of explosion, eco-friendliness, and low cost of materials.

The battery developed at KITS utilizes a photoactive bifunctional air-electrocatalyst with a semiconductor structure with alternating energy levels, which significantly improves the rates of oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) that generate electricity. The photoactive bifunctional catalyst is a compound that accelerates chemical reactions by absorbing light energy and has an improved light absorption ability compared to conventional zinc-air battery catalysts.

In a zinc-air battery, which uses metal and air as the anode and cathode of the battery, OER and ORR must be alternately performed for electrical energy conversion of oxygen as the cathode active material.Therefore, the catalytic activity of the positive electrode current collector, made of carbon material, is an important factor in determining the energy density and overall cell efficiency of zinc-air batteries.

Accordingly, the research team focused on the p-n heterojunction, the basic structural unit of solar cells and semiconductors, as a measure to improve the slow catalytic activity of zinc-air batteries. The goal was to accelerate the oxygen production-reduction process by using the interface characteristics of semiconductors in which electron movement occurs. To this end, a cathode material with a heterojunction bandgap structure was synthesized, with an n-type semiconductor.

In addition, an experiment was conducted under real-world conditions without light in order to confirm the commercial potential of the photoactive bifunctional catalyst with a p-n heterojunction structure with alternating energy levels. The prototype battery showed an energy density of 731.9 mAh gZn-1, similar to the best energy efficiency performance of existing zinc-air batteries.

In the presence of sunlight, the energy density increased by about 7% up to 781.7 mAh gZn-1 and it showed an excellent cycle performance of 334 hours at1,000 cycles, the best among known catalysts.

https://www.mining.com

Green hydrogen production

Researchers have developed a new photoelectrode structure that is used for the production of green hydrogen which does not involve any fossil fuel during its creation process. The new structure allows the electrode to have 400 percent more efficiency than current photoelectrodes.

A photoelectrode is a semiconductor that absorbs solar energy to initialize electrochemical transformations. The electrode dissociates water molecules into hydrogen and oxygen. Because the photoelectrode uses sunlight as its main energy source, the semiconductor is perfect for the production of green hydrogen which relies on renewable energy for its production. Normally, a photoelectrode is created by embedding self-assembled nanopillars in a semiconductor film, without regarding the detailed structure of the stacked material. Such production methods lead to a lowered efficiency of electrical charge collection.

The National Research Foundation of Korea (NRF) stated that a joint team involving researchers from NRF, Ajou University, and Stanford University developed a photoelectrode with a dual-textured heterostructure. Researchers said that the new semiconductor has a largersurface area for the production of hydrogen compared to conventional electrodes. The larger the surface area, the more effective the electrode becomes.

"This research has a meaning as it suggested a new idea to the field of dual-textured heterostructures," Ajou University researcher Cho In-sun said in a statement on April 5. The research paper was published in *Chemical Engineering Journal*, an international scientific journal.

https://www.ajudaily.com

SINGAPORE

Efficiency record for solar cell technology

A team of researchers from the National University of Singapore (NUS) has set a new record in terms of the power conversion efficiency of solar cells made using perovskite and organic materials. This technological breakthrough paves the way for flexible, light-weight, low cost and ultra-thin photovoltaic cells which are ideal for powering vehicles, boats, blinds and other applications.

"Technologies for clean and renewable energy are extremely important for carbon reduction. Solar cells that directly convert solar energy into electricity are among the most promising clean energy technologies. High power conversion efficiency of solar cells is critical for generating more electrical power using a limited area and this, in turn, reduces the total cost of generating solar energy," explained lead researcher Presidential Young Professor Hou Yi, who is from the NUS Department of Chemical and Biomolecular Engineering and also leads the "Perovskite-based Multi-junction Solar Cells Group" at the Solar Energy Research Institute of Singapore at NUS.

"The main motivation of this study is to improve the power conversion efficiency of perovskite/organic tandem solar cells. In our latest work, we have demonstrated a power conversion efficiency of 23.6% - this is the best performance for this type of solar cells to date," added Dr Chen Wei, Research Fellow at the NUS Department of Chemical and Biomolecular Engineering and the first author of this work.

This achievement is asignificant leap from the current power conversion rate of about 20% reported by other studies on perovskite/organic tandem solar cells, and is approaching the power conversion rate of 26.7% of silicon solar cells, which is the dominating solar technology in the current solar photovoltaic (PV) market. This innovation was published in *Nature Energy* on 20 January 2022. The research was conducted in collaboration with scientists from the University of Hong Kong, China and Southern University of Science and Technology, also in China.

In their latest project, Assistant Professor Hou and his team break new ground in the field of perovskite/organic tandem solar cells. Their discovery opens the doors to thin-film tandem solar cells that are light and bendable, which could have wide-ranging applications such as solar-powered blinds, vehicles, boats and other mobile devices.

A tandem solar cell comprises two or more subcells electrically connected using interconnecting layers (ICLs). The ICL plays a critical role in determining the performance and reproducibility of a device. An effective ICL should be chemically inert, electrically conductive and optically transparent.

Although perovskite/organic tandem solar cells are attractive for next-generation thin-film photovoltaics, their efficiency lags behind other types of tandem solar cells. To address this technological challenge, Asst Prof Hou and his team developed a novel and effective ICL that reduces voltage, optical and electrical losses within the tandem solar cell. This innovation significantly improves the efficiency of the perovskite/organic tandem solar cells, achieving a power conversion rate of 23.6%.

https://www.newswise.com

Biodegradable batteries

A team of scientists at the Nanyang Technological University (NTU) in Singapore have developed paper-thin biodegradable zinc batteries in an attempt to find a sustainable option for powering flexible and wearable electronic systems.

The paper-thin zinc batteries are made of electrodes that are screen printed onto both sides of a piece of cellulose paper which is then reinforced with hydrogel. The thickness of the battery is around 0.4mm, which is roughly the thickness of two strands of human hair. As the printed paper items are extremely thin and non-toxic, they do not require aluminium or plastic casings or packaging to encapsulate the battery components. Also, avoiding the packaging layers enables the battery to store a higher amount of energy, and thus power, within a smaller system. Once the battery reaches the end of its usable life, it can be buried in the soil, where it breaks down completely within a month.

According to the *Journal of Advanced Science*, the NTU research team used a 1.5 in x 1.5 inches (4 cm x 4 cm) square printed paper battery to successfully power a small electric fan for up to 45 minutes. The researchers also pointed out that even bending or twisting the battery did not affect the power supply.

Also, in another experiment they used a 4cm x 4cm battery to power an LED where it remained lit even after cutting away parts of the paper battery. The research team opined that their biodegradable paper-thin batteries could be used for flexible electronics such as wearables and foldable smartphones. They could also be used in biomedical sensors for health monitoring. It could also solve the issue of finding batteries of the right size.

https://www.thebetterindia.com

THAILAND

Floating solar farm

Renewables firm BayWar.e. has worked with one of Thailand's leading manufacturers and distributors of processed cassava products – Ubon Bio Ethanol PCL (UBE) - to set up its first floating solar platform in UbonRatchathani, The Floating Photovoltaic farm, often termed "floatovoltaic", is expected to generate 2.83 MW or about 4,440 MWh of energy in the first year of operation alone. The project started supplying electricity as Commercial Operation Date (COD) in early 2022 and it is the first floating solar cell platform project operate as Corporate PPA in Thailand.

Two floating platform technologies have been deployed over two ponds, with one using a pure pontoon technology and the other deployed with a pontoon and metal support structure floating technology.In addition, the project is made up of 6,900 units of bifacial PV modules and a bespoke Medium Voltage SKID being engineered for the floating farms.

"This project with UBE in UbonRatchathani sets the stage for more floating solar opportunities not only in Thailand but beyond for BayWar.e. Many countries and urban cities in Asia face issues with land scarcity and as such, we are constantly looking at innovative and new ways to adapt, providing solutions that work locally driven not only at the government level, but also complemented by private sector led initiatives." said Daniel Gaefke, APAC Director, BayWar.e.In developing its floatovoltaic farm, BayWar.e. was selected as UBE's partner because of the firm's successful track record globally and in the region.

"Sustainability is important to UBE for both social and environmental dimensions, and it is our mission to be responsible corporate citizens. The solar floating farm in UbonRatchathani is one of many renewable energy projects we have done as we place more emphasis on sustainable operations and the use of clean energy. Furthermore, waste from the production process is used to create renewable energy. In total, we are now generating more than 10 MWh in electricity alone from renewable energy. UBE is passionate and ambitious about our sustainability initiatives and is targeting to operate on 100% green energy."

The project in Ubon Ratchathani, with UBE, represents BayWar.e.'s desire to partner with corporations and government agencies in Thailand and around the region to work on clean energy projects. Working with UBE on the floatovoltaic farm in Ubon marks BayWar.e.'s first floating solar project outside of Europe and the first in Asia Pacific, with more upcoming projects in thepipeline, including a few in Asia Pacific.

https://www.pv-magazine.com

EUROPE

GERMANY

New record for solar cell efficiency

A German research team has developed a tandem solar cell that reaches 24 percent efficiency – measured according to the fraction of photons converted into electricity (i.e. electrons). This sets a new world record in terms of the highest efficiency achieved so far with this combination of organic and perovskite-based absorbers. The solar cell was developed by Professor Dr. Thomas Riedl's group at the University of Wuppertal together with researchers from the Institute of Physical Chemistry at the University of Cologne and other project partners from the Universities of Potsdam and Tübingen as well as the Helmholtz-Zentrum Berlin and the Max-Planck-Institut für Eisenforschng in Düsseldorf. The results have been published today (April 13, 2022) in *Nature* under the title"Perovskite/organic tandem solar cells with indium oxide interconnect."

Conventional solar cell technologies are predominantly based on the semiconductor silicon and are now considered to be"as good as it gets."Significant improvements in their efficiency – i.e., more watts of electrical power per watt of solar radiation collected – can hardly be expected. That makes it all the more necessary to develop new solar technologies that can make a decisive contribution to the energy transition. Two such alternative absorber materials have been combined in this work. Here, organic semiconductors, which are carbon-based compounds that can conduct electricity under certain conditions, were used. These were paired with a perovskite, based on a lead-halogen compound, with excellent semiconducting properties. Both of these technologies require significantly less material and energy for their production compared to conventional silicon cells, making it possible to make solar cells even more sustainable.

As sunlight consists of different spectral components, i.e. colors, efficient solar cells have to convert as much of this sunlight as possible into electricity. This can be achieved with so-called tandem cells, in which different semiconductor materials are combined in the solar cell, each of which absorbs different ranges of the solar spectrum. In the current study the organic semiconductors were used for the ultraviolet and visible parts of the light, while the perovskite can efficiently absorb in the near-infrared. Similar combinations of materials have already been explored in the past, but now the research team succeeded in significantly increasing their performance.

At the start of the project, the world's best perovskite/organic tandem cells had an efficiency of around 20 percent. Under the leadership of the University of Wuppertal, the Cologne researchers, together with the other project partners, were able to increase this value to an unprecedented 24 percent. "To achieve such high efficiency, the losses at the interfaces between the materials within the solar cells had to be minimized," said Dr. Selina Olthof of the University of Cologne's Institute of Physical Chemistry. "To solve this problem, the group in Wuppertal developed a so-called interconnect that couples the organic sub-cell and the perovskite sub-cell electronically and optically."

As interconnect, a thin layer of indium oxide was integrated into the solar cell with a thickness of merely 1.5 nanometres to keep losses as low as possible. The researchers in Cologne played a key role in assessing the energetic and electrical properties of the interfaces and the interconnect in order to identify loss processes and further optimize the components. Simulations by the group in Wuppertal showed that tandem cells with an efficiency of more than 30 percent could be achieved in the future with this approach.

https://scitechdaily.com

SWEDEN

New energy storage system

Researchers from Sweden's Chalmers University of Technology designed an energy system that stores solar energy in liquid

form for up to 18 years, a press statement reveals. With the help of scientists from China›s Shanghai Jiao Tong University, the Chalmers team has tested its device, called the Molecular Solar Thermal system (MOST), by connecting it to a thermoelectric generator, proving that it can produce electricity on-demand. The Chalmers team has been working on its technology for more than a decade, and it believes it may soon be a viable option for charging low-power electronics devices.

The system was designed using specially-developed molecules of carbon, hydrogen, and nitrogen. When these are hit by sunlight, the atoms within the molecules are rearranged, turning them into an energy-rich isomer that's stored in liquid form. Impressively, the researchers say their system stores energy in this liquid form for up to 18 years. It is then released using a special catalyst that returns the molecules to their original shape, releasing the stored energy as heat.

The Chalmers researchers collaborated with scientists from China's Shanghai Jiao Tong University, who brought a thermoelectric generator to the table. This allowed them to produce a small amount of electricity, though the collaborators believe this could be improved by future models.

"The generator is an ultra-thin chip that could be integrated into electronics such as headphones, smart watches, and telephones," said researcher Zhihang Wang from the Chalmers University of Technology. "So far, we have only generated small amounts of electricity, but the new results show that the concept really works. It looks very promising."

According to research leader Kasper Moth-Poulsen, Professor at the Department of Chemistry and Chemical Engineering at Chalmers, the MOST system "means that we can use solar energy to produce electricity regardless of weather, time of day, season, or geographical location. It is a closed system that can operate without causing carbon dioxide emissions."

The proof of concept's current output stands at a relatively small 0.1 nW, though the researchers say their system could be used to address the issue of solar energy being intermittent by storing energy for months on end and deploying it just when it›s needed. A finished model could be used to power small electronic devices. Next, the Chalmers team aims to improve their system's performance and also are also working on building an affordable commercial version of their system that could potentially be used in homes.

https://interestingengineering.com

UK

Hydrogen fuel cell

Scientists at Imperial College London have engineered a hydrogen fuel cell that utilizes iron rather than rare and expensive platinum, allowing better application of the technology. Hydrogen fuel cells transform hydrogen into electricity with water vapor being the sole by-product, rendering them an appealing green substitute for portable power sources, especially for vehicles.Nevertheless, their extensive use has been hindered partly by the cost of one of the main parts. To enable the reaction that generates the electricity, the fuel cells depend on a catalyst composed of platinum, which is costly and rare.

Currently, a European team directed by scientists at Imperial College London has developed a catalyst using just iron, nitrogen and carbon — materials that are inexpensive and easily available — and shown that it can be used to operate a fuel cell at high power. Their outcomes are reported in the journal *Nature Catalysis*.

The team's innovative goal was to create a catalyst where all the iron was spread as single atoms inside an electrically conducting carbon matrix. Single-atom iron possesses more diverse chemical properties than bulk iron, where all the atoms are crowded together, making it additionally reactive.These properties will enable the iron to boost the reactions desirable in the fuel cell, serving as a good alternative for platinum. In laboratory trials, the researchers demonstrated that a single-atom iron catalyst has a performance close to that of platinum-centered catalysts in an actual fuel cell system.

Besides creating an inexpensive catalyst for fuel cells, the technique the researchers formulated could be adjusted for other catalysts in other processes, for example, chemical reactions utilizing atmospheric oxygen as a reactant rather than costly chemical oxidants, and in wastewater treatment using air to eliminate harmful pollutants.

The researchers worked together with UK fuel cell catalyst producer Johnson Matthey to test the catalyst in suitable systems. They hope to expand their new catalyst's scope, so that it can be employed in commercial fuel cells. For the time being, they are aiming to enhance the stability of the catalyst, so that it equals platinum in both durability and performance.

https://www.azocleantech.com

Ultra-thin solar panels

A team of researchers from the University of Surrey and Imperial College London collaborated with Amsterdam's research institute AMOLF to develop a method to help achieve a 25% increase in energy levels absorbed by wafer-thin solar photovoltaic (PV) panels.The researchers claim that their solar panels, just one micrometer thick (1µm), convert light into electricity more efficiently than others due to their thinness and pave the way towards making it easier to generate more clean, green energy.

In the paper published in the American Chemical Society's (ACS) journal *Photonics*, the team demonstrates the power of hyperuniform disordered (HUD) patterns for lightweight, flexible, and efficient PVs by focusing on the absorption properties in ultrathin (1 µm) silicon.

The HUD pattern consists of a two-dimensional network of silicon walls resembling the underlying honeycomb structure in black butterfly wings. The current 3D nanophotonic wafer designs can only prevent light reflection via impedance matching of the solar cell, but it fails to extend the light paths in silicon cells required for photon absorption.

Dr. Marian Florescu from the University of Surrey's Advanced Technology Institute (ATI) said, "One of the challenges of working with silicon is that nearly a third of light bounces straight off it without being absorbed and the energy harnessed. A textured layer across the silicon helps tackle this, and our disordered yet hyperuniform honeycomb design is particularly successful."

Hyperuniform disordered media are isotropic (having the same properties in all directions) and possess constraint randomness — such that the density fluctuations on large scales behave more like those of ordered solids. HUDs are highly flexible mediums to control light transport, emission, and absorption in unique ways.In the study, the research team achieved light absorption in a 1 micrometer (~1 µm) thick silicon slab, over twofold in the wavelength range from 400 to 1000 nm when textured with optimized HUD patterns compared to slabs that are without patterns.

The level of absorption obtained is the highest demonstrated until now in a silicon slab as thin as one micrometer. To achieve this, researchers pursued the approach of k-space engineering (an array of numbers representing spatial frequencies in the MR image) of HUD patterns with a tailored scattering spectrum and diffractive coupling of solar irradiation into guided modes of the silicon slab.

The team focused on the trade-off between light trapping and increased carrier recombination shownby the nanostructures. On investigation, they discovered that efficiencies above 20% could be obtained for several optimized HUD designs and state-of-the-art silicon PV technologies.The team used the diffraction approach in the absorber to enhance light trapping into the ultrathin photovoltaic. Guided modes of thin silicon slab tend to become leaky (quasi-guided) in the presence of textures, which can in and out couple to the electromagnetic modes supported by the surrounding medium. Total absorption is achieved by summing the coupling contributions of each mode.

To maximize the sunlight absorption in the slab, the team efficiently coupled the loose modes for wavelengths ranging from 350 nm to 1100 nm. Due to several modes in a one µm silicon slab, a pattern structure that diffracts incident light to the range from ~15µm to ~20µm raise to minus one ensures all sunlight has a mode to couple to. The team decorated the two-dimensional HUD point pattern with 200 nm tall silicon walls following a Delaunay tessellation protocol (fundamental computational geometric structure) that forms a continuous silicon network.

However, the light absorption with the two-phase design was no longer expected to be optimal as the 3D texture strongly disrupted the wavelengths of the silicon slab. Researchers then considered the power spectral density (PSD), which is the Fourier transform of the 2D design, to represent scattering strength better. The tessellation protocol causes the resulting 3D network to become nearly hyperuniform.

The team successfully demonstrated light trapping in the thinnest silicon slab by decorating the point pattern with two materials in a wall network fashion.In the laboratory, absorption rates of 26.3 mA/cm2 were achieved, a 25% increase from the previous record of 19.72 mA/cm2 in 2017. They secured an efficiency of 21% but anticipate that further improvements will push the figure higher, resulting in significantly better efficiencies than many commercially available photovoltaics.

Besides improving solar power generation, the findings could also benefit other industries where light management and surface engineering are crucial, such as photo-electrochemistry, solid-state light emission, and photodetectors.

https://mercomindia.com

Rigid and flexible solar modules

A group of researchers at Dartmouth College in New Hampshire, USA, have developed a new flexographic printing method that can help manufacture Perovskite solar cells quickly and reliably. This new technique brings inexpensive mass printing of solar cells closer to reality. Perovskites are materials that have the same crystal structure as the mineral calcium titanium oxide, which was the first-discovered perovskite crystal.

These materials have shown potential for high performance and low production costs when used to create solar cells. The researchers documented their findings in a study titled, "Eliminating the Perovskite Solar Cell Manufacturing Bottleneck via High-Speed Flexography," published in *Advanced Materials Technologies*.The authors of the paper are Julia Huddy, a third-year PhD student at Dartmouth;Youxiong Ye,a former postdoctoral researcher at the university and is now working as a metallurgist at an American steel corporation, and William Scheideler, Assistant Professor of Engineering at the university.

Currently, all the commercially produced solar panels use solar cells made from silicon which must be processed to very high purity. This energy-intensive process uses large amounts of hazardous solvents and is also very expensive. In comparison, these perovskite cells are made of layers of minuscule crystals made of low-cost light-sensitive materials. The raw materials can be mixed into a liquid to form a kind of ink that can be printed onto many different kinds of materials.

The new printing method developed by the engineers at the Dartmouth Engineer combines high-speed flexography, where ink is applied to various surfaces using flexible printing plates, and sol-gel inks composed of perovskite crystals. This accelerates the processing time of the material by 60 times, according to the study.

https://indianexpress.com

NORTH AMERICA

USA

Solar panels that work at night

Researchers at Stanford modified commercially available solar panels to generate a small amount of electricity at night by exploiting a process known as radiative cooling, which relies on, no lie, the frigid

vacuum of space. The research was published in early April 2022 in *Applied Letters in Physics*.

"We tend to think of the sun as the important renewable energy resource," said Shanhui Fan, the lead researcher on the project. "The coldness of outer space is also an extremely important renewable energy resource."While the modified panels generate a tiny amount of energy compared with what a modern solar panel does during the day, that energy could still be useful, especially at night when energy demand is much lower, the researchers said.Technically speaking, the modified solar panels don't generate solar electricity at night. Instead of exploiting sunlight (or starlight or moonlight, which still doesn't work), the researchers added technology that exploits radiative cooling.

When an object is facing the sky at night, it radiates heat out to outer space, which means that an object can become cooler than the air temperature around it. This effect could have obvious applications in cooling buildings, but the difference in temperature can also be used to generate electricity.

Fan, a professor of electrical engineering, and his fellow researchers added technology to a commercial solar panel that could do just that and were able to generate a small amount of electricity at night. The modified panel generated 50 milliwatts per square meter at night. While that's much more than previous iterations of this technology, it's well below what a commercial solar panel can produce during the day. One back-of-the-envelope calculation returns close to 200 watts per square meter for one commercial solar panel.

"So, this is significantly lower," Fan said. "But it may potentially be useful for some of the low power density applications." That might include nighttime lighting, charging devices, and keeping sensors and monitoring equipment online, Fan said.Fan says that the modifications were made to commercial solar panels, which means the technology could be widely deployed. He also said that by improving the design, more electricity could be generated.

There are still a lot of questions to be answered before any commercial application can be rolled out, Geoff Smith, emeritus professor in applied physics at The University of Technology Sydney, wrote in an email response to questions. Smith, who was aware of the research but not involved, has doubts that it ever will be an economically viable source of energy."Adding complexity and avenues for degradation to renewable energy systems despite being scientifically interesting rarely makes it in practice," he wrote.

In response, Fan says that the research proves that you can generate electricity in this way, and it wasn't meant to prove anything about future practical applications. Still, Smith agrees that greater attention should be paid to outer space as a renewable energy source. In his view, cooling and other modes of electricity generation are more promising, but the night sky is indeed a valuable avenue for shifting energy use.Even if it's not yet producing a lot of electricity, radiative cooling is pretty much ubiquitous.

https://www.cnet.com

AI to help scale up solar cell manufacturing

Perovskites are a family of materials that are currently the leading contenders to potentially replace today's silicon-based solar photovoltaics. They hold the promise of panels that are far thinner and lighter, that could be made with ultra-high throughput at room temperature instead of at hundreds of degrees, and that are cheaper and easier to transport and install. But bringing these materials from controlled laboratory experiments into a product that can be manufactured competitively has been a long struggle.

Manufacturing perovskite-based solar cells involves optimizing at least a dozen or so variables at once, even within one particular manufacturing approach among many possibilities. But a new system based on a novel approach to machine learning could speed up the development of optimized production methods and help make the next generation of solar power a reality.

The system, developed by researchers at MIT and Stanford University over the last few years, makes it possible to integrate data from prior experiments, and information based on personal observations by experienced workers, into the machine learning process. This makes the outcomes more accurate and has already led to the manufacturing of perovskite cells with an energy conversion efficiency of 18.5 percent, a competitive level for today's market.

The research is reported today in the journal *Joule*, in a paper by MIT professor of mechanical engineering TonioBuonassisi, Stanford professor of materials science and engineering Reinhold Dauskardt, recent MIT research assistant Zhe Liu, Stanford doctoral graduate Nicholas Rolston, and three others.

Perovskites are a group of layered crystalline compounds defined by the configuration of the atoms in their crystal lattice. There are thousands of such possible compounds and many different ways of making them. While most lab-scale development of perovskite materials uses a spin-coating technique, that's not practical for larger-scale manufacturing, so companies and labs around the world have been searching for ways of translating these lab materials into a practical, manufacturable product.

"There's always a big challenge when you're trying to take a lab-scale process and then transfer it to something like a startup or a manufacturing line," says Rolston, who is now an assistant professor at Arizona State University. The team looked at a process that they felt had the greatest potential, a method called rapid spray plasma processing, or RSPP.

The manufacturing process would involve a moving roll-to-roll surface, or series of sheets, on which the precursor solutions for the perovskite compound would be sprayed or ink-jetted as the sheet rolled by. The material would then move on to

a curing stage, providing a rapid and continuous output"with throughputs that are higher than for any other photovoltaic technology," as per Rolston.

https://news.mit.edu

Plant-based jet fuel

Researchers at Washington State University announced the development of a plant-based jet fuel that could displace petroleum-derived fuels. Based on lignin, an organic polymer in plants, the WSU jet fuel was tested for its energy density, fuel efficiency and emissions. The results, the WSU team says, suggest their fuel, when combined with other bio-fuels, could serve as a 100% drop-in replacement.

According to Bin Yang, professor with WSU's Department of Biological Systems Engineering and co-author of a study recently published in the journal *Fuel*, the lignin-based fuel displayed increased energy density and could totally replace aromatics.

"Aromatics are associated with increased soot emissions, as well as contrails, which are estimated to contribute more to the climate impact of aviation than carbon dioxide," said Joshua Heyne, co-author, University of Dayton scientist and current co-director of the joint WSU-Pacific Northwest National Laboratory Bioproducts Institute.

"Aromatics are still used in fuel today because we do not have solutions to some of the problems they solve: they provide jet fuel with a density that other sustainable technologies do not," he added. "Most unique is their ability to swell the O-rings used to seal metal-to-metal joints, and they do this well."

Yang developed a patented process that turns lignin from agricultural waste into bio-based lignin jet fuel. Such sustainable fuel, the researchers say, could help the aviation industry reduce dependance on increasingly expensive fossil fuels while meeting higher environmental standards. Additional contributors to the study include Zhibin Yang, University of Dayton; Zhangyang Xu and Maoqi Feng, WSU; John Cort, Pacific Northwest National Laboratory; and RafalGieleciak, Natural Resources Canada.

Yang and his team's research has been supported by the DARPA through the U.S. Department of Defense, the U.S. Department of Energy, the National Science Foundation, the U.S. Department of Transportation, the National Renewable Laboratory, the Joint Center for Aerospace Technology Innovation and WSU's Bioproducts, Science and Engineering Laboratory.

https://www.design-engineering.com

Device to convert heat into electricity

Most of the world's electricity today is produced by burning coal or natural gas to boil water and create steam for spinning turbines. In a paper published in *Nature*, researchers have now reported a solid-state device with no moving parts that can convert heat into electricity with an efficiency higher than that of steam turbines.The breakthrough could lead to an affordable and low-maintenance thermal battery system for storing renewable energy on the grid.

The new device, which its developers at MIT and the National Renewable Energy Laboratory call a heat engine, is a thermophotovoltaic (TPV) cell. Just like solar cells convert sunlight into electricity, TPV cells are made of materials that can convert infrared radiation from heat sources into electricity. The efficiency of these cells so far has hovered around 32 percent because they operate at lower temperatures.

By combining two different metal alloy layers, the researchers have made a device that harnesses heat from white-hot sources at temperatures of 1,900 to 2,400°C. The top layer absorbs the highest-energy infrared waves, while the lower layer captures lower-energy radiation. A mirror at the bottom of the device reflects any unabsorbed heat back to the heat source, so that it can be reused.

A 1cm x 1cm prototype device made by the researchers was able to produce electricity with 40 percent efficiency. By contrast, the average steam turbine has an efficiency of around 35 percent.With better reflectors the TPV efficiency could go up to 50 percent, the team says. Plus, what gives TPVs added advantage over steam engines is also "the potential for lower cost, faster response times, lower maintenance, ease of integration with external heat sources and fuel flexibility."

For a grid-scale thermal battery, the team envisions a system in which surplus electricity from wind or solar farms could be stored in insulated banks of materials such as graphite. When the grid needs power, TPVs could convert the stored heat into electricity and send it to the grid. Such a large-scale system would need TPV cells that are 10,000 square feet in size, or about a quarter of a football field. But Henry points out that the existing infrastructure for making large-scale photovoltaic cells could be adapted to manufacture TPVs.

https://www.anthropocenemagazine.org