ASIA-PACIFIC

AUSTRALIA

Low cost solar technologies

Commonwealth Scientific and Industrial Research Organisation (CSIRO) is part of a consortium that's working to develop a series of low-cost solar technologies to help meet the rising energy demand across the world. The Victorian Organic Solar Cell (VICOSC) Consortium is a research collaboration between CSIRO, Monash University, the University of Melbourne, Bluescope Steel, Innovia Films, Innovia Security and Robert Bosch SEA, with funding support from the Victorian State Government and the Australian Government through the Australian Renewable Energy Agency.

The consortium has developed flexible and lightweight printable solar cells, wherein printable 'solar inks' are deposited onto flexible plastic films using various techniques including spray coating, reverse gravure, slot-die coating and screen printing. Offering greater flexibility and affordability, these technologies are different from traditional, silicon-based solar cells. Being lightweight and flexible, solar panels can be integrated into windows, window furnishings, rooftops and even consumer packaging. Being affordable, these solar cells can provide for the energy needs of remote outback locations and developing communities.

Pilot-scale production is now ready for expansion. New organic materials and solar cell device architectures have been developed to achieve power conversion efficiencies of around 9 per cent on small-scale devices. The consortium's pilot-scale, roll-to-roll printing lines have successfully fabricated 10 x 10 centimetre flexible solar modules, while larger solar modules up to A3 size are also being printed.

Further development into hybrid organic-inorganic solar inks has significantly advanced the performance of large-area printed solar cells. The consortium can now produce pilot-scale quantities for incorporation into a wide range of prototypes. The low barriers to entry mean this technology can provide new opportunities for Australian manufacturing, opening up new markets and new jobs.

http://www.architectureanddesign.com.au

New record for solar cell efficiency

Researchers from the University of New South Wales (UNSW) in Australia has achieved an efficiency record of 12.1% for a 16cm^2 perovskite solar cell, the largest cell of its kind. Confirmed by the international testing centre Newport in Bozeman, Montana, the result sets a new world efficiency record for the perovskite photovoltaic cell certified with the highest energy conversion efficiency. Led by the Australian Centre for Advanced Photovoltaics (ACAP) senior research fellow Dr Anita Ho-Baillie, the team also achieved an 18% efficiency rating on a 1.2cm^2 single perovskite cell, and an 11.5% for a 16cm^2 four-cell perovskite mini-module. The cell is said to be 10 times larger than the current certified high-efficiency perovskite cells on record.

Ho-Baillie said: "This is a very hot area of research, with many teams competing to advance photovoltaic design. "Perovskites came out of nowhere in 2009, with an efficiency rating of 3.8%, and have since grown in leaps and bounds. "These results place UNSW among the best groups in the world producing state-of-the-art high performance perovskite solar cells. And I think we can get to 24% within a year or so."

The team is currently working to increase the efficiency of the perovskite solar cell efficiency to 26%. ACAP director and Ho-Baillie's mentor Martin Green said: "We will capitalize on the advantages of perovskites and continue to tackle issues important for commercialization, like scaling to larger areas and improving cell durability." UNSW said that the research is supported by $3.6m funding through the Australian Renewable Energy Agency's (ARENA) 'solar excellence' initiative.

http://solar.energy-business-review.com

CHINA

Ultra-efficient solar cells

Researchers in Hong Kong have taken a new type of solar cell developed in Japan to the next level of efficiency, opening the door to a wide range of applications. Perovskite solar cells, as they are called, use a thin film of perovskite crystal that combines metal atoms, such as lead, and organic substances containing elements such as bromine, to generate current. These cells can be produced cheaply and easily using printing technology to apply the material to a substrate or other object.

In 2009, researchers at Japan's Toin University of Yokohama confirmed that a thin film of perovskite crystal can function as a solar cell. The power conversion efficiency was initially less than 5% but was increased to over 10% in 2012. Researchers and companies around the globe have since been racing to achieve higher efficiency levels. Among them is a group of researchers led by Hong Kong Polytechnic University professor Charles Chee Surya. His team came up with perovskite-silicon tandem solar cells. A perovskite solar cell functions as the top layer, harvesting short-wavelength light, while the silicon-coated bottom layer absorbs long-wavelength light. The two layers enable the module to achieve a power conversion efficiency of 25.5%, the highest in the world for a perovskite cell, according to Surya. The previous highest rate was 22.8%, achieved by a Swiss team.

Perovskite cells are not only versatile, Surya's group also estimates that their power generation costs will be about 30% lower than those of conventional silicon cells. "The market for perovskite solar cells is going to grow quite substantially in the future," Surya said. He explained that the cells can be applied to a wide range of products, including wearable devices and sensors for home appliances. But there are safety and durability problems that must be overcome before perovskite solar cells can be put to widespread use. One concern is the use of lead, which is tightly regulated in much of the world. The decline in power conversion efficiency seen after just a few days is another hurdle to practical application.

http://asia.nikkei.com

Green biodiesel production

Biofuel is a natural and renewable diesel engine fuel derived from biological

materials, such as plant oils and animal fats. However, the purification of traditional liquid biodiesel catalyst generates a huge amount of wastewater. Hong Kong Polytechnic University (PolyU) researchers have thus adopted precise surface chemistry engineering to develop a new class of solid catalyst for use in biodiesel production.

This new Catalyst for Green Biodiesel can be synthesized in one step from low-grade unrefined feedstock such as waste cooking oil, with no aqueous treatment steps required. Ethanol or propanol extracted from plants can also be used to replace methanol in the synthesis to avoid the usual intense reliance on petroleum. With high catalytic activity, the catalyst can operate at significantly lower temperatures and pressures than existing solid biodiesel catalysts, and be reused more than 30 times. It is most certainly a clean, energy-saving and cost-effective innovation.

http://www.scmp.com

INDIA

Fuel from wastewater

The researchers at Indian Institute of Technology (IIT) - Kharagpur are generating the gas from distillery wastewater. This process will have a two-pronged effect: hydrogen production and bioremediation of the waste water, said Debabrata Das, faculty of the biotechnology department, who is leading the research. A bioreactor with a 10 meter cube volume has been installed at IIT Kharagpur to produce hydrogen continuously from distillery effluent. "This gas can also be used in the fuel cell directly to generate 52kwh of electricity that can light up an entire village," Das said.

"Hydrogen is found to be suitable as a fuel in vehicles and all major automobile companies are in competing to build hydrogen fuel automobiles in the near future. The humnngous rise in energy consumption by 2030 would require an alternative fuel resource with highest energy density . Hydrogen fulfils this criterion. Hydrogen is being considered as a `fuel for the future' because it has the highest energy density of 143kJg," Das explained.

The ministry of renewable energy in its "National Hydro gen Energy Road Map" has projected that by 2020, one million hydrogen-fuelled vehicles would be on Indian roads and 1,000MW of hydrogen-based power generating capacity would be set up in the country. It has entrusted IIT Kharagpur with the responsibility of reaching that goal as soon as possible.

http://timesofindia.indiatimes.com

Biofuel from aquatic weeds

Scientists at Indian Institute of Technology (IIT) – Kharagpur have unlocked the secret to ramp up yields of biofuel sourced from commonly found aquatic weeds such as water hyacinths. In a new study published on December 1 in Nature Scientific Reports, researchers have shown that this weed — which contains up to 50 percent hemicelluloses — can now be used as an economic and abundant source of biofuel.

"We show that the secret to rapidly producing soluble sugars from amorphous natural polymers such as hemicelluloses lies in their smallest scale-the pores," said Saikat Chakraborty, faculty member at the Department of Chemical Engineering and lead researcher of the Bioenergy Research Group at IIT – Kharagpur. Chakraborty and co-author Sajal Kanti Dutta have uncovered the pore-scale phenomena that result in "fourfold increase in the yields of fermentable sugars and bioethanol" from hemicelluloses.

"It turns out that three quarters of the soluble sugars we obtain for generation of bioethanol are produced from the pore-scale reactions. So increasing the polymer's porosity and degree of swelling will enhance the deconstruction of hemicelluloses from plant cell walls, thus increasing bioethanol," the authors said.

Hemicelluloses are the second most abundant natural polymer on earth — after cellulose — and a new technology engendered from this pore-scale phenomena could rapidly produce biofuels from locally available plant sources, added Chakraborty. Apart from water-hyacinth, hemicellulose-based bioethanol can also be produced from commonly available grasses, red and green algae, etc., which have 2.5 to 3 times more hemicellulose than cellulose. Scientists at the institute's chemical engineering department and PK Sinha Centre for Bioenergy are now working to transform these fundamental insights into new biofuel technologies that would help fight climate change.

http://tech.firstpost.com

Solar model for paddy harvesting

The final year automobile engineering students of Rajiv Gandhi Government Polytechnic, India, have developed a low cost-lightweight, environment-friendly manually operated solar paddy harvester (MOSPH) suitable for small farmers. The model has been developed under the guidance of in-charge, head of department, D Devarasiddappa. "The entire power source is packed and placed inside a bag. The harvester can be operated easily with power source unit carried on shoulder," Devarasiddappa said here.

The added advantage of the system is that it can also be used for domestic lighting when not being used for harvesting, he said. The overall cost of the developed model is approximately Rs. 14000. Unlike conventional paddy harvesters that require fossil fuel, MOSPH utilizes abundantly available solar energy to produce the required electrical energy to operate the paddy harvester. The model would be displayed at National Innovation Talent Contest for Polytechnics (NITCP) at NITTTR, Kolkata which is being sponsored by Sir Dorabji Tata Trust, Mumbai.

http://energy.economictimes.indiatimes.com

Solar energy to preserve seasonal produce

A Mumbai-based start-up has used solar energy to preserve seasonal produce, helping prevent undernourishment among rural women and women farmers. All that S4S Technologies (Science for Society) did was provide solar conduction dryers, which dehydrate vegetables and fruits, to 230 rural women in 17 of Maharashtra's villages. Another group comprising 200 women from villages in Thane and Aurangabad — called the control group — were not provided with the dryers.

Developed by S4S, the electricity-free solar-powered food dehydrator uses controlled radiation technology to trap the infrared rays that dry fruits and vegetables. The

dehydrated products regain their original properties when put in water. Every year, 25%-30% of the 250 million tonnes of fruits and vegetables produced in India are lost.

"Undernutrition or malnutrition is intergenerational. It passes from a mother to her children," said Vaibhav Tidke, chief executive officer, S4S. "Undernourishment is attributed to poverty, which results in poor ability to buy food and maintain dietary variations, food shortage across off-seasons when agri-products are not available on farms, gender inequality as women are not equipped to buy and supply nutritional food, and poor feeding practices that rely on staple food as major component of diet."

The women were trained to use the dryers to dehydrate onions, fenugreek, spinach, dried ginger, mangoes and papaya. These dehydrated products were integrated in their daily diet, especially during the lean season — January to June — when fresh produce is not available for consumption. The fact that vegetables were ready to be consumed during the lean season increased the Dietary Diversity Score — amount of nutrients in one's diet — in the experimental group by 37% more than the control group. "During the lean season, women end up eating starchy food. They boil potatoes with salt and some spice; all of which has no nutrition," said Tidke. "Dehydrating locally available seasonal food and cooking it improved the women's haemoglobin count by an average of one point — from 8g/dL to 9g/dL, for instance," he added.

With the dryer reducing moisture content in agri-animal produce and maintaining nutritional values, women farmers and rural women can preserve seasonal produce for six months to a year, without using chemicals. "When vegetables, fruits or any agricultural products are dehydrated, there is a less-than-5% loss in minerals and protein activity owing to the controlled temperature increase during the drying process. The concentration of nutrients, vitamins and protein activity is increased by almost five times owing to the removal of water. Hence, the net gain is enormous," said Bhaskar Thorat,head, chemical engineering department, ICT, and advisor for S4S. "This concentration increases energy levels and improves haemoglobin levels," he added.

In addition to consuming the dried product and preventing wastage, the women also sold the surplus. Of the 200 women in the experimental group, 105 sold the surplus dehydrated food — approximately 20,000kg of agricultural products. With more than Rs10 lakh in proceeds, the consumption of dehydrated vegetables and fruits helped the women save Rs40 to Rs60 a week during the lean season. The team plans to write to the state women and child welfare and tribal departments with the proposal to introduce solar conduction dryers in villages. "There needs to be a policy intervention in terms of installing solar dryers at the panchayat levels," said Tidke.

The two-year project was executed by S4S, Institute of Chemical Technology, Mumbai and Hyderabad-based National Institute of Nutrition. It is supported by the Biotechnology Industry Research Assistance Council (Department of Biotechnology), Bill & Melinda Gates Foundation and USAID. The solar conduction dryer is a patented technology recognised by the UN, USAID, UKAID, FICCI and University of Texas. It costs three to five times less than other solar dryers and processes 1 tonne material annually.

http://www.hindustantimes.com

JAPAN

Safe and inexpensive hydrogen production

A research team led by Kiyotomi Kaneda and Takato Mitsudome at Osaka University have now developed a catalyst that realizes efficient environmentally friendly hydrogen production from organosilanes. The catalyst is composed of gold nanoparticles with a diameter of around 2 nm supported on hydroxyapatite. The catalyst was synthesized from chloroauric acid using glutathione as a capping agent to prevent nanoparticle aggregation, resulting the formation of small size of gold nanoparticles. Glutathione-capped gold nanoparticles were then adsorbed on hydroxyapatite and glutathione was removed by subsequent calcination.

The team then added the nanoparticle catalyst to solutions of different organosilanes to measure its ability to induce hydrogen production. The nanoparticle catalyst displayed the highest turnover frequency and number attained to date for hydrogen production catalysts from organosilanes. For example, the nanoparticle catalyst converted 99% of dimethylphenylsilane to the corresponding silanol in just 9 min at room temperature, releasing an equimolar amount of hydrogen gas at the same time. Importantly, the catalyst was recyclable without loss of activity. On/off switching of hydrogen production was achieved using the nanoparticle catalyst because it could be easily separated from its organosilane substrate by filtration. The activity of the catalyst increased as the nanoparticle size decreased.

A prototype portable hydrogen fuel cell containing the nanoparticle catalyst and an organosilane substrate was fabricated. The fuel cell generated power in air at room temperature and could be switched on and off as desired. Images of the catalyst after use in the fuel cell resembled those of the unused catalyst, indicating that the hydroxyapatite-supported nanoparticle catalyst readily resisted aggregation. Generation of hydrogen from inexpensive organosilane substrates under ambient conditions without additional energy input represents an exciting advance towards the goal of using hydrogen as a green energy source.

https://www.eurekalert.org

EUROPE

GERMANY

Multicrystalline silicon solar cell

The potential of photovoltaics (PV) has not yet been exhausted. Both industry and research continue to work intensively on increasing the efficiency and reducing the costs of solar cells, the basic component of every PV power plant. Now researchers at Fraunhofer ISE have produced a multicrystalline silicon solar cell with 21.9 percent efficiency, successfully bringing the world record back to Freiburg. The potential of photovoltaics (PV) has not yet been exhausted. Both industry and research continue to work intensively on increasing the efficiency and reducing the costs of solar cells, the ba-

sic component of every PV power plant. Now researchers at Fraunhofer ISE have produced a multicrystalline silicon solar cell with 21.9 percent efficiency, successfully bringing the world record back to Freiburg.

Higher efficiencies and optimized processing steps are decisive for decreasing the cost of solar electricity even further. Both of these are an integral part of the photovoltaic research at the Fraunhofer Institute for Solar Energy Systems. With its newest efficiency value, the Freiburg researchers have once again broken a world record: A multicrystalline silicon solar cell converts 21.9 percent of the incident sunlight into electricity. As in the years from 2004 to 2015, Fraunhofer ISE again holds the world's record for multicrystalline silicon. The record solar cell consists of n-type high performance multicrystalline silicon, or HP mc-Si. Compared to p-type silicon, this material shows a higher tolerance to impurities, especially iron. The industrial production today uses multicrystalline p-type silicon material with average solar cell efficiencies of about 19 percent. The new material and technology approaches applied by Fraunhofer ISE for the record cell have the potential to improve the efficiency of multicrystalline silicon even further in the near future.

"We are very happy about this excellent result, which is due largely to the fact that Fraunhofer ISE's expertise runs along the entire value chain of silicon photovoltaics," says the visibly pleased Institute Director, Dr. Andreas Bett. "At the Institute our expertise spans the entire range from the crystallization of silicon through to the quality assurance of PV power plants. The research areas of material development, characterization and cell technology all played a part in the development of the world record cell." The various research groups at Fraunhofer ISE consulted continuously, optimizing the material and the cell process in tandem. Dr. Stephan Riepe, Head of the Group "Silicon – Crystallization and Epitaxy," explains the procedure as follows: "In our Silicon Material TEchnology Center SIMTEC, we adjusted the crystallization process with the goal of creating a material optimized for the planned solar cell processing procedure. We worked closely and in constant exchange with our colleagues until we all achieved our common target of world record efficiency."

The work of the ambitious researchers at Fraunhofer ISE, however, continues further. The "multiTOP" project, in which the record cell was achieved, continues to run up to March 2018. The project is headed by Dr. Jan Benick, Team Leader of Innovative Clean Room Technologies for High Efficiency Silicon Solar Cells. He looks into the future: "Our goal is to develop an advanced cell technology for the n-type multicrystalline wafer that really demonstrates its full potential. The question is, how far can we get to closing the efficiency gap to monocrystalline material." The colleagues in solar cell characterization acted as a decisive link between the researchers in materials and cell technology.

Dr. Martin Schubert, Department Head of Characterization and Simulation assumed the role of navigator: "With our characterization work, we were able to help our colleagues in materials to improve the material quality and to customize it for the production process. On the other side, we were able to provide our colleagues in solar cell development with tips on where the relevant losses in the current cell technology can be found."

https://www.ise.fraunhofer.de

NORTH AMERICA

CANADA

Mass production of solar cells

Printing solar cells may soon be as easy and inexpensive as printing a newspaper, thanks to researchers who have cleared a critical manufacturing hurdle in the development of a new class of solar devices. Dr. Hairen Tan and his team have cleared a critical manufacturing hurdle in the development of a relatively new class of solar devices called perovskite solar cells. This alternative solar technology could lead to low-cost, printable solar panels capable of turning nearly any surface into a power generator, researchers said.

"Economies of scale have greatly reduced the cost of silicon manufacturing. Perovskite solar cells can enable us to use techniques already established in the printing industry to produce solar cells at very low cost," said Ted Sargent from University of Toronto in Canada. "Potentially, perovskites and silicon cells can be married to improve efficiency further, but only with advances in low-temperature processes," said Sargent. Today, virtually all commercial solar cells are made from thin slices of crystalline silicon which must be processed to a very high purity. It is an energy-intensive process, requiring temperatures higher than 1,000 degrees Celsius and large amounts of hazardous solvents.

In contrast, perovskite solar cells depend on a layer of tiny crystals – each about 1,000 times smaller than the width of a human hair – made of low-cost, light-sensitive materials. Since the perovskite raw materials can be mixed into a liquid to form a kind of 'solar ink', they could be printed onto glass, plastic or other materials using a simple inkjet printing process.

However, until now, there has been a catch – in order to generate electricity, electrons excited by solar energy must be extracted from the crystals so they can flow through a circuit. That extraction happens in a special layer called the electron selective layer (ESL). The difficulty of manufacturing a good ESL has been one of the key challenges holding back the development of perovskite solar cell devices. "The most effective materials for making ESLs start as a powder and have to be baked at high temperatures, above 500 degrees Celsius," said Dr Heiren Tan. "You can not put that on top of a sheet of flexible plastic or on a fully fabricated silicon cell – it will just melt," he added.

Tan and his colleagues developed a new chemical reaction than enables them to grow an ESL made of nanoparticles in solution, directly on top of the electrode. While heat is still required, the process always stays below 150 degrees Celsius, much lower than the melting point of many plastics. The new nanoparticles are coated with a layer of chlorine atoms, which helps them bind to the perovskite layer on top -this strong binding allows for efficient extraction of electrons. Researchers reported the efficiency of solar cells made using the new method at 20.1 per cent.

The study was published in the journal Science.

http://indianexpress.com

USA

Sustainable energy storage

A battery developed by scientists at Oregon State University is said to show promise for sustainable, high power energy storage. According to the researchers, it is the first battery to use only hydronium ions as the charge carrier. Hydronium is a positively charged ion produced when a proton is added to a water molecule. The researchers have demonstrated that hydronium ions can be reversibly stored in an electrode material consisting of PTCDA; an organic, crystalline, molecular solid. The battery uses dilute sulphuric acid as the electrolyte.

"It doesn't use lithium or sodium or potassium to carry the charge, and just uses acid as the electrolyte," said assistant professor Xiulei Ji. "There's a huge natural abundance of acid, so it's highly renewable and sustainable." According to Ji, cations used in batteries have always been alkali metal, alkaline earth metals or aluminium. "No non-metal cations were being considered seriously for batteries," he said.

The study observed a big dilation of the PTCDA lattice structure during intercalation – which meant the electrode was being charged. "Organic solids are not typically contemplated as crystalline electrode materials, but many are crystalline, arranged in an ordered structure," Ji explained. "PTCDA has a lot of internal space between its molecule constituents so it provides an opportunity for storing big ions and good capacity."

The hydronium ions also said to migrate through the electrode structure with low friction which translates to high power. "It's not going to power electric cars," Ji said. "But it does provide an opportunity for battery researchers to go in a new direction as they look for alternatives for energy storage, particularly for stationary grid storage."

http://www.newelectronics.co.uk

CO_2 emissions into renewable fuels

Researchers with the Department of Mechanical Engineering at Texas A&M University are making the best use of our energy waste—turning one of our most potent pollutants and greenhouse gasses, carbon dioxide (CO_2), into hydrocarbon fuels that can help the environment and solve growing energy needs. "We're essentially trying to convert CO_2 and water, with the use of the sun, into solar fuels in a process called artificial photosynthesis," said Dr. Ying Li, associate professor of mechanical engineering and principal investigator. "In this process, the photo-catalyst material has some unique properties and acts as a semiconductor, absorbing the sunlight which excites the electrons in the semiconductor and gives them the electric potential to reduce water and CO_2 into carbon monoxide and hydrogen, which together can be converted to liquid hydrocarbon fuels."

The first step of the process involves capturing CO_2 from emissions sources such as power plants that contribute to one-third of the global carbon emissions. As of yet, there is no technology capable of capturing the CO_2, andat the same time re-converting it back into a fuel source that isn't expensive. The material, which is a hybrid of titanium oxide and magnesium oxide, uses the magnesium oxide to absorb the CO_2 and the titanium oxide to act as the photo-catalyst, generating electrons through sunlight that interact with the absorbed CO_2 and water to generate the fuel.

The project is still in the fundamental research stage. One of the challenges with this technology is that the current conversion efficiency of converting CO_2 and water into renewable solar fuels remains low, less than a few percent. According to Li, the conversion process also takes considerable time and the material can only absorb a fraction of the emitted sunlight. For Li and his team, solving these issues revolves around engineering more efficient materials with nano-scale structures and advancing the reactor design so that the materials placed within the reactor can absorb sunlight in the most efficient manner. "There are also other considerations," said doctoral student Huilei Zhao, a student contributing to the ongoing research in Li's research group. "Concentrated sunlight exposure can lead to a higher conversion efficiency and we've found that if we operate at a higher temperature with this reaction, the conversion efficiency can be dramatically increased."

https://phys.org

New energy-efficient technology

Rutgers' Richard E. Riman has developed a new invention to prove that the future will see a wide variety of composite materials that are expected to be cheaper, lighter, stronger and greener for our planet. Riman, a renowned professor in the Department of Materials Science and Engineering in the School of Engineering, developed an energy-efficient technology capable of harnessing mostly low-temperature, water-based reactions. This invention brought about nine years ago by Riman has now resulted in his team being able to produce things in water that earlier were produced at temperatures much higher than those required to thermally decompose plastics.

So far, the revolutionary technology has been employed to produce more than 30 different materials, including concrete that has the potential to store carbon dioxide, the key greenhouse gas connected to climate change. Other materials include several multiple families of composites that incorporate a variety of ceramics, polymers and metals whose behavior can be processed to resemble seashells, bone, wood and also steel.

Riman, recently named a fellow of the National Academy of Inventors and holder of a number of patents, stated that a promising option is developing materials for lightweight automobiles. The materials could be used for engine, exterior and interior applications. Other materials could carry out improved magnetic, optical and electronic functions that replace mechanical ones. With 30 years of teaching experience in the Department of Materials Science and Engineering, Riman concentrates on developing ceramic materials under sustainable conditions. This refers to low energy with a low carbon dioxide footprint.

Riman's patented technology develops bonds between materials at low temperatures. This technology is called reactive hydrothermal liquid-phase densification (rHLPD), also referred to as low-tempera-

ture solidification. rHLPD has been used in producing a variety of ceramic composite materials at Rutgers, according to an article featured last summer in the *Journal of the American Ceramic Society*.

Riman invented this new technology after analyzing how engineers densified Alaskan fields of ice and snow to develop airplane landing strips. Even though Riman had this idea decades ago, he launched the technology only after climate change became a major problem.

http://www.azobuild.com

Solar-powered water purifier

Researchers have developed a solar-powered purifier which could provide a highly efficient and inexpensive way to turn contaminated water into potable water for personal use. The device could help address global drinking water shortages, especially in developing areas and regions affected by natural disasters, researchers said. "Using extremely low-cost materials, we have been able to create a system that makes near maximum use of the solar energy during evaporation. At the same time, we are minimising the amount of heat loss during this process," said lead researcher Qiaoqiang Gan, associate professor at University at Buffalo (UB) in the US.

The team built a small-scale solar still. The device, which they call a "solar vapour generator," cleans or desalinates water by using the heat converted from sunlight. The sun evaporates the water. During this process, salt, bacteria or other unwanted elements are left behind as the liquid moves into a gaseous state. The water vapour then cools and returns to a liquid state, where it is collected in a separate container without the salt or contaminants.

"People lacking adequate drinking water have employed solar stills for years, however, these devices are inefficient," said Haomin Song, PhD candidate at UB. "Many devices lose valuable heat energy due to heating the bulk liquid during the evaporation process. Systems that require optical concentrators, such as mirrors and lenses, to concentrate the sunlight are costly," Song said.

The team addressed these issues by creating a solar still about the size of mini-refrigerator. It is made of expanded polystyrene foam and porous paper coated in carbon black. Like a napkin, the paper absorbs water, while the carbon black absorbs sunlight and transforms the solar energy into heat used during evaporation. The solar still coverts water to vapour very efficiently. For example, only 12 per cent of the available energy was lost during the evaporation process, a rate the research team believes is unprecedented. The accomplishment is made possible, in part, because the device converts only surface water, which evaporated at 44 degrees Celsius.

Based upon test results, researchers believe the still is capable of producing three to 10 litres of water per day, which is an improvement over most commercial solar stills of similar size that produce one to five litres per day. Materials for the new solar still cost roughly USD 1.60 per square meter - a number that could decline if the materials were purchased in bulk, researchers said. The research was published in the journal *Global Challenges*.

http://energy.economictimes.indiatimes.com

Crystalline material could double efficiency of solar cells

A new material has been shown to have the capability to double the efficiency of solar cells by researchers at Purdue University and the National Renewable Energy Laboratory. Conventional solar cells are at most one-third efficient, a limit known to scientists as the Shockley-Queisser Limit. The new material, a crystalline structure that contains both inorganic materials (iodine and lead) and an organic material (methyl-ammonium), boosts the efficiency so that it can carry two-thirds of the energy from light without losing as much energy to heat. In less technical terms, this material could double the amount of electricity produced without a significant cost increase.

Libai Huang, assistant professor of chemistry at Purdue, says the new material, called a hybrid perovskites, would create solar cells thinner than conventional silicon solar cells, and is also flexible, cheap and easy to make. "My graduate students learn how to make it in a few days," she says. The breakthrough is published this week in the journal *Science*.

The most common solar cells use silicon as a semiconductor, which can transmit only one-third of the energy because of the band gap, which is the amount of energy needed to boost an electron from a bound state to a conducting state, in which the electrons are able to move, creating electricity. Incoming photons can have more energy than the band gap, and for a very short time – so short it's difficult to imagine – the electrons exist with extra energy. These electrons are called "hot carriers," and in silicon they exist for only one picosecond (which is 10^{-12} seconds) and only travel a maximum distance of 10 nanometers. At this point the hot carrier electrons give up their energy as heat. This is one of the main reasons for the inefficiency of solar cells.

Huang and her colleagues have developed a new technique that can track the range of the motion and the speed of the hot carriers by using fast lasers and microscopes. "The distance hot carriers need to migrate is at least the thickness of a solar cell, or about 200 nanometers, which this new perovskite material can achieve," Huang says. "Also these carriers can live for about 100 picoseconds, two orders of magnitude longer than silicon." Kai Zhu, senior scientist at the National Renewable Energy Laboratory in Golden, Colorado, and one of the journal paper's co-authors, says that these are critical factors for creating a commercial hot-carrier solar cell.

"This study demonstrated that hot carriers in a standard polycrystalline perovskite thin film can travel for a distance that is similar to or longer than the film thickness required to build an efficient perovskite solar cell," he says. "This indicates that the potential for developing hot carrier perovskite solar cell is good." However, before a commercial product is developed, researchers are trying to use the same techniques developed at Purdue by replacing lead in the material with other, less toxic, metals. "The next step is to find or develop suitable contact materials or structures with proper energy levels to extract these hot carriers to generate power in the external circuit," Zhu says. "This may not be easy."

https://phys.org