ENVIRONMENTAL ENGINEERING

DIVISION NEWSLETTER

SEPTEMBER - 2017

EED NEWSLETTER

ENVIRONMENTAL ENGINEERING features the Application of ENVIRONMENTAL Technologies to ENGINEERING Systems to attain OPTIMAL Performance according to ESTABLISHED Standards.

The Newsletter of the Environmental Engineering Division (EED) will attempt to highlight a Variety of Environmental Technology Applications aimed at Enhancing Engineering Systems Performances in accordance with the Latest Standards by presenting Excerpts of and Links to Selected Articles from a Variety of Websites. EED Members are encouraged to forward materials on Environmental Engineering topics for review by the Newsletter Editorial Staff. EED Newsletter Readers are urged to forward comments on materials that appear in its content.

The EED Newsletter will feature presentations in **NINE** Sections:

1. ENVIRONMENTAL TECHNOLOGIES
2. ENVIRONMENTAL REGULATIONS
3. EDITORIAL BOARD SELECTIONS
4. CHAIRMAN/DIVISION NEWS
5. NEWSLETTER READER COMMENTS
6. NEWSLETTER EDITORIAL BOARD
7. NEWSLETTER REFERENCES - TECH
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9. EDITORIAL BOARD SELECTION REFERENCES

It is envisioned that the EED Newsletter will be Monthly enterprise involving ALL members of the EED in its production. Your participation in providing and reviewing EED Newsletter materials is encouraged and will be greatly appreciated by the EED Newsletter Editors.

1. ENVIRONMENTAL TECHNOLOGIES

CARBON NANOTUBES WORTH THEIR SALT

Lawrence Livermore scientists, in collaboration with researchers at Northeastern University, have developed carbon nanotube pores that can exclude salt from seawater. The nanotubes are hollow structures made of carbon atoms in a unique arrangement that is responsible for their remarkably high water permeability, while the tiny pore size blocks the larger salt ions. They are more than 50,000 times thinner than a human hair. (Ref 1)

1. ENVIRONMENTAL TECHNOLOGIES

NEW STEEL BEATS THE STRENGTH-DUCTILITY TRADE-OFF

A Hong Kong-Beijing-Taiwan mechanical engineering team has recently developed a new steel (called D&P Steel) as it adopted a new deformed and partitioned (D&P) strategy that addressed the strength-ductility trade-off. This breakthrough steel has two advantages. First - the raw materials cost of D&P steel is only 20% of the steel used in aerospace and defense applications. The chemical composition of D&P steel belongs to the system of medium manganese steel, containing 10% manganese, 0.47% carbon, 2% aluminum, 0.7% vanadium (mass percent), and the balance is iron. The second advantage is that this breakthrough steel can be developed using conventional processing routes, including warm rolling, cold rolling and annealing. (Ref 2)

CHEAPER, GREENER BIOFUELS PROCESSING CATALYST

Many biofuels are costly to produce because the precursor product, bio-oil, must be processed before it is sent to the refinery to be turned into liquid fuel. Illinois Sustainability Technology Center (ISTC) researchers have identified and tested a new processing method. Biofuels are produced by the same chemical reaction that forms petroleum. However, what takes millions of years naturally in the ground takes only minutes in the lab using a process that is very similar to pressure cooking.

ISTC findings point to a cheaper, more environmentally friendly and renewable catalyst for processing that uses common bacteria and the metal palladium, which can be recovered from waste sources such as discarded electronics and processed sewage. The bio-oil produced in the lab from algae contains impurities like nitrogen and oxygen, but treating it with palladium as a catalyst during processing helps remove those impurities to meet clean-air requirements. (Ref 3)

1. ENVIRONMENTAL TECHNOLOGIES

A SMART GRAPHENE MEMBRANE TO DESALINATE WATER

An international team of researchers, including scientists from Shinshu University (Japan) and the director of Penn State's ATOMIC Center, has developed a graphene-based coating for desalination membranes that is more robust and scalable than current nano-filtration membrane technologies. The result could be a sturdy and practical membrane for clean water solutions as well as protein separation, wastewater treatment and pharmaceutical and food industry applications.

The hybrid membrane the team developed uses a simple spray-on technology to coat a mixture of graphene oxide and few-layered graphene in solution onto a backbone support membrane of polysulfone modified with polyvinyl alcohol. The support membrane increased the robustness of the hybrid membrane, which was able to stand up to intense cross-flow, high pressure and chlorine exposure.

Even in early stages of development, the membrane rejects 85 percent of salt, adequate for agricultural purposes though not for drinking, and 96 percent of dye molecules. Highly polluting dyes from textile manufacturing is commonly discharged into rivers in some areas of the world. The Japanese Science and Technology Agency supported this work at the Global Aqua Innovation Center. (Ref 4)

1. ENVIRONMENTAL TECHNOLOGIES

NEW ACID-FREE MAGNET RECYCLING PROCESS CREATED

Researchers at the Critical Materials Institute (CMI) - a U.S. Department of Energy Innovation Hub led by Ames Laboratory - developed a new recycling process that recovers high purity rare earth elements. For shredded magnet-containing electronic wastes, the process does not require pre-processing such as pre-sorting or demagnetization. The result of the new process is recovered rare-earth oxides of high purity, without the production of fumes or use of hazardous mineral acids. Additionally, valuable by-products of e-waste components can be recovered for further recycling including copper, chromium and nickel. The by-products pay for the chemicals used in the recycling process. (Ref 5)

ANCIENT ROMAN CONCRETE STANDS THE TEST OF TIME -1

Roman structures still stand—buildings, bridges, arches, roads, piers, and breakwaters—thanks in large part to the concrete and mortar that the Roman engineers designed. Amazingly, even in corrosive saltwater environments, Roman harbor structures have remained strong and intact for more than 2,000 years. So what did the Romans know that we don't? To find out, researchers from Lawrence Berkeley National Laboratory and the University of Utah analyzed samples of Roman concrete from harbor structures in Italy at Berkeley Lab's Advanced Light Source (ALS) facility. The researchers examined thin sections of the concrete under an electron microscope to map the distribution of minerals

1. ENVIRONMENTAL TECHNOLOGIES

ANCIENT ROMAN CONCRETE STANDS THE TEST OF TIME - 2

The research team was surprised to discover high concentrations of zeolite, phillipsite, and tobermorite occupying the porous spaces in the concrete, many of them created by the dissolution of other minerals, such as feldspar. It was postulated that the steady percolation of seawater into the Roman concrete reacted with the lime and the volcanic ash to create these interlocking minerals that occupied void space, making the concrete stronger. In contrast, anti-corrosive Portland cement mixes are formulated to be inert and unreactive with seawater, yet start to deteriorate far earlier.

The research team will experiment in the future with different combinations of seawater and volcanic ash to make a modern-day concrete with the unique properties of the Roman cement. It is also possible that fly ash—a problematic byproduct of coal combustion—could be a worthy substitute for the volcanic ash component of the Roman cement. This would be an immense environmental benefit. Widespread use of this concrete would reduce the construction industry's dependence on Portland cement - the manufacture of which requires high-temperature kilns WITH significant amounts of CO_2 emissions. (Ref 6)

NREL, SWISS SCIENTISTS POWER PAST SOLAR EFFICIENCY RECORDS - 1

Collaboration between researchers at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), the Swiss Center for Electronics and Micro-technology (CSEM), and the École Polytechnique Fédérale de Lausanne (EPFL) shows the high potential of silicon-based multi-junction solar cells.

1. ENVIRONMENTAL TECHNOLOGIES

NREL, SWISS SCIENTISTS POWER PAST SOLAR EFFICIENCY RECORDS - 2

In testing silicon-based multi-junction solar cells, the researchers found that the highest dual-junction efficiency (32.8%) came from a tandem cell that stacked a layer of gallium arsenide (GaAs) developed by NREL atop a film of crystalline silicon developed by CSEM. An efficiency of 32.5% was achieved using a gallium indium phosphide (GaInP) top cell. A third cell, consisting of a GaInP/GaAs tandem cell stacked on a silicon bottom cell, reached a triple-junction efficiency of 35.9%—just 2% below the overall triple-junction record.

The existing photovoltaics market is dominated by modules made of single-junction silicon solar cells, with efficiencies between 17% and 24%. The researchers noted in the report that making the transition from a silicon single-junction cell to a silicon-based dual-junction solar cell will enable manufacturers to push efficiencies past 30% while still benefiting from their expertise in making silicon solar cells. The funding for the research came from the Energy Department's SunShot Initiative—which aims to make solar energy a low-cost electricity source for all Americans through research and development efforts in collaboration with public and private partners—and from the Swiss Confederation and the Nano-Tera.ch initiative. (Ref 7)

SCIENTISTS DESIGN FLEXIBLE ORGANIC BATTERY - 1

Queen's University, Belfast scientists have designed a new flexible organic battery that could revolutionize how medical implants are powered. The charge in the batteries is set to last three times as long as in their conventional counterparts. Research leader Dr. Geetha Srinivasan from Queen's University's Ionic Liquid Laboratories (QUILL) research center said the device was also non-flammable and had no leakage issues.

1. ENVIRONMENTAL TECHNOLOGIES

SCIENTISTS DESIGN FLEXIBLE ORGANIC BATTERY - 2

The organic battery could be used to power body sensors such as pacemakers. The technology could also have a non-medical application in foldable phones or laptops of the future - the designs of which are currently constrained by rigid batteries. With the right funding in place, Dr. Srinivasan said the devices could easily be commercialized - so that it could be powering phones or similar devices within the next five years.(Ref 8)

SYSTEM RECYCLES CO2 TO MAKE ETHANOL AND ETHYLENE

Scientists at the DOE Lawrence Berkeley Laboratory have harnessed the power of photosynthesis to convert carbon dioxide into fuels and alcohols at efficiencies far greater than plants. The achievement marks a significant milestone in the effort to move toward sustainable sources of fuel. The sun-to-fuel path is among the key goals of the Joint Center for Artificial Photosynthesis (JCAP), a DOE Energy Innovation Hub established in 2010 to advance solar fuel research.

The initial focus of JCAP research was tackling the efficient splitting of water in the photosynthesis process. Having largely achieved that task using several types of devices, JCAP scientists doing solar-driven carbon dioxide reduction began setting their sights on achieving efficiencies similar to those demonstrated for water splitting. Another research group at Berkeley Lab is tackling the challenge by focusing on a specific component in a photovoltaic-electrochemical system. In a recent study they describe a new catalyst that can achieve carbon dioxide to multi-carbon conversion using record-low inputs of energy. (Ref 9)

2. ENVIRONMENTAL REGULATIONS

GREEN BUILDING TRENDS IN THE WORLD'S MOST SUSTAINABLE CITIES

Singapore's 24-story "Tree House" holds the Guinness World Record for largest vertical garden. The condominium's largest wall features 24,638 square feet of vertical green space, incorporating the benefits of healthy flora into the façade itself. Rooftop gardens are a long-standing staple of green buildings, but these vertical structures allow an even greater expansion of the benefits they provide. Stockholm, Sweden leads the charge for greener cityscapes. About 40 percent of the city is green space, and the city aims to be fossil fuel free by 2040. Zurich, Switzerland ranks highest on the Arcadis 2016 Sustainable Cities Index and has led the way in sustainable building design for decades. The Swiss incorporate the Minergie principles into every major building project, a set of sustainability standards that applies to skyscrapers as well as to residential households. (Ref 1)

TRASH TO TREASURE: THE BENEFITS OF WASTE-TO-ENERGY TECHNOLOGIES

Organic waste such as paper, wood and food produces millions of tons of methane emissions at landfills every year in the USA according to a study by the Department of Energy (DOE) Argonne National Laboratory. This is because landfill gas from waste contains high concentrations of methane, which has about 30 times higher global warming impact compared to carbon dioxide. Methods to produce fuel from municipal waste include biochemical, such as anaerobic digestion and fermentation, and *thermochemical*, such as hydrothermal liquefaction, pyrolysis and gasification. The resulting energy products include renewable natural gas, bio-char, bio-oil and hydrocarbon fuels (gasoline, diesel and jet fuel. (Ref 2)

2. ENVIRONMENTAL REGULATIONS

INFRASTRUCTURE COST OF CLIMATE CHANGE

The climate of Montreal is changing and will continue to do so at a rapidly increasing rate and with much more spatial variability in the future, according to a study from the Department of Building, Civil and Environmental Engineering at Concordia University. Researchers set out to test the reliability of NASA's downscaled climate data set - the NEX-GDDP - as a tool to accurately model the long-term annual climate impacts on the scale of a city.

Using the Greater Montreal Area and its neighboring regions for their case study, the researchers compiled observed data recorded at eight local weather stations from 1950 to 2006. They then compared it to data yielded from the NASA data set for the same period and common temporal and spatial scales. They found significant trends in the city's climate, which can be captured fairly well by the downscaled data. Comparing the projected trends from 2006 to 2099 with past observations, they showed that the Montreal region's climate will continue to change at a faster, more intense rate and with more pronounced spatial-temporal variability. (Ref 3)

SOLAR FUELS - 1

Experts have developed techniques to convert sunlight into “solar fuels.” The process involves exposing water molecules to sunlight to separate the hydrogen and oxygen atoms, and then combining the hydrogen with carbon dioxide to create liquid fuels. The generated hydrogen can also be condensed (under pressure at very low temperatures) into liquid hydrocarbon fuels (LH2), simple hydrogen gas, and metal hydride, or converted to methanol. Another well-established technique is to combine hydrogen with nitrogen to make ammonia, which can then be compressed into a liquid at moderate temperatures, and is relatively easy to transport. Bill Gates recently launched Breakthrough Ventures, a

2. ENVIRONMENTAL REGULATIONS

SOLAR FUELS - 2

$1 billion fund to invest in scientific discoveries that have the potential to deliver cheap and reliable clean energy to the world. Gates believes solar fuels can be an "energy miracle," as they would overcome challenges to renewable energy adoption while producing reductions in greenhouse gas emissions. (Ref 4)

B OF A: $12.6B IN ENVIRONMENTAL INVESTMENTS CREATED 40,000 JOBS

According to a report released by the Bank of America released this week, the $12.6 billion it invested from 2013 to 2016 supported almost 40,000 jobs, contributed almost $15 billion to GDP and generated close to $30 billion in total economic output. Those investments comprise just a small part of what Bank of America says will be a long-term total of $125 billion that it describes as an “environmental business commitment.” The majority of jobs is within the broader energy efficiency industry and includes employment linked to building retrofits or more efficient lighting installations. More than 40% of these newly created jobs lie within the clean energy sector, including wind power, solar and other renewable power technologies. The rest of the jobs - approximately 6% - are within the nascent electric vehicles industry. (Ref 5)

3. EDITORIAL BOARD SELECTIONS

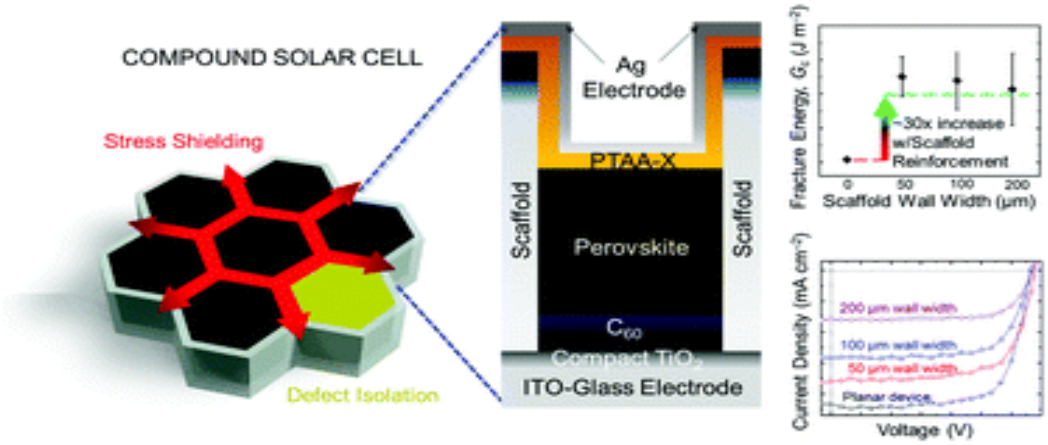
SCAFFOLD-REINFORCED PEROVSKITE COMPOUND SOLAR CELLS - 1

A new concept in solar cell design -the compound solar cell (CSC) - addresses the intrinsic fragility of these materials with mechanically reinforcing internal scaffolds. The internal scaffold effectively partitions a conventional monolithic planar solar cell

3. EDITORIAL BOARD SELECTIONS

SCAFFOLD-REINFORCED PEROVSKITE COMPOUND SOLAR CELLS - 2

into an array of dimensionally scalable and mechanically shielded individual perovskite cells that are laterally encapsulated by the surrounding scaffold and connected in parallel *via* the front and back electrodes. The CSCs exhibited a significant increased in fracture energy of □13 J m^{-2}—a 30-fold increase over previously reported planar perovskite (□0.4 J m^{-2})—while maintaining efficiencies comparable to planar devices. Notably, the efficiency of the microcells formed within the scaffold is comparable to planar devices on an area-adjusted basis. This development is a significant step in demonstrating robust perovskite solar cells to achieve increased reliability and service lifetimes. (Ref 1)



(CONTRIBUTED BY DR. JAMES ZUCCHETTO, EED NEWSLETTER ASSOCIATE EDITOR)

4. CHAIRMAN/DIVISION NEWS

EED will be sponsoring a joint meeting with the St. Louis, MO Section of ASME and is currently looking for a speaker for the event. The meeting will be scheduled in either February or March of 2018 at the Engineers Club in St. Louis, MO. We are looking for a speaker to present for 1-2 hours on an environmental topic such as Remediation/Superfund sites. If you are interested please email Ryan at ryanneil84@hotmail.com with a potential topic and availability.

5. EED NEWSLETTER READER COMMENTS

YOU ARE ENCOURAGED TO FORWARD YOUR COMMENTS ON THE TOPICS AND DISCUSSIONS PRESENTENTED IN THE EED NEWSLETTER. PLEASE FORWARD YOUR COMMENTS BY EMAIL TO ANY MEMBER OF THE EED NEWSLETTER EDITORIAL BOARD. THEIR EMAIL ADDRESSES APPEAR IN THE SECTION BELOW

6. EED NEWSLETTER EDITORIAL BOARD

7. NEWSLETTER REFERENCES - TECHNOLOGIES

1.https://www.sciencedaily.com/releases/2017/08/170824182653.htm

2. https://www.sciencedaily.com/releases/2017/08/170825124908.htm
3. https://www.sciencedaily.com/releases/2017/08/170825112839.htm

4. https://www.sciencedaily.com/releases/2017/08/170830172341.htm
5. https://www.sciencedaily.com/releases/2017/09/170907132528.htm
6. http://www.asme.org/engineering-topics/articles/technology-and-society/ancient-roman-concrete-stands-test-time
7. https://www.nrel.gov/news/press/2017/swiss-scientists-power-past-solar-efficiency-records.html

8. http://www.bbc.com/news/uk-northern-ireland-41253913

9. https://www.sciencedaily.com/releases/2017/09/170918151713.htm

8. NEWSLETTER REFERENCES - REGULATIONS

1. http://www.triplepundit.com/2017/08/three-green-building-trends-inspired-worlds-sustainable-cities/?utm_source=Daily+Email+List&utm_campaign=bb9b66b89e-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_9dedefcee3-bb9b66b89e-220508121

2. https://www.sciencedaily.com/releases/2017/08/170827101845.htm

3. https://www.sciencedaily.com/releases/2017/08/170831151303.htm

8. NEWSLETTER REFERENCES - REGULATIONS

4. http://www.renewableenergyworld.com/articles/2017/09/how-india-can-export-sunshine-around-the-world.html?cmpid=enl_rew_solar_energy_news_2017-09-11&email_address=jimzuc@comcast.net&eid=383618532&bid=1862747

5. jobs/?utm_source=Daily+Email+List&utm_campaign=b279a6fafb-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_9dedefcee3-b279a6fafb-220508121

EDITORIAL BOARD SELECTION REFERENCES

1.http://pubs.rsc.org/en/content/articlelanding/2017/ee/c7ee02185b#!divAbstract

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