ALU Energy News

November & December 2016

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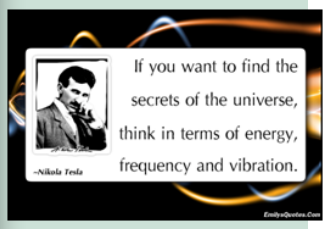
ALU ENERGY SOCIETY



More efficient and cheaper energy storage system for the Future: Z-Cell battery

Energy demands are increasing day by day in our life. The production of electricity is insufficient in our country. Hence, the energy storage system is most important in our society. Battery is one of the storage systems; the last two decades researcher was developed both rechargeable and non-rechargeable battery.

In December 2016, Australian company (Redflow) introduced a new kind of battery; it is new home energy storage system, which is Z-Cell battery. It is a 10 kW/h usable storage capacity, can provide three kW of nonstop power, and is suitable for off-grid and on-grid exploitation. In this Z-Cell battery, the zinc bromide ($ZnBr_2$) technology's pros. and cons. compared to its main challenger: lithium ion batteries. While there are many lithium-ion storage systems on the market, the Redflow Z-Cell stands out as the only $ZnBr_2$ flow battery.

Its unique chemistry gives a lot of advantages over lithium-ion storage systems. One is it can recline inactive for long periods at any level of charge without suffering from deterioration. Another one is storage capacity will never decline over its entire lifespan. Multiple Z-Cell batteries can be installed to provide additional power and storage capacity. The company claims that it is designed for outdoor installation and weighs 240 kg and it will come with a comprehensive product warranty of 10 years or 30,000 kW/h and Z-Cell is 100% Recyclable.

If fully cycled once it will take 8.2 years to reach the end of its warranty. As most households are unlikely to use it at full capacity, many people could buy a Z-Cell and be confident that they won't be out of pocket if a fault develops for 10 years.

The Z-Cell battery can be discharged 100% every day without affliction any harm at all, which is very different from other battery on the market. In addition it does not refuse in storage capacity over time. It starts off with 10 kW/h on the day it's first turned on, and it will have 10 kW/h on the day it dies. And according to Redflow, for a family that uses it at 80% capacity, that's likely to be around 14 years later.

The Redflow Z-Cell is 100% Recyclable. All components of the Z-Cell are entirely recyclable. One could be pulled separately right now and all the plastic and metal could be fully recycled using currently existing methods. The $ZnBr_2$ solution can be cleaned and reused in another Z-Cell.

Source: Redflow, Australia

Fuel from Sewage is the future!

The technology, hydrothermal liquefaction, mimics the geological conditions Earth uses to create crude oil, using high pressure and temperature to achieve in minutes something that takes Mother Nature millions of years. The resulting material is similar to petroleum pumped out of the ground, with a small amount of water and oxygen mixed in. This bio crude can then be refined using conventional petroleum refining operations.

It may sound like science fiction, but wastewater treatment plants across the United States may one day turn ordinary sewage into bio crude oil, thanks to new research at the Department of Energy's Pacific Northwest National Laboratory (PNNL).

"There is plenty of carbon in municipal waste water sludge and interestingly, there are also fats"

Wastewater treatment plants across the U.S. treat approximately 34 billion gallons of sewage every day. That amount could produce the equivalent of up to approximately 30 million barrels of oil per year. PNNL estimates that a single person could generate two to three gallons of bio crude per year.

Sewage, or more specifically sewage sludge, has long been viewed as a poor ingredient for producing bio-fuel because it's too wet. The approach being studied by PNNL eliminates the need for drying required in a majority of current thermal technologies which historically has made wastewater to fuel conversion too energy intensive and expensive. HTL may also be used to make fuel from other types of wet organic feedstock, such as agricultural waste.

Using hydrothermal liquefaction, organic matter such as human waste can be broken down to simpler chemical compounds. The material is pressurized to 3,000 pounds per square inch -- nearly one hundred times that of a car tire. Pressurized sludge then goes into a reactor system operating at about 660 degree Fahrenheit. The heat and pressure cause the cells of the waste material to break down into different fractions – bio crude and an aqueous liquid phase.

"There is plenty of carbon in municipal waste water sludge and interestingly, there are also fats," said Corinne Drennan, who is responsible for bioenergy technologies research at PNNL. "The fats or lipids appear to facilitate the conversion of other materials in the wastewater such as toilet paper, keep the sludge moving through the reactor, and produce a very high quality bio crude that, when refined, yields fuels such as gasoline, diesel and jet fuels."

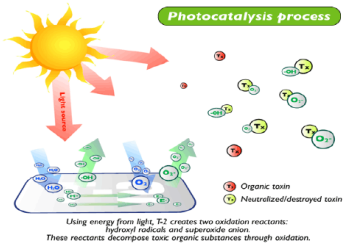
Source: Department of Energy's Pacific Northwest National Laboratory

Innovation in photo-catalysis: Efficient way cleaning of Polluted water!

"The microwave treatment method can significantly reduce the reaction time, most importantly the fast crystallization and simplification of the preparation procedure"

In India, approximately 70 percent of the population uses ground water as drinking water. Leaching of harmful substances such as agrochemical residues, the arsenic of Himalayan ore veins, and hexavalent chromium produced from leather tanneries is essential. This contamination has come to be seen as a societal and health problems for as many as 50 million people.

In order to solve such drinking-water issues worldwide, photocatalytic water purification technology has developed. This technology uses photocatalysts and the UV rays from sunlight to detoxify polluted water at high speeds, creating safe and purified water. It is cost effective and environmentally friendly way of purifying water.



New photo catalyst LiNbO3for Corrosion Reducing and Environment Friendly Sustainable Concrete Construction.

The study on magneli phase was carried out for the first time in 1956 and the recent research works are mainly focused on the investigations of charge location and metal–insulator transition. Magneli phase titanium oxides (Ti_nO_{2n-1}), n = 4 to 10, have been utilized for REM fabrication because they can be synthesized into porous monolithic structures at low cost and are reported to produce $OH^{\bullet}$ via water oxidation. The unique chemical, electrical, and magnetic properties of Ti_nO_{2n-1} have motivated their use as battery electrodes, fuel cell supports, memristor devices, photo catalysts, and electrodes for electrochemical oxidation and reduction of water contaminants.

The microwave treatment method can significantly reduce the reaction time, most importantly the fast crystallization and simplification of the preparation. Hence today, microwave treatment method appears as a new green technology for the preparation of advanced functional materials. The methylene blue (MB) dye decomposition efficiency of 100 % was achieved in 1h by the anorthic Carbon doped Ti_4O_7 which was prepared by microwave treatment of 30 min.

Source: Journal of Material Science: Materials in Electronics,

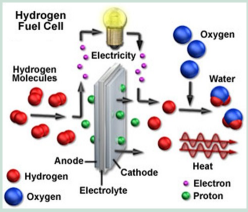
10.1007/s10854-016-4961-z

Eco-friendly and Low cost Production of Hydrogen Gas for fuels cell application

"Up to 99% of hydrogen production efficiency is achieved using nanoparticle catalyst with organosilane"

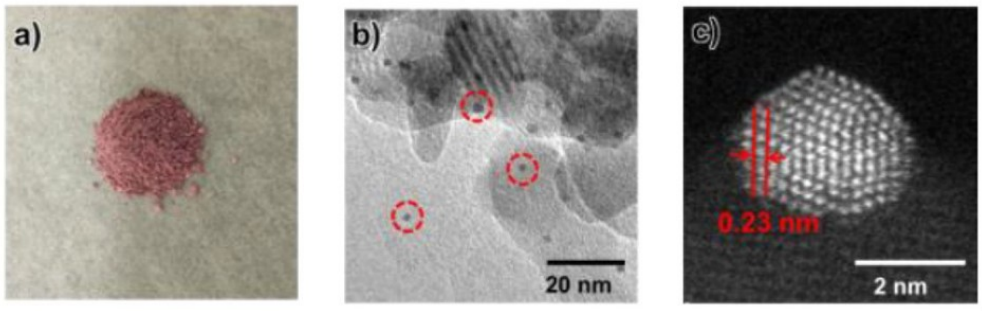
Hydrogen gas is one of the most important alternative energy sources in recent years. It is widely used for carbon-based fuels and is mainly produced from water as it is reacted with oxygen. Hydrogen is highly reactive and combustible gas and therefore it must be kept safe and handle with more care. Hydrogen gas can be generated using inexpensive, eco-friendly, safe, and duly air-stable organosilanes. These organosilane catalysts can efficiently generate hydrogen in high yield. Tremendously, combination of organosilane and transistion metal catalyst has superior properties, such as it works at room temperature in aerobic conditions; hence doesn't require any external energy input.

Kiyotomi Kaneda and Takato Mitsudome and his research group at Osaka University, synthesized an eco-friendly catalyst of organosilanes for hydrogen production. The synthesized catalyst composed of gold nanoparticles (2 nm diameter) on hydroxyapatite. The preparation of gold catalyst was carried out using precursor of chloro-auric acid and capping agent of glutathione (to avoid nanoparticle aggregation). The synthesized glutathione-capped gold nanoparticles were adsorbed on hydroxyapatite and this glutathione was removed by adequate annealing.



Courtesy: Olympus Microscopy Resource Center

a) Gold nanoparticle catalyst (Au/HAP-NC), b) Images of gold nanoparticles (black dot in red circle) through Transmission Electron Microscope, c) Annular Dark Field



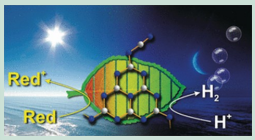
of gold nanoparticles through Scanning Electron Microscope.

Courtesy: Osaka University

The researcher tested efficiency of the reaction by mixing the synthesized gold catalyst to various organosilanes solutions for measure its capacity to enhance hydrogen production. Upto 99% of hydrogen production efficiency is achieved using nanoparticle catalyst with organosilane. The portable hydrogen fuel cell was fabricated using the developed nanoparticle catalyst on organosilane substrate by this research group. Formation of aggregation is greatly prevented and the life of the catalyst is improved.

Hydrogen gas was successfully produced using inexpensive organosilane substrates under ambient conditions. In this work, the team were described that this method doesn't require external energy input to produce hydrogen and it is a green energy source.

Source: *Scientific Reports*, DOI: 10.1038/srep37682



Courtesy:
Wiley
publication

"The nature have split photosynthesis into a light reaction generating electrons and holes as of solar energy, with a dark reaction"

Hydrogen from sunlight -- but as a dark reaction

The nature in addition to a light reaction from photosynthesis, generating electrons and holes as of solar energy, there is also called a dark reaction generating the actual "fuels" or chemicals that transport and store this energy. This second, time-lagged process is independent of the primary energy source, and the fuel is continually produced over the entire diurnal cycle.

The Storage of electric energy is usually performed in batteries or by electrochemical conversion into fuels for example hydrogen or methane. Mimicking Nature's photosynthesis in a process known as "artificial photosynthesis" would imply using a material that is able to store the electrons right following their light-induced generation and release them on demand.

Such a material for storing the electrons was explored in Bettina V. Lotsch at the Max Planck Institute for Solid State Research, Germany, and collaborators in Zurich and Cambridge. It was obtained from "melon," an ordered carbon nitride polymer, which is currently heavily investigated for its photo catalytic and semiconducting properties. The as-modified graphitic nitride is a yellow solid, which changes color upon exposure to light. "This polymer turns blue after photo-irradiated in the presence of certain electron donors in an oxygen-free environment," said the scientists. This "blue radical" state contains trapped electrons.

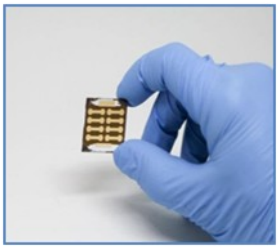
The scientists make out that when the light was switched off and a hydrogen-evolution co-catalyst was added, the polymer turned yellow again while producing hydrogen by releasing the stored electrons. it is possible to decouple the generation of photo induced electrons from their use for fuel production, within one single, inexpensive material. This could be a significant advance for the production of storable solar fuels independent of the intermittency of solar irradiation.

Source: Nature communication, DOI: 10.1002/anie.201608553

Courtesy: Momentum Energy—Habitat

Printable solar cells

Dr. Hairen Tan and his team from University of Toronto, Faculty Applied Science & Engineering developed new class of solar devices are called as ‘‘perovskite solar cells”, they claim that it will eliminate all barriers from previous generation perovskite type solar cells. This alternative technology could lead to low cost, printable solar panels capable of revolving any surface into a power generator.



All commercial solar cells are made from thin slices of crystalline silicon (high purity) requires higher temperature more than 1000^{o}C and large amounts of hazardous solvents for purification. Further, potentially it improves the efficiency of perovskite and silicon cells, the advances of perovskite solar cell using a low-temperature process. The perovskite solar cells depend on a layer of tiny crystals each about 1,000 times smaller than the width of a human hair and they made of low-cost, light-sensitive materials.

“This alternative technology could lead to low cost, printable solar panels capable of revolving any surface into a power generator”

In addition perovskite raw materials can be mixed into a liquid state and transform into kind of 'solar ink', they could be printed onto glass, plastic or other materials using a simple inkjet printing process. The main challenges of previous generation perovskite type materials has difficulty in layering good electron selective layer or extraction special layer (ESL). The Toronto team agreeably explains the computational studies of newly developed ESL. Tan said most effective materials for making ESL start as a powder baked at high temperatures more than 500^{o}C, and it’s just melt top of flexible plastic or fully fabricated silicon cell. Further the new technique face toward solving this problem, perovskite layer was strong binding with chlorine atoms, which helps the efficient extraction of electrons, and their efficiency was reached 20.1%, and also stability of cells retained more than 90% of their efficiency even after 500 hours of use.

Moreover, new kind perovskite cells directly coated on silicon without damaging the underlying material and hybrid perovskite-silicon cell can boost the efficiency up to 30% or higher, it makes solar power a much better economic proposition. The possibility applications for solar cells from smart phone covers that provide charging capabilities to solar active tinted windows that offset building energy use.

Courtesy: Momentum Energy—Habitat

This is a big step forward because you can put these cells anywhere you can think of — they work well in cloudy conditions,” said Dr Scholes

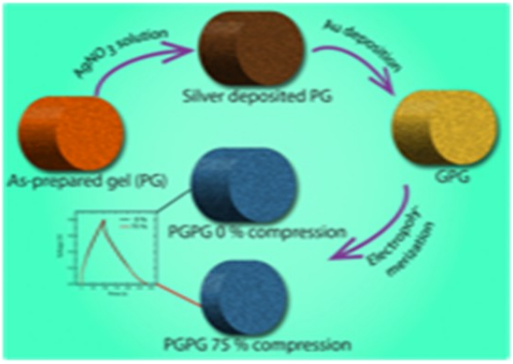
Courtesy: Momentum Energy—Habitat

Source: Science daily

Super capacitors bathed in green tea could power wearable electronics

Courtesy: Momentum Energy—Habitat

It is become the trend that the most famous versions are sold in the form of watches or sports bands. But soon, more suitable products could become available in softer materials made in part with an unexpected ingredient: Green tea! Recently there is report published in ACS journal that a new flexible and compact rechargeable energy storage device for wearable electronics that is infused with green tea polyphenols.



Courtesy: The Journal of Physical Chemistry

" Powering soft wearable electronics with a long-term source of energy remains but a challenge'

Powering soft wearable electronics with a long-term source of energy remains but a challenge. Super capacitors could potentially fill this role they meet the power necessities, and can quickly charge and discharge many cycle. But most super capacitors are rigid, and the compressible supercapacitors developed so far have run into roadblock. They have been made with carbon-coated polymer sponges, but the coating material tends to gang up and compromise performance.

Courtesy: Momentum Energy—Habitat

Krishnamoorthy and his team from NCL India wanted to different approach by equipping polymer gels in green tea extract, which infuses the gel with polyphenols. The polyphenols converted a silver nitrate solution into a uniform coating of silver nanoparticles. Thin layers of conducting gold and poly (3,4-ethylenedioxythiophene) were then applied. And the resulting super capacitor established power and energy densities of 2,715 watts per kilogram and 22 watt-hours per kilogram enough to operate a heart rate monitor, LEDs or a Bluetooth module. The researchers tested the device's durability and found that it performed well even after being compressed more than 100 times.

Source: The Journal of Physical Chemistry C, DOI: 10.1021/acs.jpcc.6b12822