Hydrogen production breakthrough could herald cheap green energy

September 12 2014

(Phys.org) —Scientists have taken a major step forward in the

production of hydrogen from water which could lead to a new era of cheap, clean and renewable energy.

Chemists from the University of Glasgow report in a new paper in *Science* today on a new form of hydrogen production which is 30 times faster than the current state-of-the-art method. The process also solves common problems associated with generating electricity from renewable sources such as solar, wind or wave energy.

Hydrogen is easily produced from water by electrolysis, a process which uses electricity to break the bonds between water's constituent elements, hydrogen and oxygen, and releases them as gas. Hydrogen gas can be burned to produce power with no negative impact on the environment, unlike power produced by burning fossil fuels.

One of the problems of generating electricity via renewable power is that the output either needs to be used immediately or stored. Using renewable power to produce hydrogen allows the capture of electricity in an environmentally-friendly state which is easily stored and distributed.

Currently, industrial production of hydrogen relies overwhelmingly on fossil fuels to power the electrolysis process. The most advanced method of generating hydrogen using renewable power uses a method known as proton exchange membrane electrolysers (PEMEs). To reach optimum efficiency, PEMEs require precious metal catalysts to be held in high-pressure containers and subjected to high densities of electric current, which can be difficult to reliably achieve from fluctuating renewable sources.

The new method allows larger-than-ever quantities of hydrogen to be produced at atmospheric pressure using lower power loads, typical of those generated by renewable power sources. It also solves intrinsic safety issues which have so far limited the use of intermittent renewable

energy for hydrogen production.

The research team was led by Professor Lee Cronin of the University of Glasgow's School of Chemistry. Professor Cronin said: "The process uses a liquid that allows the hydrogen to be locked up in a liquid-based inorganic fuel. By using a liquid sponge known as a redox mediator that can soak up electrons and acid we've been able to create a system where hydrogen can be produced in a separate chamber without any additional energy input after the electrolysis of water takes place.

"The link between the rate of water oxidation and hydrogen production has been overcome, allowing hydrogen to be released from the water 30 times faster than the leading PEME process on a per-milligram-of-catalyst basis."

The research was produced as part of the University of Glasgow Solar Fuels Group, which is working to create artificial photosynthetic systems which produce significant amounts of fuel from solar power.

Professor Cronin added: "Around 95% of the world's hydrogen supply is currently obtained from fossil fuels, a finite resource which we know harms the environment and speeds climate change. Some of this hydrogen is used to make ammonia fertilizer and as such, fossil hydrogen helps feed more than half of the world's population."

"The potential for reliable hydrogen production from renewable sources is huge. The sun, for example, provides more energy in a single hour of sunlight than the entire world's population uses in a year. If we can tap and store even a fraction of that in the coming years and decrease our reliance on fossil fuels it will be a tremendously important step to slowing climate change."

The University of Glasgow's Dr Greig Chisholm, Dr Mark Symes and

Benjamin Rausch also contributed to the paper, 'Decoupled catalytic hydrogen evolution from a molecular metal oxide redox mediator in water splitting', which is published in *Science*.

More information: "Decoupled catalytic hydrogen evolution from a molecular metal oxide redox mediator in water splitting." Benjamin Rausch, Mark D. Symes, Greig Chisholm, Leroy Cronin. *Science* 12 September 2014: Vol. 345 no. 6202 pp. 1326-1330. DOI: 10.1126/science.1257443

Provided by University of Glasgow