Progress made in building rechargeable lithium-air battery

July 20 2012, by Bob Yirka

(Phys.org) -- Researchers in the United Kingdom have taken another step towards proving that so named lithium-air ($Li-O_2$) batteries might one day become practical. Up to now the problem has been using the technology to build a battery that uses oxygen and that can survive many charge-discharge-recharge cycles. Now Zhangquan Peng, Stefan Freunberger, Yuhui Chen and Peter Bruce of Saint Andrews in Scotland, have developed a way to build a lithium-air battery, using a gold electrode that, as they describe in their paper published in the journal *Science*, survived a hundred cycles with just 5% loss of power.

Traditional lithium ion batteries are based on metal phosphate (or oxide) cathodes that serve as positive electrodes, carbon based anodes that serve as negative electrodes and an electrolyte to move the ions between the two. With lithium air batteries, air is used as the cathode; oxygen reacts with lithium ions and electrons on the surface of the cathode, forming lithium peroxide which leads to an electrical current being created during discharge. When recharging, everything happens in reverse resulting in oxygen being released back into the air. Up till now, the problem has been in preventing the cathodes and electrolytes from breaking down after repeated cycles of charging and discharging. To prevent that from happening, the UK team used a thin film of porous gold as the electrode.

That simple adjustment did indeed prevent the parts from decomposing, unfortunately, it's not the solution to the problem, as using gold would not only be far too heavy, it would much too expensive for use in car

batteries or consumer electronics. But as the researchers note, their work hasn't resulted in a method of building lithium-air batteries for general use, but instead has shown that the technology itself works as hoped and that if another material can be used instead of gold, we might yet see the development of such batteries which could offer far more storage capacity than today's offerings. Some have suggested that a phone with such a battery could be used for week without recharging, or that electric cars could finally start competing with gas guzzlers in the distance drivers could expect to travel before having to recharge.

More information: A Reversible and Higher-Rate Li-O2 Battery, *Science*, DOI: 10.1126/science.1223985

ABSTRACT

The rechargeable nonaqueous Li-O2 battery is receiving a great deal of interest because theoretically its specific energy far exceeds the best that can be achieved with lithium-ion cells. Operation of the rechargeable Li-O2 battery depends critically on repeated and highly reversible formation/decomposition of Li2O2 at the cathode on cycling. Here, we show that this is possible, using a dimethyl sulfoxide electrolyte and porous gold electrode (95% capacity retention from cycles 1 to 100), whereas previously only partial Li2O2 formation/decomposition occurred and with limited cycling. Furthermore, we present data indicating that the kinetics of Li2O2 oxidation on charge is approximately 10-fold faster than on carbon electrodes.