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Stanford's battery-life research steps into economy class

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(Phys.org)—Looking for better battery designs and solutions is a priority pursuit for many scientists, and the Batteries for Advanced Transportation Technologies (BATT) Program is always on the lookout for worthy contributions. Supported by the U.S. Department of Energy and managed by the Lawrence Berkeley National Laboratory, BATT is a leader in U.S. research in battery solutions for electric vehicles. They have not missed the fact that Prof. Yi Cui, Associate Professor, Department of Materials Science and Engineering at Stanford University, has been leading a team that is coming up with new answers for energy storage.

"Several fundamental studies still need to be conducted to develop viable Si electrodes for batteries," BATT has written in the past. "Yi Cui's group at Stanford University is working on understanding the properties of various Si nanostructures and is designing new ones based on particles and wires that target improving Si cyclability."

BATT has recognized an important issue addressed by Cui, the conductivity of Si electrodes. "The electrical conductivity of Si is a major factor in determining the power and energy capabilities of an electrode that does not contain inactive materials such as conductive additives and binder. Future work in the Cui group will focus on designing new Si structures and pre-lithiation methods that are amenable to scale up so that large quantities of this anode material can be made at a low cost. Fundamental questions such as the best morphology for electrode packing, the type of surface coating for improving cyclability, and the optimal state of charge for these electrodes still need to be answered."

This month, Prof. Yi Cui and his Stanford team offer more answers in a newly published paper appearing in the journal *Nature Communications.* To compensate for fluctuating renewables in wind and solar systems, new approaches to storage are needed and Cui's team present a battery technology that works when the sun or wind falls short, in the form of sharp drop-offs of wind and solar systems. The battery electrodes can run for a thousand charge cycles without degrading, an advancement when typically the electrodes degrade with time.

As *New Scientist* translates, the secret sauce in their battery prototype involves the negatively charged cathode coating in copper hexacyanoferrate and an anode made of activated carbon and a conductive polymer. The compounds allow electricity-carrying ions to move in and out easily.

"We demonstrate a new type of safe, fast, inexpensive, long-life aqueous electrolyte battery, which relies on the insertion of potassium ions into a copper hexacyanoferrate cathode and a novel activated carbon/polypyrrole hybrid anode. The cathode reacts rapidly with very little hysteresis. The hybrid anode uses an electrochemically active additive to tune its potential. This high-rate, high-efficiency cell has a 95% round-trip energy efficiency when cycled at a 5C rate, and a 79% energy efficiency at 50C. It also has zero-capacity loss after 1,000 deep-discharge cycles."

As important to the design is the cost factor. A key stumbling block in the search for answers in energy storage rests in viability. Many solutions are promising in the lab but present daunting costs that are eventually branded as impractical. No existing energy storage technology, the Cui team said, can economically provide the power, cycle life and energy efficiency needed to respond to the costly short-term transients that arise from renewables and other aspects of grid operation.

"Virtually all of the energy-storage capacity currently on the grid is provided by pumped hydroelectric power, which requires an immense capital investment, is location-dependent and suffers from low energy efficiency," according to the authors. They said that their battery's components are cheap and commercially available.

via www.newscientist.com/blogs/one … d-scale-battery.html

More information: *Nature Communications* 3, Article number: 1149 doi:10.1038/ncomms2139