

Breakthrough Energy-Dense Battery Uses Lithium and Sulfur

The solid battery could also prove cheaper than current lithium-ion technology once developed. By Julia Pyper and ClimateWire | June 6, 2013

Safe, low-cost, energy-dense batteries are widely considered to be the holy grail in furthering low-carbon energy use. Making high-performance batteries has proved elusive, but scientists at the Oak Ridge National Laboratory claim they've made a breakthrough. The Oak Ridge lab announced yesterday it has designed and tested a completely solid lithium-sulfur battery with about four times the energy density of comparable lithium-ion battery technology. Given the abundance of elemental sulfur, the battery can also be produced at a much lower cost.

"Our approach is a complete change from the current battery concept of two electrodes joined by a liquid electrolyte, which has been used over the last 150 to 200 years," said Chengdu Liang, lead author of an ORNL study published this week in the journal *Angewandte Chemie International Edition*. Lithium-ion batteries power many of today's electronics, and are also used in electric vehicles and for grid-scale energy storage. The problem is that conventional lithium-ion batteries are expensive and rely on a highly flammable liquid electrolyte to carry charge between the anode and cathode. In contrast, the lithium-sulfur battery developed by ORNL is completely solid and much more stable. Researchers achieved this by synthesizing a novel class of sulfur-rich materials and combining it with solid electrolyte material, also developed at ORNL.

Lithium-sulfur batteries are solid, safer and cheaper. They are also about eight times more energy-dense than lithium-ion batteries. But because lithium-sulfur batteries deliver about half the voltage of their lithium-ion counterparts, the ORNL battery ultimately has four times more energy density than lithium-ion technologies, which is still a significant advantage. Another benefit is the wide availability of sulfur - a common byproduct of petroleum processing. "Sulfur is practically free," said Liang. Scientists have been chasing the potential of lithium-sulfur batteries as a long-lasting, large-scale commercial energy storage option for decades, but with little success. In using a liquid electrolyte, as in a lithium-ion battery, the sulfur batteries could effectively conduct ions but would prematurely break down. By completely changing the battery design, ORNL researchers were able to switch from liquid to solid electrolytes and eliminate the issue of sulfur dissolution. Liang called the development "game-changing."

"In the past, we had no way to make it work; now we have the way, and we showed that this is possible with this new material and this new design," he said. "Now battery designers, manufacturers and researchers can look into this new system, and based on the material we discovered, they can design a new series of batteries for different applications." Liang said the all-solid lithium-sulfur battery could replace the use of lithium-ion batteries in electric vehicles and for grid storage. The technology is still in the developmental stage, however. Further research is needed to find out how quickly this new technology can penetrate the market.

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