High-energy density magnesium batteries for smart electrical grids

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(PhysOrg.com) -- Magnesium-based batteries are, in theory, a very attractive alternative to other batteries.

Magnesium (Mg) is cheap, safe, lightweight, and its compounds are usually non-toxic. Mg is less expensive (metallic lithium [Li] costs about 24 times more than metallic Mg) because Mg is abundant in the Earth's crust. Mg is safer because it is stable when exposed to the atmosphere. Mg provides a theoretical specific capacity of 2,205 ampere-hours/kilogram, making it an attractive high-energy density battery system.

Furthermore, it provides two electrons per atom and has electrochemical characteristics similar to Li (12 grams-per-Faraday [g/F], compared to 7 g/F for Li or 23 g/F for sodium).

Proper design and architecture should lead to Mg-based batteries with energy densities of 400-1,100 watt-hour per kilogram for an open circuit voltage in the range of 0.8 – 2.1 V, which would make it an attractive candidate for electrical grid energy storage and stationary back-up energy.

To make Mg-based batteries practical, researchers at DOE's National Energy Technology Laboratory are developing novel alloys of Mg doped with different elements such as calcium, zinc, and yttrium. These alloys are being produced by melting and casting as well as powder metallurgy.

A new displacement reaction hypothesis, based on the reaction of nanostructured transition metal compounds with Mg, has resulted in a thermodynamically favorable reversible displacement reaction of transition metals and Mg-alloys.

Recent accomplishments include a new, intermetallic anode compound formulated by melting/casting and synthesis of a new MgMn1-xFexSiO4/C composite, and other transition metal oxide spinel cathode systems. Mg-based electrolytes and other ionic electrolytes have also been developed and are being tested.

Provided by National Energy Technology Laboratory

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