Researchers produce nanostructures with potential to advance energy devices

September 4 2013

New types of nanostructures have shown promise for applications in electrochemically powered energy devices and systems, including advanced battery technologies.

One process for making these nanostructures is dealloying, in which one or more elemental components of an alloy are selectively leached out of materials.

Arizona State University researchers Karl Sieradzki and Qing Chen have been experimenting with dealloying lithium-tin alloys, and seeing the potential for the nanostructures they are producing to spark advances in lithium-ion batteries, as well as in expanding the range of methods for creating new nanoporous materials using the dealloying process.

Their research results are detailed in a paper they co-authored that was recently published on the website of the prominent science and engineering journal *Nature Materials* (Advance online publication).

Sieradzki is a materials scientist and professor in the School for Engineering of Matter, Transport and Energy, one of ASU's Ira A. Fulton Schools of Engineering.

Chen earned his doctoral degree in materials science at ASU last spring and is now a postdoctoral research assistant.

Nanoporous materials made by dealloying are comprised of nanometerscale zigzag holes and metal. These structures have found application in catalysis (used to increase the rate of chemical reactions) as well as actuation (used to mechanically move or control various mechanisms or systems) and supercapacitors (which provide a large amount of high electrical capacity in small devices).

They could also improve the performance of electrochemical sensing technology and provide more resilient radiation damage-resistant materials.

The nanostructures that Sieradzki and Chen have produced by dealloying lithium-tin alloys allows for more efficient transport and storage of the electric charge associated with lithium, while the small size prevents fracture of the tin reservoir that serves as a storage medium for lithium.

Lithium-ion batteries are one of the leading types of rechargeable batteries. They are widely used in consumer products, particularly portable electronics, and are being increasingly used in electric vehicles and aerospace technologies.

Sieradzki and Chen say that with more research and development the porous nanostructures produced by dealloying lithium alloys could provide a lithium-ion battery with improved energy-storage capacity and a faster charge and discharge – enabling it to work more rapidly.

One major advantage is that the porous nanostructures providing this electrochemical power boost can evolve spontaneously during tunable dealloying processing conditions. This, Sieradzki explains, opens up possibilities for developing new nanomaterials that could have a multitude of technological applications.

"There are a lot of metals that scientists and engineers have not be able to make nanoporous," he says. "But it turns out that with lithium you can lithiate and de-lithiate a lot of materials, and do it easily at room temperature. So this could really broaden the spectrum for what's possible in making new nanoporous materials by dealloying."

More information: www.nature.com/nmat/journal/va … nt/abs/nmat3741.html

Provided by Arizona State University