Battery Material Prevents Fires, Stores Five Times the Energy

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Researchers at Oak Ridge National Laboratory have developed a solid electrolyte to replace flammable ones used in lithium-ion batteries.

Safer, cheaper batteries are needed to make electric vehicles competitive.

Battery protection: This micrograph shows a powdery material that has a nanostructure (far right) that improves its conductivity.

An electrolyte developed by researchers at Oak Ridge National Laboratory could enable lithium-ion batteries that store five to 10 times more energy and are safer than the ones that recently caught fire on Boeing's 787 Dreamliner.

While the cause of the Boeing fire hasn't yet been determined, Boeing could have reduced the risk of fire by choosing a safer electrode chemistry (see "Grounded Boeing 787 Dreamliners Use Batteries Prone to Overheating"). But it would have had fewer options for the electrolyte—the material that allows current to flow through a battery. Lithium-ion batteries, even the ones that use relatively safe electrodes, still use flammable liquid electrolytes.

Solid electrolytes would be much safer, but it's been difficult to make them conductive enough for use in batteries. The ORNL researchers, in work published in the current issue of the Journal of the American Chemistry Society, have an easy method for making a nanostructured form of one solid electrolyte. The nanostructure improves the material's conductivity 1,000 times, enough to make it useful in lithium-ion batteries. The researchers also showed that the new material is compatible with high-energy electrodes.

The solid electrolyte isn't as conductive as liquid electrolytes, but the researchers say they can compensate for this by making the electrolyte very thin, among other measures. Even then, the batteries might not charge as quickly or provide the same boost of power possible with liquid electrolytes, but this would be okay in many applications, such as in electric cars, where the sheer number of battery cells makes it easy to deliver adequate bursts of power.

The solid electrolyte not only makes batteries safer, it could also enable the use of higher energy electrode materials. As a result, while the rate at which these batteries deliver power may be less than today's lithium-ion batteries, the total amount of energy they can store would be far higher. A much smaller battery could then be used—saving space and weight on airplanes and greatly reducing the cost of electric vehicles.

The solid electrolyte might be particularly suited to lithium-sulfur batteries, which can store a lot of energy, but have safety issues and can't be recharged enough times to last the life of a car (see "Nanostructures Boost Battery Life Fivefold"). The lithium-metal electrodes can cause battery shorts and fires. The solid electrolyte helps stabilize the lithium metal and serves as a barrier to prevent shorts. The sulfur electrodes in these batteries also degrade when used with liquid electrolytes—some of the sulfur can be dissolved in the liquid and lost. The solid electrolyte prevents that.

The work is still at an early stage. So far, the researchers have only made small, half-inch test cells, And the results demonstrating the compatibility with lithium-sulfur batteries are still unpublished.

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