Researchers predict 'nanobattery' performance

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Researchers at Delft University of Technology can predict how nanostructuring – the extreme reduction of structure – will affect the performance of Li-ion batteries. The nanostructuring of battery materials is likely to be common practice in the future, but it is not always performance-enhancing. The research findings have recently been published in the *Journal of the American Chemical Society*.

A Li-ion battery is currently the smallest and lightest way to store as much rechargeable electrical energy as possible. However, the batteries are slow to charge and discharge, and this restricts their suitability for applications such as hybrid and electric vehicles. This sluggish performance is largely determined by the relatively long distance the lithium-ions have to travel through the electrode material in the battery.

The speed at which the ions make their way through the electrode material is also slow compared to that in electrolyte (the fluid between the electrode material). The current strategy is therefore to nanostructure the electrode particles; that is to say, to make them very small (measurable in nanometres), and by doing so to shorten the existing route within the electrode material.

Yet the battery performance of materials nanostructured in this way has failed to meet expectations. To a great extent, these discrepancies were not understood. By using neutron-diffraction research technology, researchers at Delft University of Technology's Reactor Institute Delft (RID) have discovered that when the electrode particles are scaled down,

the properties of the material structure change significantly. The phase balance that is generally present in this type of material changes and even disappears completely if the electrode sections become small enough.

Based on these findings, the researchers (Marnix Wagemaker, Wouter Borghols and Fokko Mulder) can predict how the nanostructures will affect the performance of the Li-ion batteries. They have concluded that the nanostructures of the electrode materials in Li-ion batteries is largely dependent on the material and the exact particle size. At a more general level, their findings are important for applications in which small ions diffuse into nanocrystals, such as hydrogen storage and the formation of alloys.

Source: Delft University of Technology