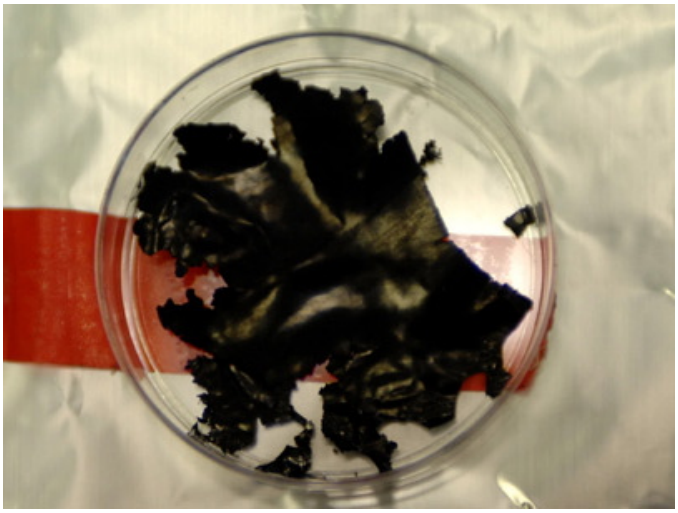
Battery Materials for Ultra-fast Charging and Discharging

Based on earlier calculations, Gerbrand Ceder of the Massachusetts Institute of Technology and colleagues found that the transport of lithium (Li) ions in lithium iron phosphate battery material ($LiFePO_4$) should be very fast and enable a high power rate for lithium ion batteries. However, in practice the power rate was low. Ceder and graduate student Byoungwoo Kang have now demonstrated that changing the surface structure of $LiFePO_4$ enables an extremely high discharge rate, comparable to supercapacitors.

When a lithium (Li) battery is discharged, Li ions and electrons move through the electrolyte and composite electrode structure and into the active cathode material. However, recent calculations show that Li ions can only move into the bulk of the crystal in the direction of one facet. In order to speed the diffusion of Li ions from the cathode surface into the bulk of the crystal, Kang and Ceder modified the composition of $LiFePO_4$ and used a processing scheme that leaves a glassy, fast ion conductor on the surface, thereby leading the lithium ions rapidly to the proper "tunnels" for more efficient movement into the material.

The researchers have demonstrated small batteries that can deliver their full energy in as little as 10 seconds. Such battery materials may enable smaller, lighter batteries in cell phones and other small devices, and they may prove valuable for hybrid and plug-in hybrid vehicles and intermittent renewable energy sources. Because this battery material is a variation of one already on the market, it could become available in just a few years. Ceder and Kang have begun a computational search for additional materials with very high rate capability.



A sample of a film carrying a new material ($LiFePO_4$) that could allow quick charging and discharging of lithium ion batteries. Credit: Massachusetts Institute of Technology

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Patents and other steps toward commercialization: The material has been licensed by two companies.

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