COMMENT

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Top electric cars can now travel more than 500 kilometres on a single charge, but their lithium-ion batteries remain inefficient.

Track batteries degrading in real time

Monitor deforming electrodes to speed development of renewable-energy storage, write **Liqiang Mai**, **Mengyu Yan** and **Yunlong Zhao**.

Energy storage is the main bottleneck for clean electricity, transport and portable electronics. Electrochemical devices such as lithium-ion batteries are most promising. These hold and release energy through reversible reactions in their electrodes. They are compact, safe and efficient — ideal for electric vehicles. Improved lithium-ion batteries have extended the mileage of electric cars from about 150 kilometres in 2012 to more than 500 km today, for Tesla's Model S 100D. Yet lithium-ion batteries remain expensive (US$250 per kilowatt-hour)[1] and of limited efficiency (200–250 watt-hours per kilogram)[2,3].

Degradation of electrodes is the main problem. But this is hard to address. The electrochemical processes involved are complicated and poorly understood. They depend, for example, on the behaviour of the electrode materials (typically involving compounds such as lithium iron phosphate and lithium nickel manganese cobalt oxide) and the liquid or solid electrolytes that transfer charge.

To learn more about why electrodes deteriorate, researchers must find fresh ways to track electrochemical processes in real time. Microscopes and spectroscopic instruments are expensive and restricted in what they can see, and using them requires specialist training. What's more, they normally operate at temperatures and pressures far from the ambient ones at which the batteries are used. This means that results and conclusions could be inaccurate.

Government, academia and industry need to share facilities, know-how and funding to develop techniques for tracking the structures and chemistry of battery electrodes. By learning more about how electrodes deform and the reactions they undergo, we can ▶