Pathways to Batteries with High Energy Density *and* High Power

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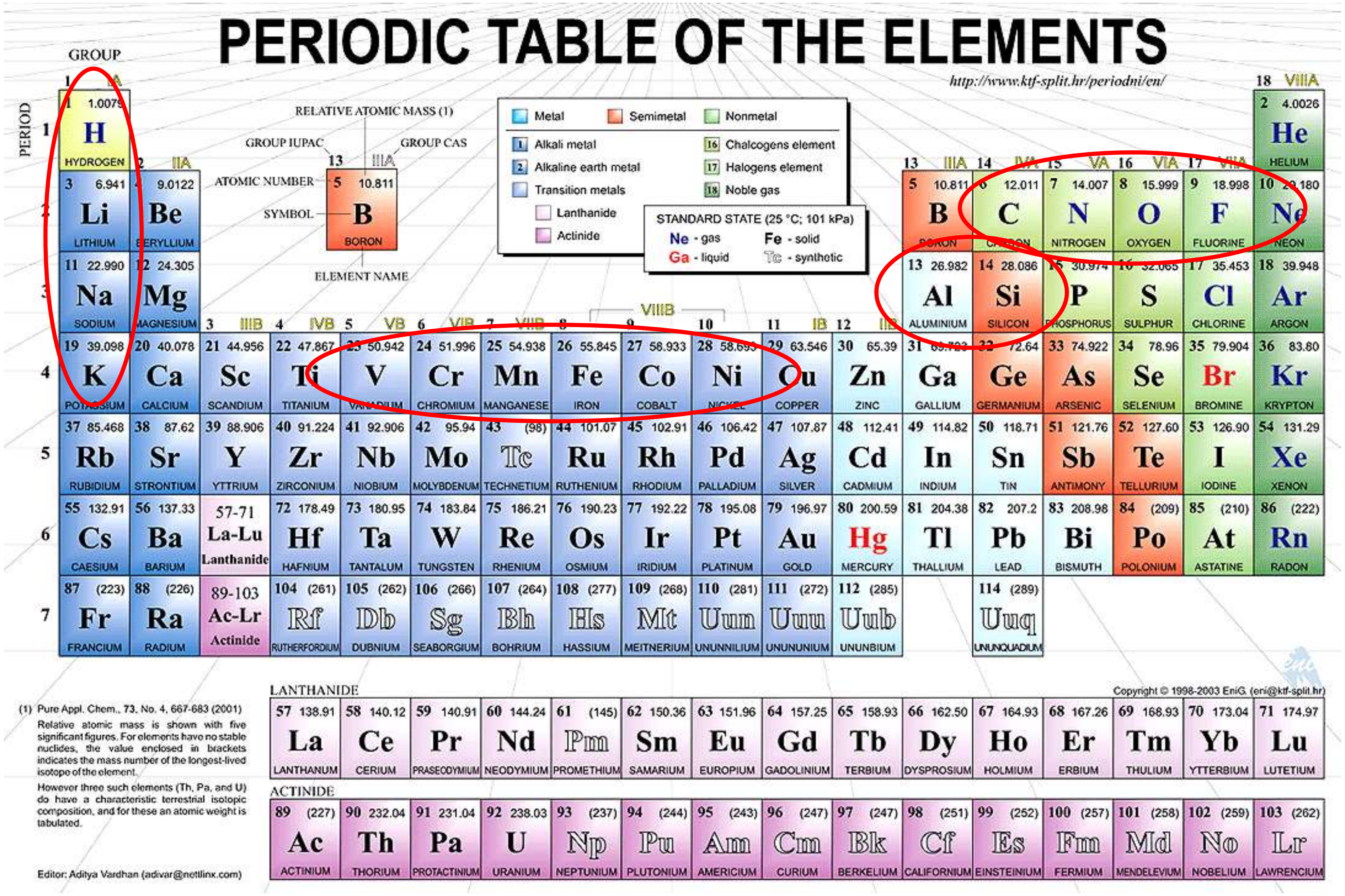
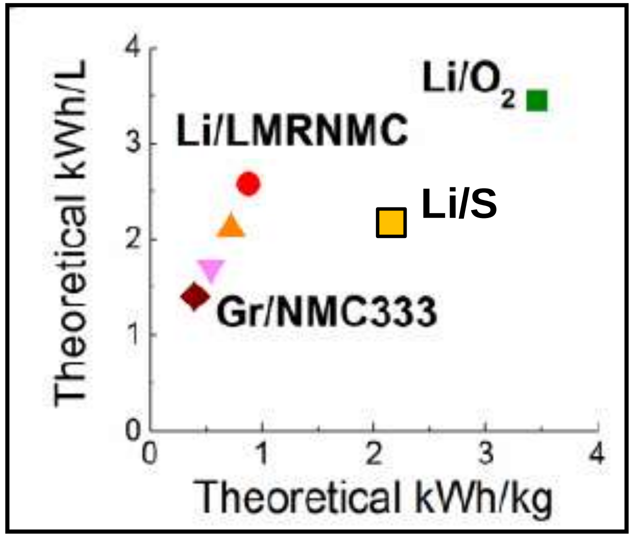
High energy batteries come from the top of the periodic table



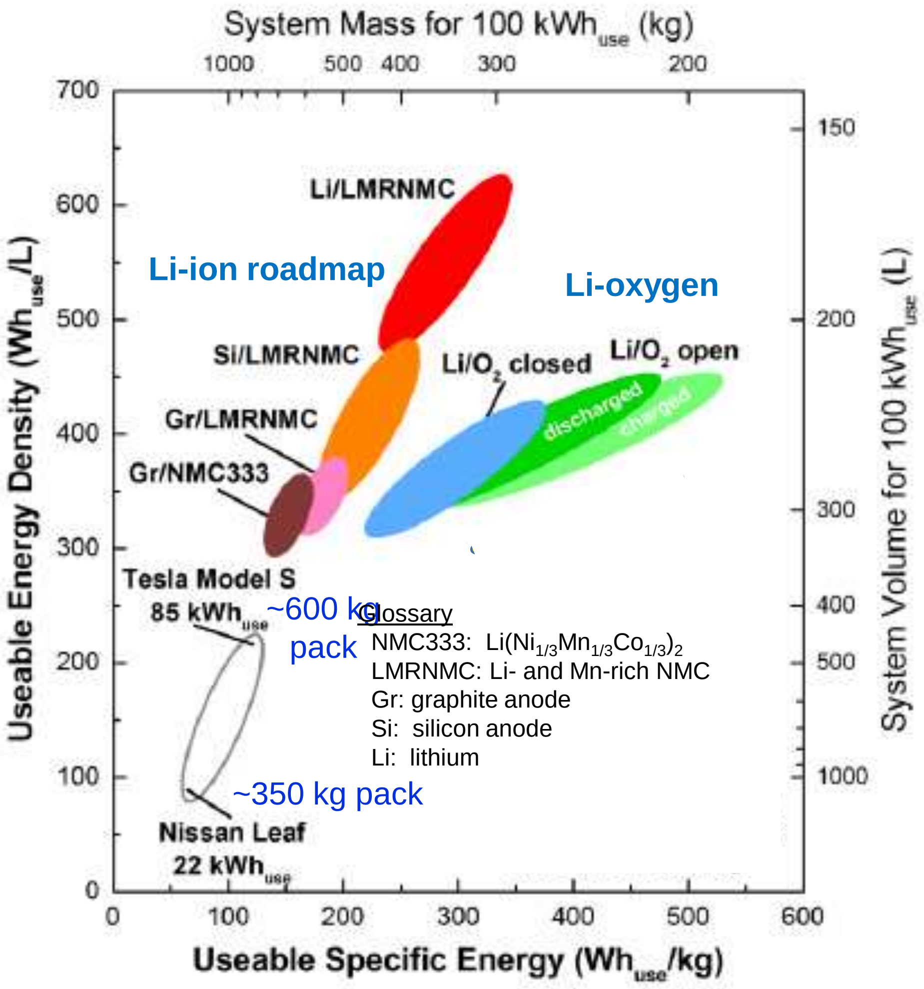
Theoretical vs Usable Energy Densities

Theoretical energy densities are all very high



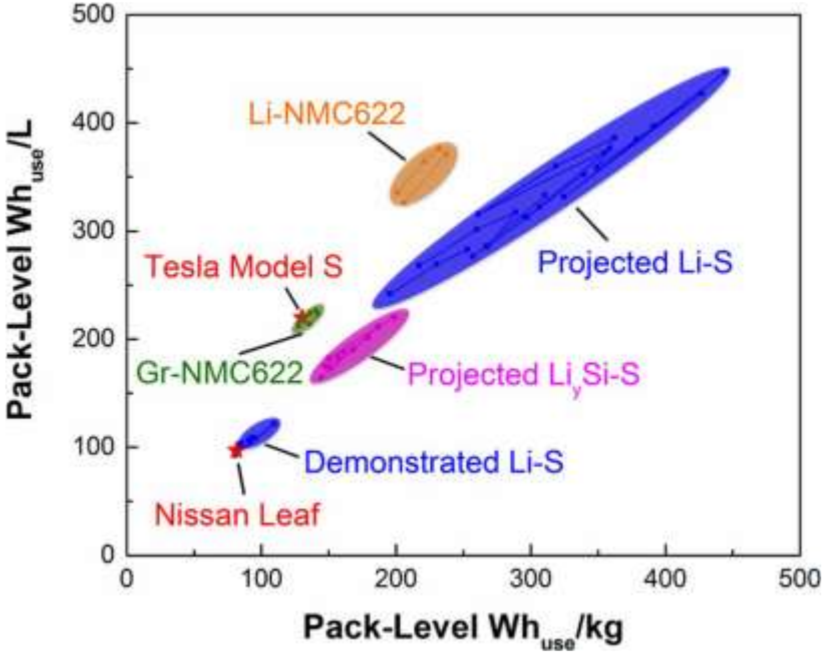
Highest Energy Density Batteries All Use Li Metal

Lithium-oxygen vs. Li-ion Roadmap



K.G. Gallagher et al., “Quantifying the promise of lithium-air batteries for electric vehicles,” *Energy Environ. Sci*, 7, 1555 (2014)

Lithium-sulfur vs. Li-ion Roadmap



D. Eroglu *et al.*, *J. Electrochem. Soc.*, 162, A982 (2015)

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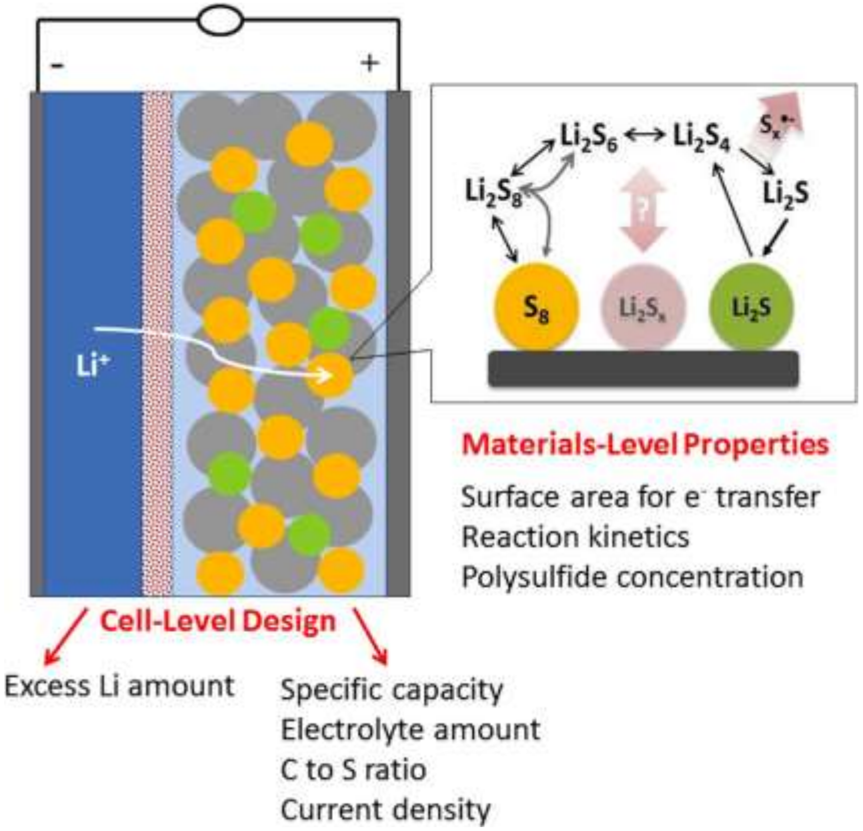
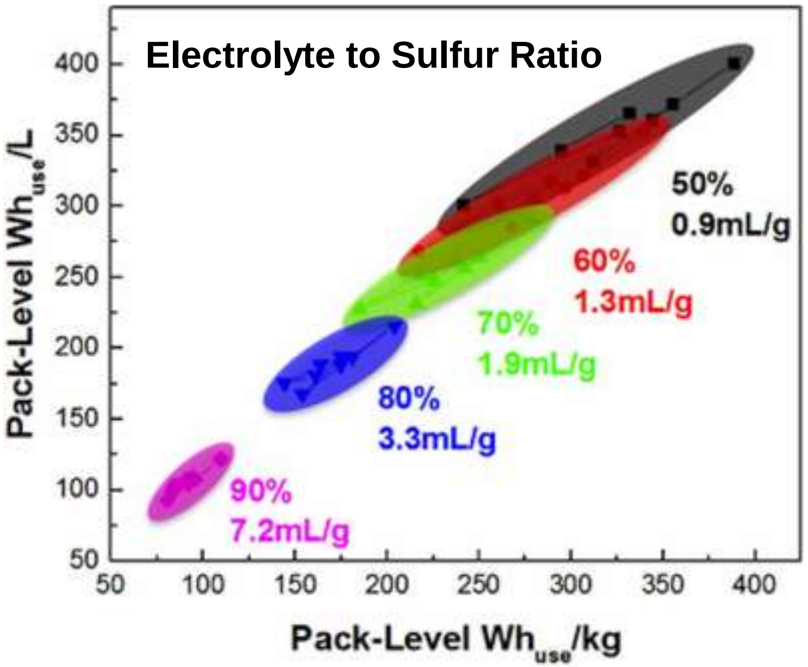
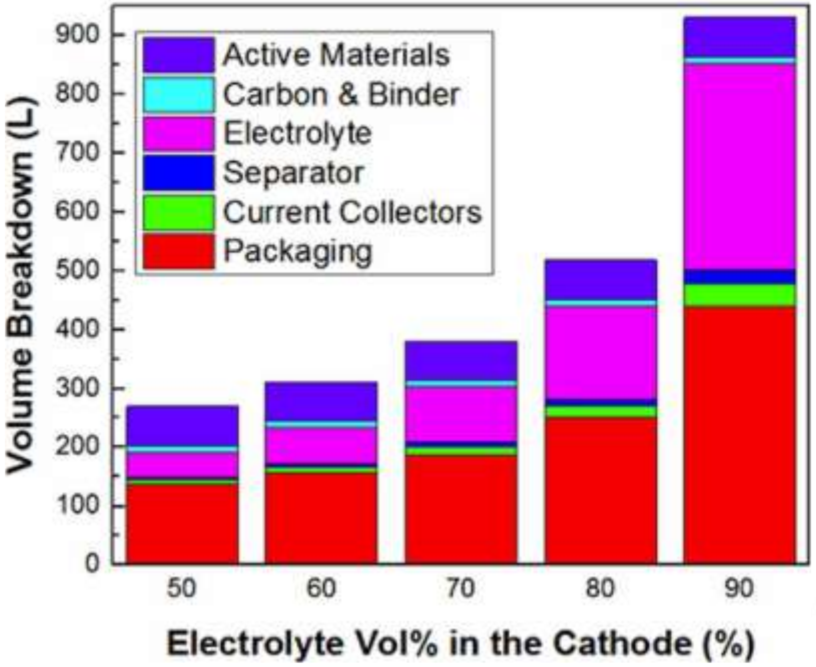
Lithium-Sulfur Batteries today require too much electrolyte, which limits the practical energy density



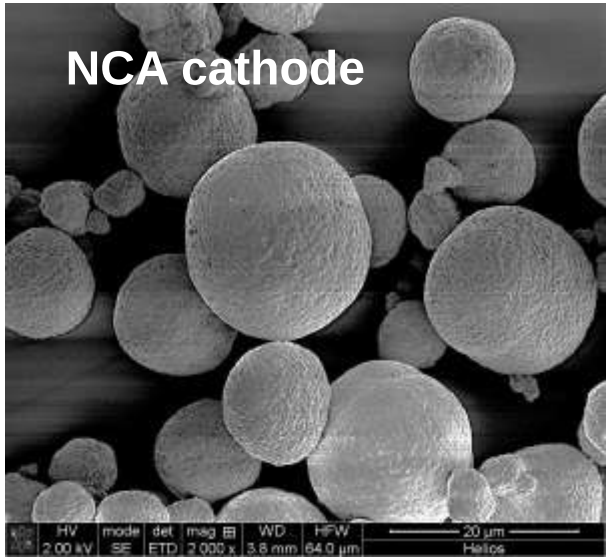


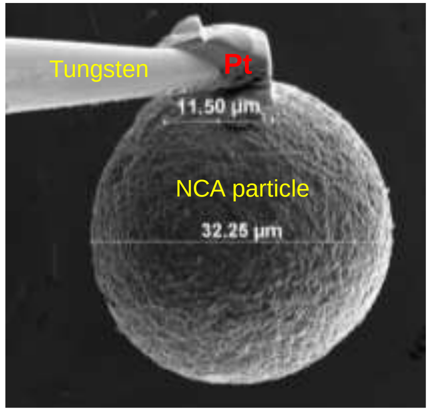


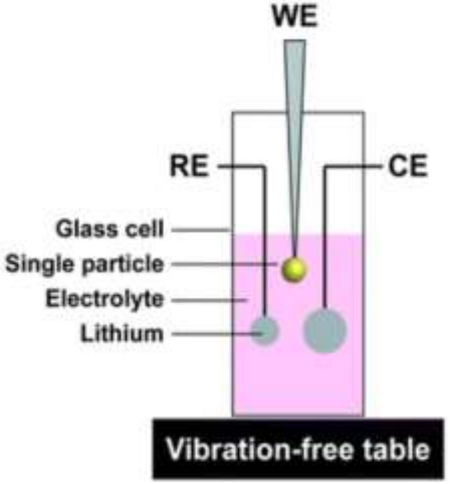
D. Eroglu *et al.*, "Critical Link between Materials Chemistry and Cell-Level Design for High Energy Density and Low Cost Transportation Battery," *J. Electrochem. Soc.*, 162, A982 (2015)

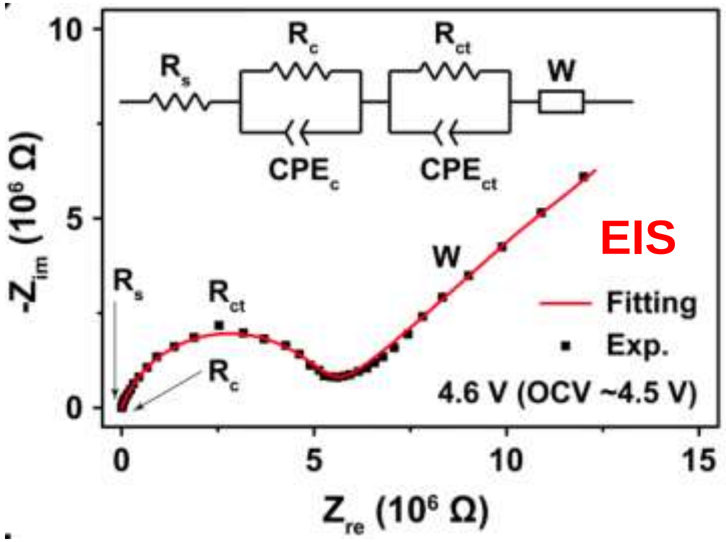
Ion Transport Constraints Limit Discharge Power

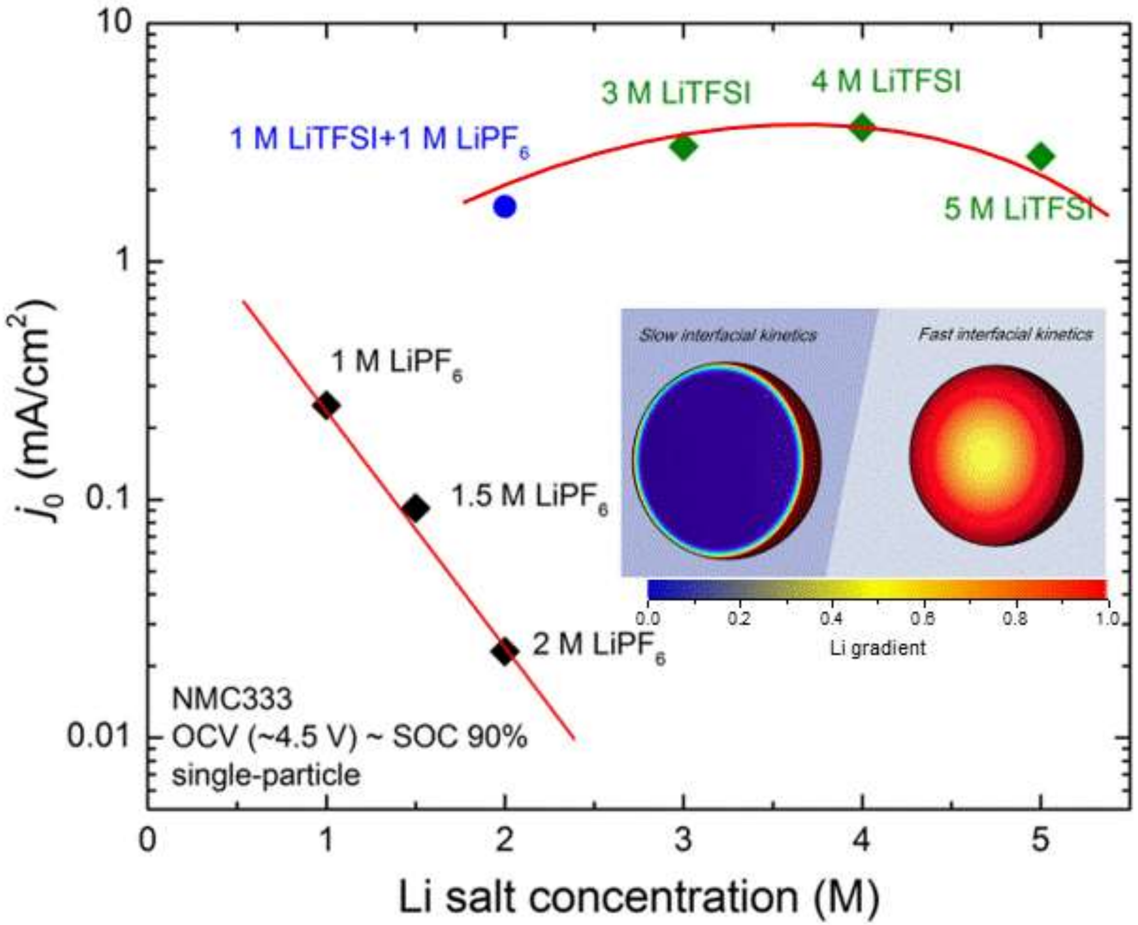
Electrolyte innovations needed to increase conductivity, interfacial transport rates











Ion Transport Constraints Limit Discharge Power

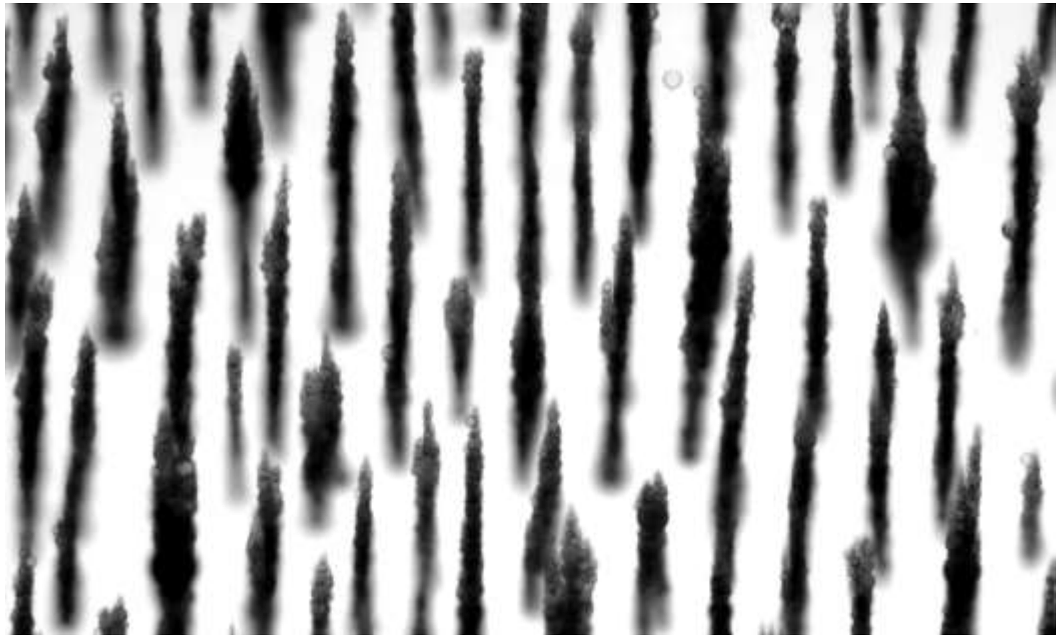

MIT Technology Review

Topics+

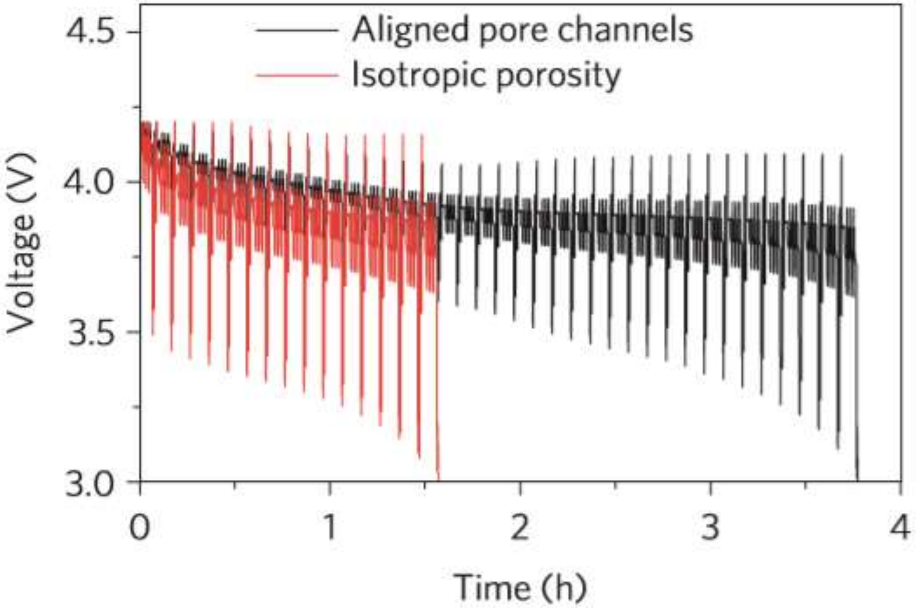
Sustainable Energy

A powerful new battery could give us electric planes that don't pollute

At electrode scale, novel low-tortuosity structures needed



Magnetic field alignment of low tortuosity electrodes



J.S. Sander, et al., "High Capacity Low-Tortuosity Battery Electrodes via Sacrificial Magnetic Templating," *Nature Energy*, 2016, DOI: 10.1038/NENERGY.2016.99 and https://www.technologyreview.com/s/612351/top-battery-scientists-have-a-plan-to-electrify-flight-and-slash-airline-emissions/

Thank you