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# Energy storage: Neutrons to understand improvement in battery performance upon anode modification

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Electric vehicles are on the way to replace gasoline-powered vehicles n our near future. To power such vehicles, Li-ion batteries with very high storage capacities are necessary, so that these cars travel sufficiently large distances before needing a recharge at charging stations. Moreover, these batteries should have long lifetimes so that they can be charged and discharged several times before needing a replacement. Now energy storage capabilities, rate performances and cycling stabilities of Li-ion batteries are strongly dependent on the electrode materials. As practical energy densities accessible with cathode materials are already close to their theoretical limits with the currently available electrolytes, improvements or replacement of anode materials becomes more paramount than the cathode materials. The widely used graphite anode is stable, but offers low energy density, and suffers from side reactions, which are severe at higher charging rates and low temperatures, leading to eventual capacity fading. Titanium oxide anodes offer much longer life cycles, but have even lower energy densities. Li metal anodes offer the highest possible energy density, but are prone to dendrite formation and thus not preferred for safety reasons. Si anodes offer second highest possible energy densities, but suffer from large volume changes leading to fast capacity fading. With help of several analytical methods, including neutron based methods; this contribution will show how battery performances can be enhanced by either altering the anode morphology, or by preparing composite anode mixtures, or by applying coatings to anode surfaces.

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Dr. Neelima Paul is a physicist with background in preparation and characterization of inorganic semiconductor nanostructures and polymers using neutron, X-ray, infrared and microscopy techniques. At TUM, she focuses on Li-ion battery research and performs operando and post-mortem evaluations of electrode microstructure and morphology, and investigates Li diffusion kinetics within cells to understand the fundamental processes, so that safer Li-ion batteries with even higher energy densities and longer lifetimes can be realized

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