Physics-informed machine learning-based swelling models for future battery cells

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Lithium-ion batteries are fundamental to achieve our net zero goals. However, designing the batteries of the future requires a very deep understanding of the interactions between all the physical phenomena occurring. One of these phenomena, which is very poorly understood, is the swelling of electrodes.

This means that as we charge and discharge our batteries, the materials inside swell and shrink. Now, what are we going to do in this HetSys project? We will develop a physics-informed data-driven model that can capture battery swelling. Then, this model is going to combine the strength of physics-based approaches with the strengths of machine learning approaches.

We'll use this model to understand swelling and eventually infer which material properties we need to minimize swelling. How are we going to achieve that? Well, we will combine a Bayesian framework with physics-based multi-scale models. We'll develop surrogate models then that are fast and accurate and that we can validate against experimental data and use to quantify uncertainties.

We'll finally implement these models in Python and share them with the broader community so everyone can benefit. (1:11) The team for this HETCIS project are Dr Lucas Figuel, who brings expertise on mechanistic and data-driven models for materials for energy storage, and myself, Dr Ferran Brosa Planella, and I bring expertise on physics-based battery models, model reduction, and also computational methods. We also have an industrial partner, which is Jaguar Land Rover, who will provide extensive automotive expertise and also experimental data to validate our models.