Boosting battery life with hybrid machine learning of degradation mechanisms

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Hi, my name is Louis Piper and I'm Professor of Battery Innovation here at the University of Warwick, and today I want to talk about a fantastic PhD opportunity with HetSys. Essentially boosting battery life with hybrid machine learning of degradation mechanisms.

What do we mean by this?

Well, a key aspect of a greener future is the electrification of cars and other transport sectors. So in that case, we're talking about batteries that perform better and last longer. Here in this slide, we're showing plots of how the type of batteries that you would have in cell phones or in your car vehicles perform. And essentially we're showing charge cycles of a traditional battery where the capacity is essentially flat.

As we push these batteries further, then we're going to be able to have more capacity in and out.
And that leads to initially a higher capacity at the beginning, but faster fade. Now what we really want is the combination of those higher capacity performance with good capacity retention, which means we want to be able to suppress the degradation mechanism inside.

The blue area really is a target zone for a lot of the battery researchers in terms of realising the high performance, high capacity, but with minimal degradation and in that case, we're looking for essentially the ability to have thousands of cycles where we are able to have less pay than 80% of the original capacity in order for have cars that will last 1020 years on the road without any issues.

So degradation inside the battery requires a combination of experiments and sophisticated modelling in order to understand why we're losing capacity. We have to understand the chemical reactions and essentially lithium shuttles back and forth between the electrodes as we cycle and some of that lithium can get stuck.

Using very sophisticated means of combining pilot line built cells with X-ray techniques, researchers at University of Warwick have determined that some of the lithium can get trapped in the positive electrode behind a thin crust that forms on the surface of the materials. This affects the transport where lithium can get stuck as you cycle. This also means that we have a beautiful data set for data mining to link with the modelling and that's where we need modellers like yourself to work on these problems.

Our approach is to combine this innovative operando X-ray testing that combines the X-rays with chemistry to provide outputs with regards to how the cycling and the transport properties manifest as capacity fade and combine that with physics based diffusion models.

Coupled with machine learning to understand how the transport has been hindered by these blocking layers in order to identify how severe this is and also develop rational design tools that can be implemented to overcome these.

This is a fantastic opportunity to combine a combination of state-of-the-art experiments with state-of-the-art modelling to do some research with impact that will contribute to EU KS goal of net zero and a cleaner future for the next generation.

We look forward to your applications. Thank you.