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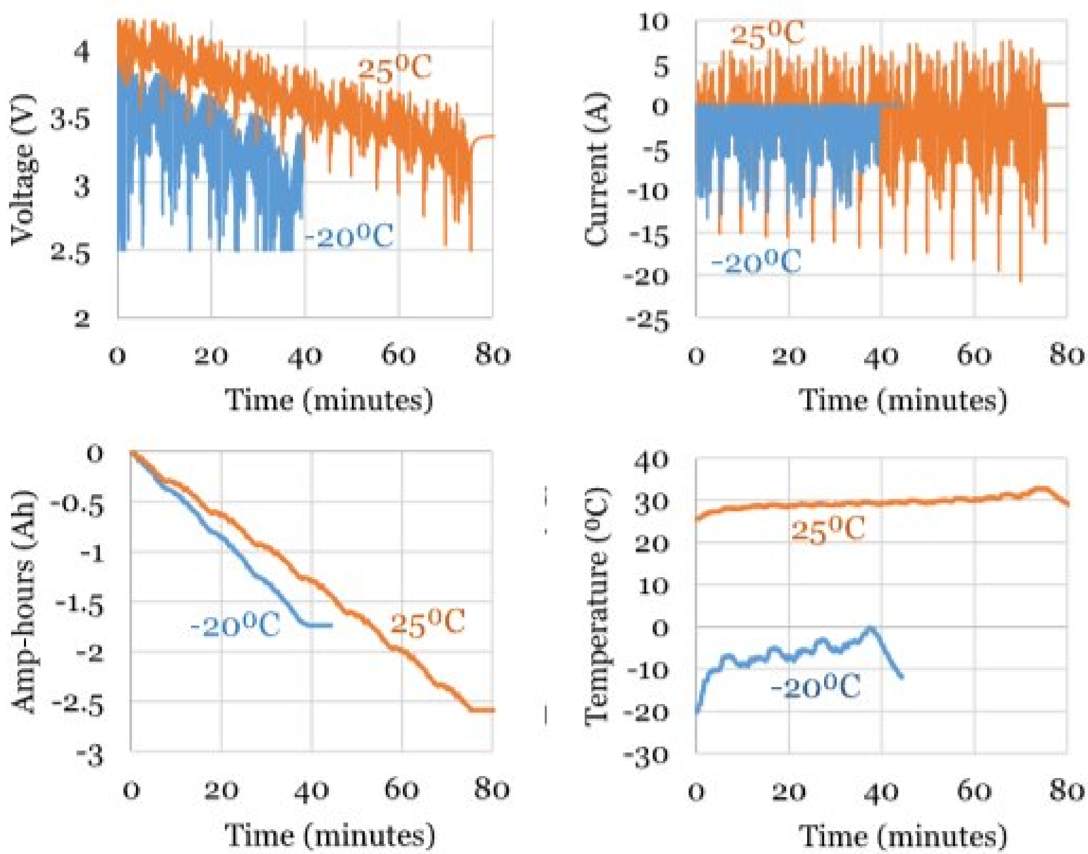
Data-driven modeling and estimation of lithium-ion battery properties

March 19 2019, by Robert Florida



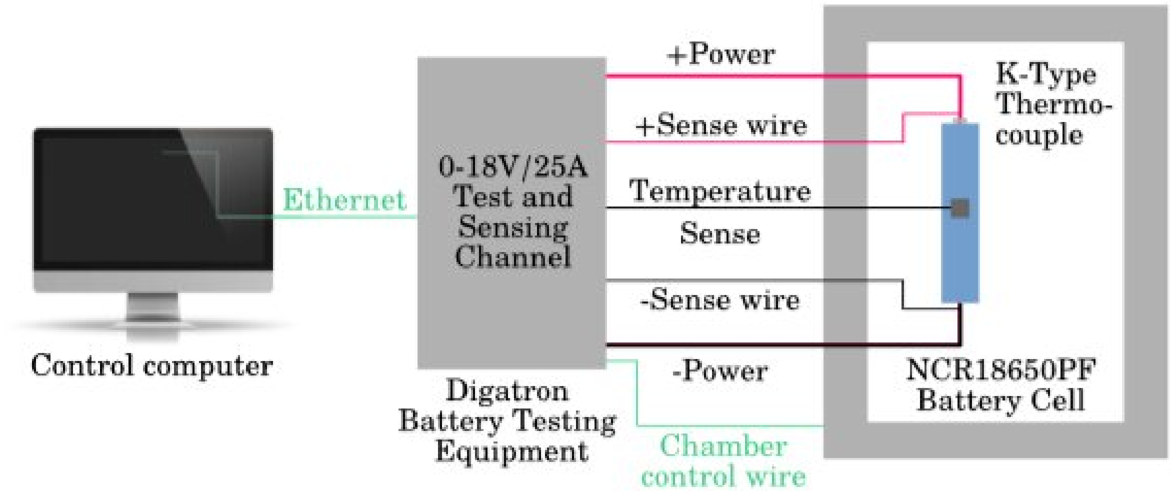
Credit: Data Science Institute at Columbia

Electric vehicles are powered by lithium-ion batteries (LIB), a rechargeable battery that's still not fully understood or perfected. And inasmuch as electric cars are expected to replace gas-powered cars, any research that improves the performance of a lithium-ion battery will be a boon for electric vehicles and the environment.

Professors Matthias Preindl and Alan West, two Columbia professors, are developing a machine-learning model that can more accurately estimate a Li-Ion battery's charge level. Current estimates of a battery's state of charge have error rates of five percent, whereas this team's model aims for an error rate of one percent. Their research is supported by a Seeds Fund Grant from the Data Science Institute.

What are known as Battery Management Systems are trained to capture a battery's state of health and to predict its remaining life time. These two concepts help owners of electric vehicles know when to stop the car to recharge its battery as well as when to schedule battery replacements. Furthermore, a high-estimation accuracy model translates into a lifetime extension of battery packs, since it allows for a Battery Management System that can identify and protect weak cells.

To design its machine-learning model, this team will apply perturbation signals—a sequence of current signals generated by a power electronic converter—to Li-Ion battery cells. The sequence of signals causes the battery cells to emit electrical responses that can be tested. The team will test the batteries in its lab, and also use power electronic converters to obtain data from batteries installed in electric vehicles. The data, which are generated every minute, measure battery functions such as temperature, voltage and volatility in the currents, resulting in hundreds of thousands of data points. The team is therefore designing an algorithm to assess the data and to design an optimization model.



Credit: Data Science Institute at Columbia

"An analogy to what we are doing is what was done with chess," says Mathias Preindl, Professor of Electrical Engineering. "Chess robots work by way of algorithms that study all the moves in all games, and based on that totality, they know all possible moves and can interpret data and select the best moves. That's what we are trying to achieve with our model."

While Preindl is an expert in how batteries interact with outside components, Allen West, a chemical engineer, understands the internal chemistry of a battery. They are using their combined engineering knowledge, along with advanced data science techniques, to design a model that can predict how to get the best performance from current Li-Ion batteries.

"As it is, we don't have quantifications to understand how a lithium-ion battery behaves," says Preindl, who also belongs to DSI's Sense, Collect and Move Data Center.

"Once we have that, we'll know when the batteries need to be charged, how long they'll last, and when they need to be replaced as well as how to extend the life of the battery," he adds. "And since electric cars and Li-Ion batteries are the future, our project has the promise to improve a key part of our transportation system while also improving our environment."

Provided by Data Science Institute at Columbia

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