Battery Simulation Propels Electric Cars in China

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Due to its size and booming economy, China is now the world's largest auto market, and industry analysts predict sales of 20 million cars in 2012 alone. Hence, the government is looking for greener alternative to gasoline to power their cars, trucks and buses. Although battery-driven cars today make up a small portion of the market, hybrid cars in China should still exceed 200,000 this year. In addition, there are approximately 125 million battery-driven bicycles on the road.

A key component of such vehicles is their batteries. Lithium-ion cells, the technology that powers most laptop computers, cell phones and other electronic devices, are the most popular type used in hybrid cars because the cells are smaller and lighter than alternative batteries. China produces revenues of $3.6 billion in lithium ion batteries each year.

The Tianjin Institute of Power Sources

Despite the widespread use of lithium ion batteries, there are still some concerns about the risk of potential fire hazards. Addressing this issue is the Tianjin Institute of Power Sources, established in 1958, one of two national laboratories involved in battery testing and evaluation. The Institute has more than 1,400 employees, of which some 400 are technical staff. The lab focuses on standards research for battery safety and makes design recommendations, which many automobile manufacturers follow.

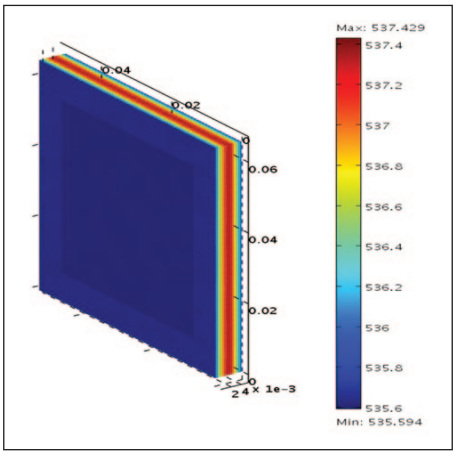

Figure 2: The cell's temperature distribution when thermal runaway occurs.

When it comes to cell safety, many factors come into play, but which ones are the most significant? Without simulations, finding the answer would require considerable funds and tedious testing, while repeating dangerous experiments and trying to control every aspect of them.

To simulate the thermal behavior of the cells at adiabatic conditions, we created a 3D model that includes 12 positive electrodes, each measuring 6.5 cm × 5 cm × 5 mm and each rated for approximately 1 Ah. The model coupled heat transfer and electrochemical reactions together. In our studies of new types of cells, the temperature rose slowly at first but eventually went over to thermal runaway (Figures 1 and 2). We calculated the major exothermal peaks and found very good correlation between the model and experimental results.

Thanks to the model, I can more easily optimize the cell geometry and study the thermal behavior of its materials, which is important in understanding the cells' safety aspects and is also helpful in product design.

> "When it comes to cell safety, many factors come into play, but which ones are the most significant?"

COMSOL models help in building safety awareness and also to save money. For a typical project, we usually run hundreds of experiments, where each one costs roughly $300. Now, because of the models, we can cut the number of experiments down to just ten or so. Also, without simulation, we would need a week to produce each experiment and another week to run it. With the simulation, I can test tens of designs in hours and send one or two very promising ones for trials. ■

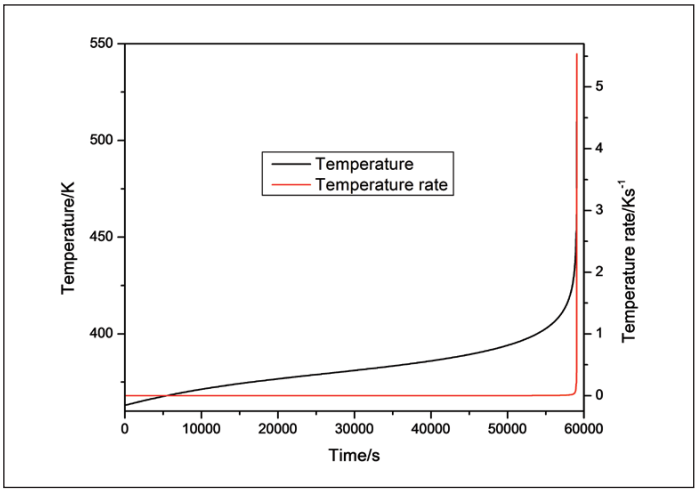

Figure 1: Plot of temperature and temperature rates over time in a lithium ion cell; the region and extent of thermal runaway is pretty evident from the sudden increase in temperature and temperature rate.

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About the Author

Dr. Songrui Wang is a researcher working at the Tianjin Institute of Power Sources. In her role as a key member of a leading research team, her work is dedicated to improving lithium ion batteries.