Battery-powered Christmas carol: A trip down memory (effect) lane

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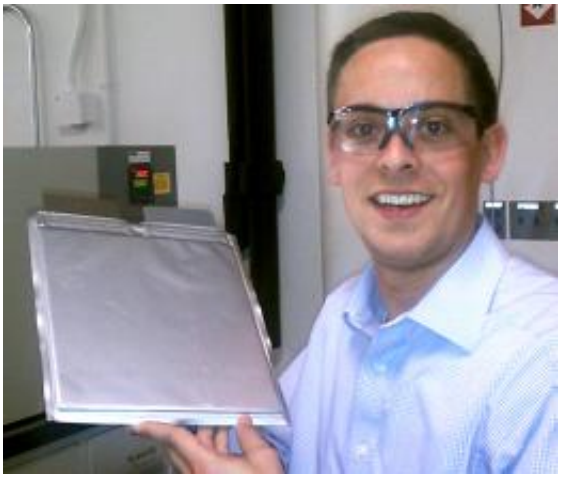

Claus Daniel, deputy director of ORNL's Sustainable Transportation Program, conducts research on batteries of all shapes and sizes.

(PhysOrg.com) -- As consumers anticipate unwrapping the latest electronic gadget during the holidays, they may not give much thought to how long their shiny devices will last. But it's a topic under significant consideration at Oak Ridge National Laboratory, where researchers such as Claus Daniel are working to understand a critical lifetime component in these devices -- the battery.

Daniel, deputy director of ORNL's Sustainable Transportation Program, says that rechargeable batteries of past Christmases pale in comparison to the more robust versions found in today's electronics. For instance,

certain battery chemistries such as nickel metal hydride previously used in consumer electronics suffered from a phenomenon known as the memory effect.

"When you discharge the battery to a certain state of charge, but not all the way down, and you do that repeatedly, the battery capacity would drop due to the memory effect," Daniel said. "For example, look at what people did with their cell phones. They only used it so much during the day, and they charged it every night, no matter if it was empty or not. Over time, the not-utilized active material, which is charged but not used for the electrochemical reaction, seeks to remember that and becomes inactive."

Newer battery chemistries like the lithium-ion battery, which currently dominates the rechargeable battery market, no longer have the risk of memory effect. But Daniel says while lithium-ion batteries are a vast improvement over previous battery types, the technology still has yet to reach its full potential.

"What is interesting about lithium ion batteries is that they're already in commercial products, but we don't understand very much about them," Daniel said. "It's still a topic of research, and we can still have dramatic improvements in this technology. We're far from hitting a wall."

Lithium-ion battery packs are bringing cutting-edge electric cars like the Nissan Leaf to market, but only about 25 percent of the mass in these hefty 400 to 600-pound batteries is made of active materials. Safety and battery life concerns limit the range in which the battery can be charged and contribute to oversizing of the battery.

"The labeled capacity is often lower than the actual capacity, in order to make the life requirement," Daniel said. "There is probably a several fold increase on energy density that we can get from the product on the

market now to what would work theoretically with the chemistry."

In addition to studying existing battery types, ORNL researchers are also conducting fundamental research on batteries yet to come -- new systems like lithium sulfur and lithium air batteries or different charge carriers such as aluminum or magnesium batteries. New applications require different approaches to battery technology, such as energy storage for the grid.

While consumer electronics demand small, lightweight batteries, utilities and power companies are focused more on cost rather than size. "If we want to increase the utilization of renewable energies on the grid beyond a certain threshold, we need to find low cost solutions for energy storage," Daniel said. "If you don't have energy storage on the grid, there's no way you can push solar and wind because those energy sources are intermittent and fluctuating."

Tips for a healthy battery

To maximize the life of existing batteries in consumer electronics like laptops and cell phones, Daniel has a few recommendations for treating your battery properly.

"A lithium-ion battery would last the longest if you charge it to 50 percent and then you never use it," Daniel says. "But that's not really practical."

The 50 percent state of charge acts as a sweet spot for lithium ion batteries because it stays far away from low and high states of charge, both of which pose potential risks for battery health.

"It keeps you furthest possible away from that low state of charge where you have power issues and other possible issues like intercalating

electrolyte into electrodes, Plus, you stay away from the high state of charge window, where you could potentially overcharge the battery, heat it up and get it in an unsafe condition," Daniel adds.

Overheating batteries leads to degradation of the battery's shelf life, which is why Daniel suggests ensuring that your electronics are kept at room temperature. "Calendar life goes down when temperature goes up," he says.

Provided by Oak Ridge National Laboratory