Electronic life extension

Everyone knows the frustration of battery discharge: that sinking feeling when your notebook computer shuts down before you've saved that vital document or the artistic annoyance when your digital camera cannot snap that last holiday sunset. Worse still, what about those times when you're stuck on a five-hour flight with only a minute's worth of charge in your mp3 player?

A solid solution to the problem could come from chemists in the UK. They have devised a new and efficient way to improve battery power as well as make that precious charge last longer. They describe their results in the latest issue of *Advanced Materials*.

Modern rechargeable batteries for electronic gadgets generally use lithium compounds as the positive electrode and have revolutionized the electronics industry. They can be made very compact but can still deliver the required voltage to run everything from cell phones to digital cameras and notebook computers. And, not forgetting those ubiquitous mp3 players.

As gadgetry becomes sophisticated so consumer demands on battery life have risen. Moreover, more powerful lithium batteries are beginning to be used in power tools and may soon be seen in electric vehicles, applications that are much more draining than those for which conventional lithium batteries are used.

Now, Kuthanapillil Shaju and Peter Bruce of the University of St Andrews, Scotland, explain how lithium batteries use so-called intercalation materials as their anode. These materials are composed of a solid network of lithium atoms together with other metals, such as cobalt, nickel, or manganese, meshed together with oxygen atoms. When you charge a lithium battery, the charging current pulls the positive lithium ions out of this network. Then, when you use the battery, it discharges as these lithium ions migrate back into the electrode, pulling electrons as they go, and so generating a current.

The challenge is to make new electrode materials that deliver high power (fast discharge) and high energy storage. Shaju and Bruce hoped they could solve these problems by developing a new way of synthesizing a particular lithium intercalation compound (Li(Co1/3 Ni1/3 Mn1/3)O2). As a bonus, they hoped to be able to simplify the complicated manufacturing process.

The St Andrews team devised a new synthetic approach to the compound that involves simply mixing the necessary precursor compounds - organic salts of the individual metals - with a solvent in a single step. This is in sharp contrast to the conventional multi-step process used for making the compound. Using this technique, they were able to make highly uniform lithium oxide intercalation materials in which nickel, cobalt, and manganese ions are embedded at regular intervals in the solid, which also contains pores for the electrolyte.

The highly porous nature of the new material is crucial to its electrical properties. The pores allow the electrolyte to make intimate contact with the electrode surface resulting in high rates of discharge and high energy storage. The St Andrews team has tested their new lithium electrode material by incorporating it into a prototype battery and found that it gives the battery far superior power and charge retention. Increasing the rate by 1000%, so that the battery can be discharged in just six minutes, reduces the discharge capacity by only 12%. The test results suggest that this approach to rechargeable batteries could be used to make even higher power batteries for vehicles and power tools. Most importantly though, the new lithium materials could mean an end to mp3 player power loss on that long-haul flight. (Assuming you remembered to charge it up in the first place.)

There's an added bonus in that replacing a proportion of the cobalt used in the traditional lithium-cobalt-oxide electrodes with manganese improves safety by reducing the risk of overheating.

Source: John Wiley & Sons, Inc.