



## Three-Dimensionally Nanostructured Lithium-Ion Batteries

Secondary lithium-ion ( $\text{Li}^+$ ) batteries are the current power source of choice for portable electronics. Nevertheless, the performance of  $\text{Li}^+$  batteries is limited by the slow diffusion of  $\text{Li}^+$  ion. Researchers in the Department of Chemistry at Colorado State University have designed a new battery architecture intended to address the slow diffusion of  $\text{Li}^+$  ions between the anode and cathode by reducing the diffusion length between these two electrodes. This architecture is designed around a nanorod array of anodes, insulated by a thin polymer electrolyte and then surrounded by a cathode matrix. The result is a  $\text{Li}^+$  battery composed of interpenetrating, nanostructured electrodes with extremely short  $\text{Li}^+$  diffusion distances and a high charge density. The goal of this research is to produce a small, lightweight battery with a long lifetime capable of discharging power rapidly.

Towards this end, these researchers have developed the means to realize each of the sophisticated components required for this battery. Utilizing anodic aluminum oxide chemistry, the electrochemical deposition of a highly desirable anode material,  $\text{Cu}_2\text{Sb}$ , as an ordered nanorod array has been developed. The electrolyte is then grown electrochemically to a thickness on the nanometer scale with very few pinholes and has been shown to be highly resistive over biases greater than 3V. Finally, using sol-gel techniques, two common  $\text{Li}^+$  battery cathode materials,  $\text{LiCoO}_2$  and  $\text{LiMnO}_2$ , may be deposited in such a way as to penetrate into the nanorod array, thereby maximizing useful surface area and charge density.

With the design and technology firmly established, it is an exciting time as these next-generation  $\text{Li}^+$  batteries are being fabricated and tested! Contact us for up-to-date information on these novel devices.

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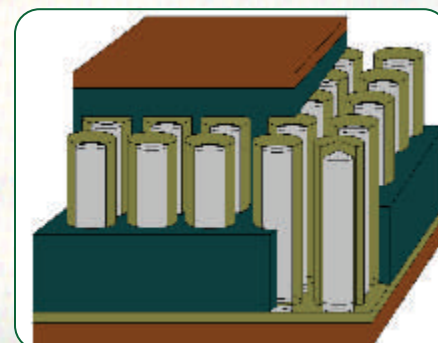
**Patent Information**  
Patent pending

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**Related Technologies**  
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### **Features and Benefits**

- Novel battery architecture dramatically decreases diffusion length of  $\text{Li}^+$  ions.
- Faster charging/discharging, greater reversibility, longer lifetime.
- Design may be applied to a variety of battery materials.
- Specialized fabrication techniques have been developed.
- Construction and testing of initial devices have already begun.



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