Category: **Chemical and Material Sciences**

**Synthesis of novel functional metal oxide electrode materials through electrochemical cycling**

**Problem Statement**

Intercalation-type metal oxides are promising negative electrode materials for safe and stable operation of rechargeable lithium-ion batteries due to the reduced risk of Li plating at low voltages. Nevertheless, lower energy and power density along with cycling instability remain bottlenecks for their implementation, especially for desirable fast-charging applications.

**Technology Overview**

Researchers at Boise State University have synthesized for the first time a nanostructured rock salt Nb2O5 material formed through repeated electrochemical cycling with Li ion, wherein an amorphous-to-crystalline transformation is observed in nanochanneled Nb2O5.

This electrode can reversibly cycle three lithium per Nb2O5, corresponding to a capacity of 269 mAh g-1 at 20 mA g-1, and retains a capacity of 191 mAh g-1 at a high rate (1 A g-1). It exhibits superb cycling stability with a capacity of 225 mAh g-1 at 200 mA g-1 for 400 cycles, and a Coulombic efficiency of 99.93%.

Researchers attribute the enhanced performance to the framework of the new cubic structure, which promotes low-energy migration paths. Their work suggests that inducing crystallization of amorphous nanomaterials through electrochemical cycling is a new avenue for creating unconventional high-performance metal oxide electrode materials.

**Applications:**

This process can be applied to rechargeable lithium-ion batteries and other metal oxide systems for energy applications.

**Benefits:**

The discovery of new materials for lithium-ion batteries has taken on a renewed urgency. Fueled by rising gas prices, there has been a surge in demand for electric vehicles (EVs), and in turn, for the lithium-ion batteries that power them. However, today’s lithium-ion batteries are still too expensive and charge too slowly. Among one of the biggest bottlenecks to charging in today’s lithium-ion batteries is the anode. The most common anode is made of graphite, which is very energy dense, but cannot be charged too quickly due to the risk of fire and explosions from a process known as lithium metal plating. Intercalation metal oxides, like the rock salt Nb2O5 material, are promising anode alternatives due to the reduced risk of lithium plating at low voltages. This process can potentially be used to make other lithium-ion battery materials that cannot be easily made via traditional means and have exceptional performance for fast charging applications.



Contact us about this technology:

Office of Technology Transfer

[techtransfer@boisestate.edu](mailto:techtransfer@boisestate.edu)

(208) 426-5765

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Inventors

[Hui Xiong, PhD](https://www.boisestate.edu/coen-materials/directory/claire-xiong/)

[Shyue Ping Ong, PhD](https://jacobsschool.ucsd.edu/people/profile/shyue-ping-ong)

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