Argonne NATIONAL LABORATORY

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Lithium-Titanium-Oxide Anodes Improve Battery Safety and Performance (ANL-IN-98-069)

Promising alternatives to graphite electrodes

The Invention

Argonne researchers have developed a new type of lithium-titanium-oxide material that can be used as a negative electrode (anode) for non-aqueous lithium electrochemical cells and batteries.

Conventional lithium-ion battery configurations often contain graphite electrodes, which operate at a potential very close to that of metallic lithium and are extremely reactive. This composition can cause lithium-ion batteries to overheat, particularly if the battery is in a charged state or if it is overcharged without protective electronic circuitry.

Argonne has identified the spinel $Li_4Ti_5O_{12}$ as a promising alternative to graphite electrodes. By successfully modifying the lithium-titanium-oxide composition with a spinel-type structure, the new material offers improved electronic conductivity. The Argonne innovation uses $Li_{4-x}Ti_5M_xO_{12}$, in which M is Mg^{2+} and/or Al^{3+}, to reduce the oxidation state of the titanium ions, thereby enhancing the electronic conductivity of the spinel electrode. This modification to lithium-titanium-oxide materials improves on the safety of graphite electrodes while also offering enhanced voltage and energy density.

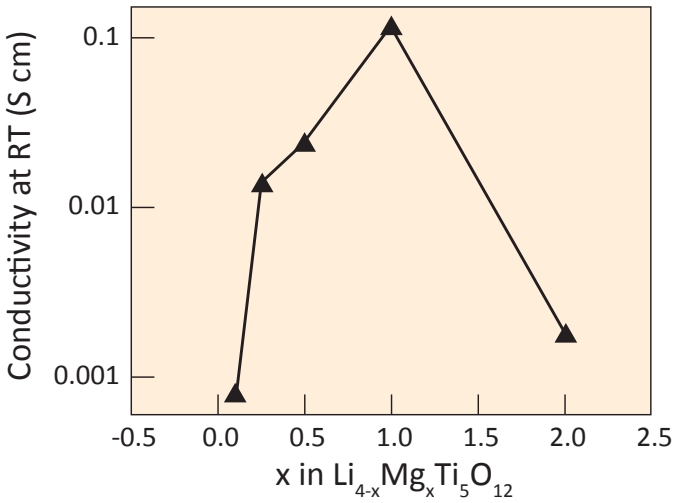
Rechargeable lithium-ion batteries have become the battery of choice for everything from cell phones to electric cars. Scientists at Argonne National Laboratory are leading efforts to revolutionize battery technology with the design and development of new battery materials for electrolytes, electrodes, and interfaces that will increase the specific energy of advanced batteries while simultaneously providing enhanced stability at a lower cost.

Benefits

- Prevents overcharge
- Improves safety
- Increases reliability
- Enhances cell voltage and energy density

Applications and Industries

- Transportation applications, such as electric and hybrid-electric vehicles
- Portable electronic devices, such as cell phones and laptop computers
- Medical devices
- Space, aeronautical and defense-related devices



$Li_4Ti_5O_{12}$ conductivity is enhanced by two orders of magnitude with magnesium doping and no change in capacity or insertion potential.

Developmental Stage

Proof of concept

Availability

Available for licensing

Argonne Invention Number

ANL-IN-98-069

Intellectual Property

US Patent 6,221,531

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December 2012
tsd_IN98069_1212_mn