Argonne NATIONAL LABORATORY

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Argonne's Intermetallic Electrodes Improve Safety and Performance in Lithium-Ion Batteries (IN-06-118)

A cost-effective approach to enhanced stability

The Invention

Argonne scientists have developed a new class of intermetallic material that can be used as a negative electrode for non-aqueous lithium electrochemical cells and batteries. Compared to graphite, the material offers significantly higher volumetric and gravimetric capacity and improves battery stability and safety.

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

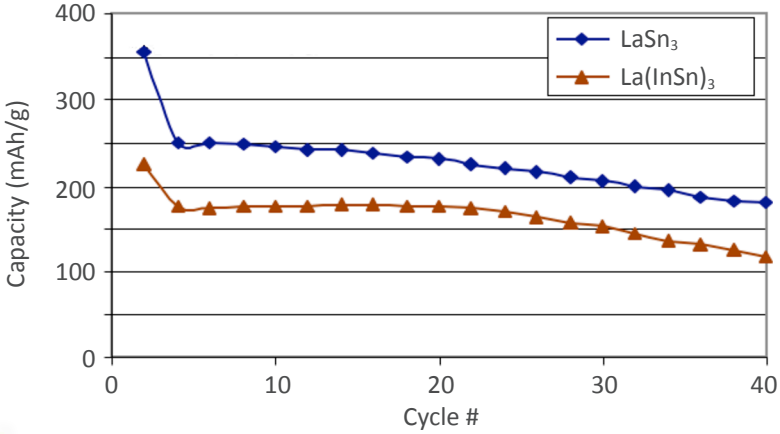
The structure of Argonne's new electrode contains the basic structural unit of an MM'_3 intermetallic compound with a $LaSn_3$-type structure, in which the M and M' atoms comprise one or more metals. The Argonne innovation reveals a new class of negative electrode materials for lithium-ion batteries that operate either by lithium insertion or by metal displacement reactions or a combination of both.

In addition to improving on the safety of current graphite electrodes, these new intermetallic electrodes offer greater structural stability to lithium insertion and extraction reactions. The electrodes also provide superior charge capacity. The $LaSn_3$-type structure resulted in specific and gravimetric capacities of 650 mAh/g and 4920 mAh/mL, respectively (based on a density of 7.57 g/mL). This compares to graphite's specific capacity of 372 mAh/g and gravimetric capacity of 818 mAh/mL (based on a density of 2.2 g/mL).

Rechargeable lithium-ion batteries have become the battery of choice for everything from cell phones to electric cars, but room for improvement remains. 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

- Significantly increased energy density
- Improved safety
- Increased reliability
- Greater structural stability
- Superior charge capacity



Cycling stability of $LaSn_3$ and In-substituted $LaSn_3$.

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

Developmental Stage

Under development

Availability

Available for licensing

Argonne Invention Number

ANL IN-06-118

Patent Information

US Patent 8,124,280

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