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Method for Preparing Advanced Lithium Ion Battery Composite Cathodes

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Inventors

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Background

Intercalation compounds have been popular in commercial energy storage devices such as Li-ion batteries, but may achieve even higher performance through improved materials. Recently, 2D materials, such as graphene, have attracted significant attention due to their unique structural and electronic characteristics. Given that conventional intercalation compounds are layered structures, the use of an exfoliation process could yield 2D nanosheets. These nanosheets could then be reassembled, restacked, or deposited layer-by-layer to form hybrid structures. However, the strong interlayer bonding found in layered transition metal oxides makes the exfoliation process difficult. In order to exfoliate these materials, protonated forms of the metal oxide must undergo ion-exchange in a cationic solutions. However, this proton-exchange method can lead to the irreversible binding of protons or the formation of hydrated phases. This can have detrimental effects on the electrochemical properties of the material and render it ineffective. Therefore, there is a need for a novel process to exfoliate intercalation compounds to produce nanosheets and other materials for energy storage applications.

Invention Description

Researchers at Arizona State University have developed a novel method for the exfoliation and controlled reassembly of thin nanosheets for cathodes in lithium ion batteries. This system produces nanosheets through a modified exfoliation approach that utilizes electrochemical oxidation in lieu of proton exchange. As a result, the exfoliation process is much faster and yields nanosheet materials that are free from adsorbed protons, thus preserving the electrochemical functionality of the materials. The nanosheets can be made using a variety of materials and can be restacked into unique bulk materials. Furthermore, the materials display greater stability, improved electrochemical properties, and are ideal for battery and energy storage technologies.

Intellectual Property Status:
Pending

Potential Applications

- Lithium ion batteries
- Energy storage
- Nanosheets

Benefits and Advantages

- **Improved Electrochemical Properties** –
  - Demonstrates enhanced electrochemical performance through increased voltage, capacity, cycling retention, and resistance to phase changes.
  - Exhibits higher discharge capacities due to a lack of protonated material.
  - Yields more electrochemically effective composites than physical mixtures.
- **Versatile** –
  - Capable of restacking with non-conventional ions to form new electrode materials.
  - Used to form hybrid structures of various materials for novel properties.
  - Allows for the creation of new materials not possible by direct synthesis (i.e. non-equilibrium structures).
- **Proven Results** – Using this method, Lithium Cobalt Oxide has been exfoliated and reassembled back into bulk materials, and demonstrated the high discharge capacity under galvanostatic cycling.

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