

'Wrapping' anodes in 3D carbon nanosheets: The next big thing in li-ion battery technology

July 22 2021

Manganese Selenide with 3D nanosheets for Superior Li-Ion Batteries

Lithium-ion batteries (LIBs) are widely used in portable electronic devices, electric vehicles, and as renewable energy sources

Manganese selenide (MnSe) is a commonly used anode material

- Drastic volume change
- Slow lithium-ion kinetics

How can we improve MnSe's performance?

Uniform MnSe nanoparticles anchored in 3D carbon nanosheet matrix (MnSe @ 3DCNM)

Li⁺ ions are shown moving through the structure.

α-MnSe, Li MnSe, β-MnSe

- High surface area
- Increased active sites for N-doping
- Improved electric conductivity
- Stable nanostructure

Irreversible phase transformation (α-MnSe → β-MnSe)

- Enhanced electrochemical properties
- Reversible specific capacity
- Capacity retention of 79.3% after 150 cycles
- Superior Li⁺ and electron transport kinetics

MnSe @ 3DCNM-1.92 provides superior electrochemical and lithium storage properties and can be used as LIB anode material

Facile synthesis of Manganese selenide anchored in Three-Dimensional carbon nanosheet matrix with enhanced Lithium storage properties
 Yu et al. (2021) | DOI: 10.1016/j.cej.2021.130243

NATIONAL KOREA MARITIME & OCEAN UNIVERSITY

"Wrapping" anodes in 3d carbon nanosheets. Credit: Korea Maritime and Ocean University

Lithium-ion batteries (LIBs), which are a renewable source of energy for electrical devices or electric vehicles, have attracted much attention as the next-generation energy solution. However, the anodes of LIBs in use today have multiple inadequacies, ranging from low ionic electronic conductivity and structural changes during the charge/discharge cycle to

low specific capacity, which limits the battery's performance.

In search of a better [anode](#) material, Dr. Jun Kang of Korea Maritime and Ocean University, along with his colleagues from Pusan National University, Republic of Korea, has designed an anode that, owing to its unique structural features, overcomes many of the existing barriers of anodic efficiency. Dr. Kang explains, "We focused on manganese selenide (MnSe), an affordable transition metal compound known for its [high electrical conductivity](#) and applicability in developing semiconductors and supercapacitors, as a possible candidate for the advanced LIB anode." However, MnSe undergoes a drastic volume change (by almost 160%) during the charging-discharging cycles, which not only reduces the performance of the electrode but also raises safety issues.

In an effort to prevent this volume change, the aforementioned researchers developed a simple and low-cost process: They uniformly infused the MnSe nanoparticles into a three-dimensional porous carbon nanosheet matrix (or 3DCNM). In the newly developed anode material (which they termed MnSe \subset 3DCNM), the carbon nanosheet scaffold endowed the anchored MnSe nanoparticles with numerous advantages, such as a high number of active sites and an enhanced contact area with the electrolyte and protected them from drastic volume expansion.

The researchers were able to synthesize a variety of MnSe \subset 3DCNM materials. Among these, they found MnSe \subset 3DCNM-1.92 to exhibit the best cycle stability and rate capabilities. When combined with lithium manganese (III,IV) oxide (LiMn_2O_4 , a commonly used cathode material) in a full cell, the team observed that MnSe \subset 3DCNM-1.92 remarkably continued to demonstrate superior electrochemical properties, including superior lithium ion and electron transport kinetics.

The team is excited about the potential implications of their

accomplishment. As Dr. Kang explains, "Using a conducive filler scaffold, we have developed an anode that boosts the battery performance while simultaneously allowing reversible energy storage. This strategy can serve as a guide for other transition metal selenides with high surface areas and stable nanostructures, with applications in storage systems, electrocatalysis, and semiconductors."

Along with this new development in the field of LIBs, the possibility of realizing a greener future becomes brighter.

More information: Litao Yu et al, Facile synthesis of Manganese selenide anchored in Three-Dimensional carbon nanosheet matrix with enhanced Lithium storage properties, *Chemical Engineering Journal* (2021). [DOI: 10.1016/j.cej.2021.130243](https://doi.org/10.1016/j.cej.2021.130243)

Provided by National Korea Maritime and Ocean University

Citation: 'Wrapping' anodes in 3D carbon nanosheets: The next big thing in li-ion battery technology (2021, July 22) retrieved 19 April 2024 from <https://techxplore.com/news/2021-07-anodes-3d-carbon-nanosheets-big.html>

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