Contribution ID: **310** Type: **Poster Presentation**

Synthesis and Characterization of Ti3C2 MXene electrode via In-situ HF and direct HF etching methods for application in battery-supercapacitor hybrid devices.

Tuesday, 4 July 2023 16:38 (1 minute)

The need for cleaner, renewable energy to tackle issues such as global warming and the rapid consumption of fossil fuels has led to an increased interest in developing high-energy and high-power density energy-storage devices. While batteries were extensively used for energy storage in the past, they suffer from a limited number of charge cycles and longer recharge times. Electrochemical capacitors have high power provision but possess comparatively low energy density. To mitigate this, a hybrid solution combining battery and supercapacitor electrochemical performance is necessary.

Herein, we report on the fabrication and structural optimization of a Ti3C2 MXene pseudo-capacitive electrode via In-situ HF and direct HF etching of the Ti3AlC2 MAX phase for use in battery-supercapacitor hybrid devices.

The SEM results showed a stacked multilayer with highly delaminated morphology, clearly exhibiting significant openings of the MXene lamellas. The EDX analysis confirmed that the MXene sample has a lower percentage of Al element; 0.78% and 0.59% for direct HF and In-situ method respectively compared to the as-prepared MAX sample (12.72%). This indicates successful etching of the Al element from the precursor sample. However, EDX showed small traces of F and Cl elements in samples synthesized using the in-situ method; a clear indication that this method requires further treatment with chemical substances such as NH4HF2 and NH4F for complete HCl etching. From the XRD pattern, the eradication of (104) peak at ˜39.0˚ 2θ for all samples indicates the full conversion of Ti3AlC2 to Ti3C2, with no notable impurity signals as seen on the EDX data, further cementing the SEM and EDX analyses.

The electrochemical properties of the MXenes are discussed, followed by their application in various fields of the energy storage industry, especially in multifunction electronics, hybrid electric vehicles, and industrial equipment.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

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Session Classification: Poster Session 1

Track Classification: Track A - Physics of Condensed Matter and Materials