

Boosting MXene capacity by self-oxidation in air atmosphere for water-in-salt electrolyte-based supercapacitor

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The use of $\text{Ti}_3\text{C}_2\text{T}_x$ (MXene) electrodes for energy storage applications is gaining momentum in recent years. The ability of the MXene to host a large variety of mono and multivalent ions regardless of their charge or ionic radius makes it an attractive anode for aqueous and non-aqueous batteries and supercapacitor devices.

In this work, we demonstrate controllable $\text{Ti}_3\text{C}_2\text{T}_x$ oxidation in an ambient atmosphere with the formation of TiO_2 nanoparticles which serve as electrochemically active (battery type material) while preserving MXene electrochemical properties (capacitive type) utilizing water-in-salt (WIS) (14 M LiCl) electrolyte. There are several advantages of the proposed hybrid $\text{TiO}_2/\text{Ti}_3\text{C}_2\text{T}_x$ anode for water-based devices: 1) uniformly distributed TiO_2 nanoparticles in the MXene matrix open the space between MXene flakes causing faster ion penetration and increasing the rate capability of the hybrid anode; 2) in the spot synthesized TiO_2 serves as source of additional energy storage material with maximum negative value (for water-based electrolytes) of intercalation/deintercalation potential; 3) MXene serves as a matrix for battery material with the possibility to create flexible free-standing electrode without additional binding components, moreover providing fast electronic conductivity. Precise control of MXene suspension oxidation by air oxygen doesn't require any additional oxidizers and elevated temperature and allows to create of the adjusted amount and lateral size of TiO_2 with ideally uniform distribution.

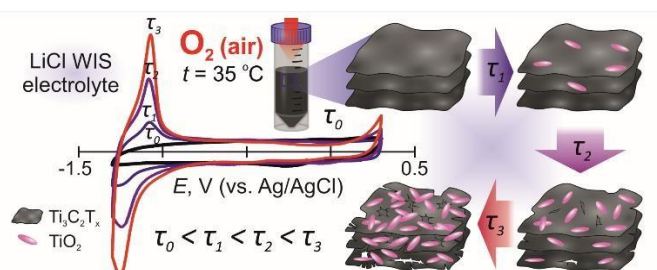


Figure 1 – Sketch of $\text{Ti}_3\text{C}_2\text{T}_x$ air oxidation process and its subsequent CV response in WIS electrolyte.

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