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Defect-Engineered Nitride-based MXene/rGO Nanohybrids: A Unified Strategy for High-Performance Energy Storage and Corrosion-Resistant Electrodes

Invited Talk

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Abstract

Two-dimensional MXenes have emerged as transformative materials for high-performance energy storage and corrosion-resistant applications; however, challenges such as restacking, surface instability, and limited electroactive sites restrict their practical deployment. In this invited talk, a comprehensive study on Ti_2NT_x/rGO and V_2NT_x/rGO nanocomposites synthesized through controlled chemical etching and reduction routes is presented. Transmission electron microscopy (TEM) and X-ray diffraction (XRD) analyses confirm the formation of multilayered architectures, expanded interlayer spacing, and Ti_2NT_x/rGO quantum dots arising from quantum confinement. The integration of reduced graphene oxide (rGO) effectively modulates the optical band gaps (Ti_2NT_x: 5.59→4.53 eV; V_2NT_x: 4.75–5.11 eV), suppresses oxidation, and enhances accessible surface area and porosity.

Electrochemical measurements reveal markedly improved charge-storage behaviour, with Ti_2NT_x/rGO achieving a specific capacitance of up to 1203.86 F g^{-1} (galvanostatic charge–discharge), while V_2NT_x/rGO delivers 622.97 F g^{-1} along with outstanding cycling stability (88.3% retention after 10,000 cycles). The optimized composites further exhibit reduced charge-transfer resistance ($R_{CT} = 7.23\ \Omega$) and excellent corrosion resistance, with corrosion rates as low as 1.5×10^{-8} mm y^{-1}. These results underscore the synergistic role of rGO in enhancing electron transport and interfacial stability.

Overall, the findings establish nitride-based MXene/rGO nanohybrids as versatile, defect-engineered, and scalable materials for next-generation supercapacitors and protective coatings, effectively bridging fundamental insights with technological relevance.

Keywords: MXene/rGO composite, Supercapacitor, Electrochemical Measurements, Anti-corrosion property

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