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2D titanium, vanadium carbide MXene, and Polyaniline heterostructures for electrochemical energy storage

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Abstract : The rising demand to meet the need for clean and sustainable energy solutions has led the market to create effective energy storage technologies. In this study, we look at the possibility of using a heterostructure made of polyaniline (PANI), titanium carbide (Ti_3C_2), and vanadium carbide (V_2C) for energy storage devices. V_2C is a two-dimensional transition metal carbide with remarkable mechanical and electrical conductivity. Ti_3C2 has solid thermal conductivity and mechanical strength. PANI, on the other hand, is a conducting polymer with customizable electrical characteristics and environmental stability. Layer-by-layer assembly creates the heterostructure of V_2C, Ti_3C_2, and PANI, allowing for precise film thickness and interface quality control. Structural and morphological characterization is carried out using X-ray diffraction, scanning electron microscopy, and atomic force microscopy. For energy storage applications, the heterostructure's electrochemical performance is assessed. Electrochemical experiments, such as cyclic voltammetry and galvanostatic charge-discharge tests, examine the heterostructure's charge storage capacity, cycle stability, and rate performance. Comparing the heterostructure to the individual components reveals better energy storage capabilities. V_2C, Ti_3C_2, and PANI synergize to increase specific capacitance, boost charge storage, and prolong cycling stability. The heterostructure's unique arrangement of 2D materials and conducting polymers promotes effective ion diffusion and charge transfer processes, improving the effectiveness of energy storage. The heterostructure also exhibits remarkable electrochemical stability, which minimizes capacity loss after repeated cycling. The longevity and long-term dependability of energy storage systems depend on this quality. By examining the potential of V_2C, Ti_3C_2, and PANI heterostructures, the results of this study expand energy storage technology. These materials' specialized integration and design show potential for use in hybrid energy storage systems, lithium-ion batteries, and supercapacitors. Overall, the development of high-performance energy storage devices utilizing V_2C, Ti_3C_2, and PANI heterostructures is clarified by this research, opening the door to the realization of effective, long-lasting, and eco-friendly energy storage solutions to satisfy the demands of the modern world.

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