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2D Titanium Carbide/Reduced Graphene Oxide Heterostructures for Supercapacitor Applications

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Abstract

Solution-processable two-dimensional (2D) materials offer the possibility of manufacturing heterostructures with various properties, creating a way to tune materials towards a specific application. Two different 2D materials, titanium carbide MXene ($Ti_3C_2T_x$) and reduced graphene oxide (rGO), have shown promising results for supercapacitor applications due to their flake-like morphology, high conductivity; and ability to intercalate molecules or ions for charge storage. Here, we demonstrate the self-assembly of a heterostructure between negatively charged $Ti_3C_2T_x$ and positively charged modified rGO after shear mixing. Changes in zeta (ζ) potential, X-ray diffraction (XRD) patterns; and Raman spectra confirm the assembly of this heterostructure. The produced rGO : $Ti_3C_2T_x$ heterostructures were used as electrodes for supercapacitors. The addition of rGO to $Ti_3C_2T_x$ allowed some widening of the voltage window. Moreover, due to the synergistic effect of these materials, an increase of the capacitance value was observed. An electrode film composed of rGO (1 wt.%) and $Ti_3C_2T_x$ (99 wt.%) achieved capacitance values up to 254 $F \cdot g^{-1}$ at 2 $mV \cdot s^{-1}$ and 193 $F \cdot g^{-1}$ at 100 $mV \cdot s^{-1}$.