Synthesis and Electrochemical Evaluation of Ti and V-based Carbide MXene via Microwave Assisted Hydrofluoric Acid Etching for Energy Storage

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1. Elemental Mapping

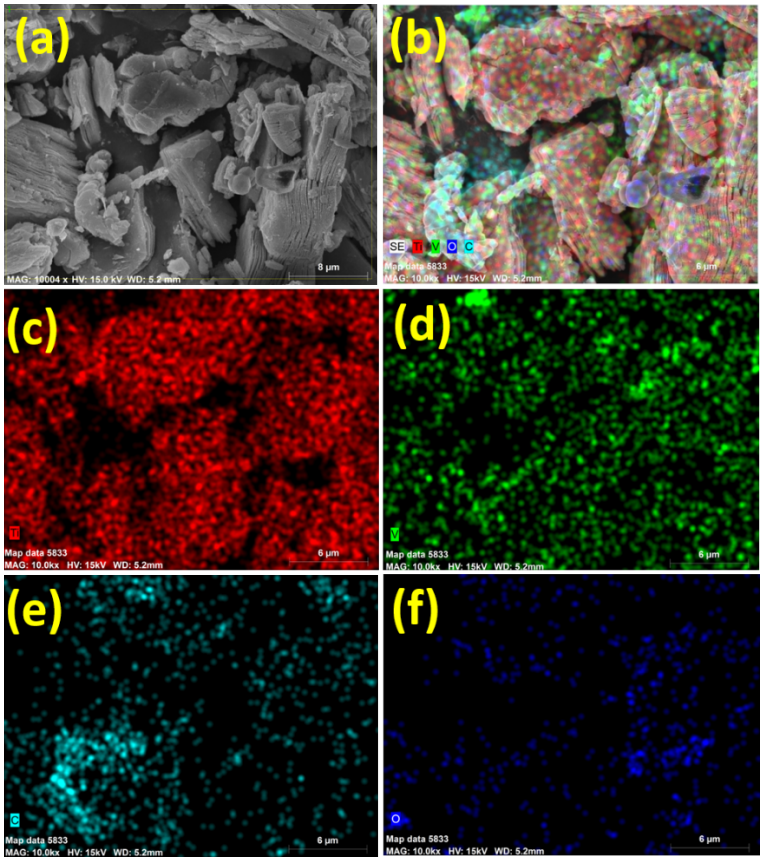

Fig. S1 EDS mapping of $Ti_3V_2C_3T_x$ MXene

2. Kinetics of storage mechanism

The kinetics of the charge storage mechanism in the synthesized $Ti_3V_2C_3T_x$ MXene material were evaluated using Dunn's model. The electrode's charge storage mechanism comprises a swift surface-controlled capacitive component and a slower diffusion-controlled distribution, analysed through the CV curve at different scan rates. The percentage of charge distribution can be calculated using the Randles-Sevcik equation, where ($I_{charge} \propto v$) and ($I_{discharge} \propto v$), which can be transformed into the following equation:

$$I(V) = K_1 v + K_2 v^{0.5} \quad (3)$$

K_1 and K_2 are arbitrary constants that can be determined from the plot of $v^{0.5}$ versus $i(v)/v^{0.5}$, as shown in **Fig. S2 (a),** where the slope and Y-intercept yield the values of K_1 and K_2, respectively. The charge storage distribution derived from equation (3) is depicted in **Fig. S2 (b)**, where the results clearly show that the diffusion-controlled process is predominant at low scan rate, accounting for 65% at 1 mVs^{-1} and decreasing to 16% at 100 mVs^{-1}. As scan rate increases the capacitive distribution dominance increased and reaches 84% at 100 mVs^{-1}. The charge distribution process is further depicted in **Fig. S2 (c-d)** for rates of 1 and 100 mVs^{-1}.

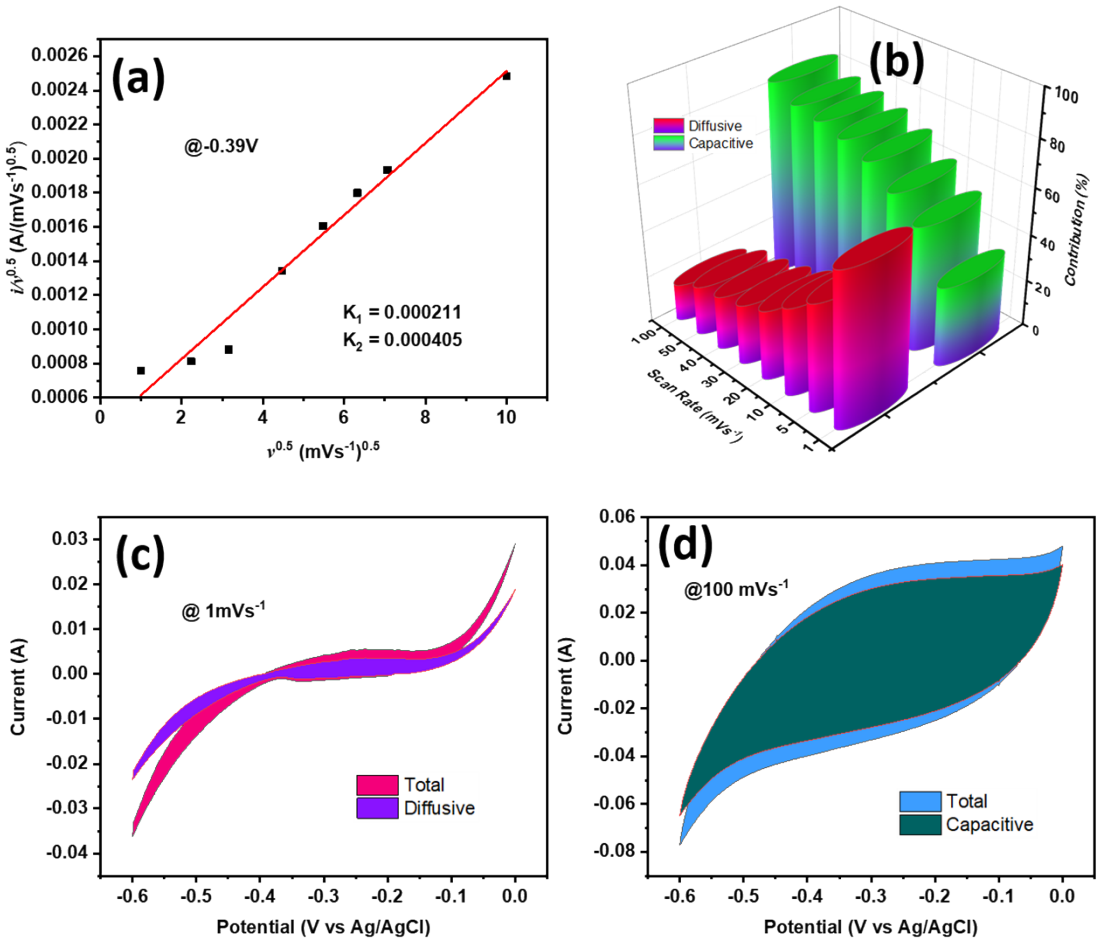

Fig. S2 K_1 and K_2 values measured for distribution calculation (b) charge distribution at different scan rates (c) Diffusion distribution dominance at low scan rate 1 mVs^{-1} (d) Capacitive distribution dominance at high scan rate 100 mVs^{-1}.

TEM analysis before and after cycling:

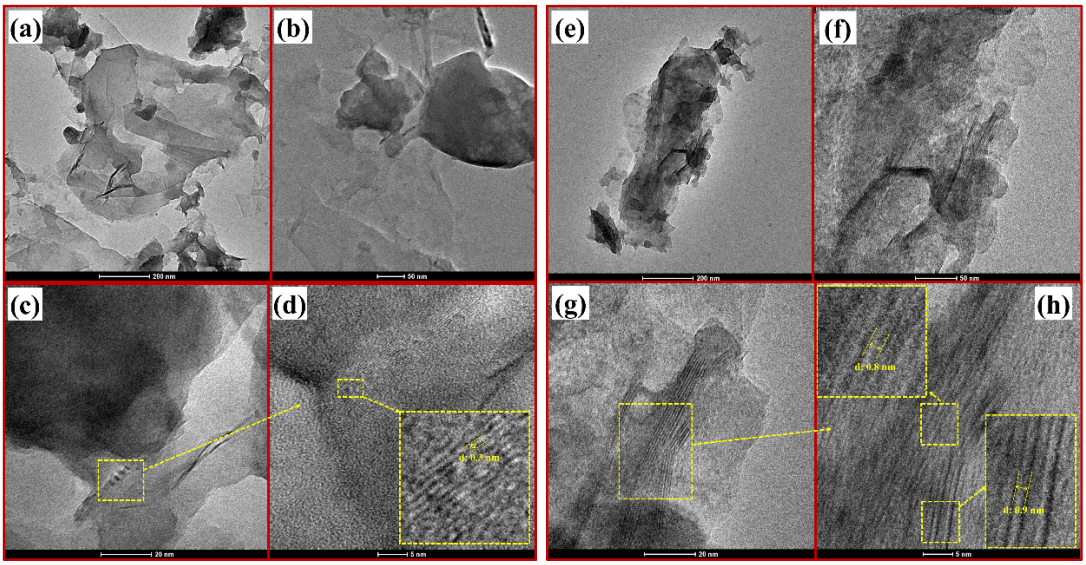

Fig. S3 (a-b) TEM images **(c-d)** HRTEM of $Ti_3V_2C_3$ MXene before cycling **(e-f)** TEM images **(c-d)** HRTEM of $Ti_3V_2C_3$ MXene after cycling.