Ionic Radius Impact of Aqueous Electrolytes on the Performance of Molybdenum Carbide MXene Electrodes

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Two-dimensional (2D) materials have emerged as promising candidates for supercapacitor applications due to their exceptional electrical conductivity, large surface area, and tunable surface chemistry,[1] which enable efficient charge storage and fast ion transport. The 2D materials can facilitate both electrical double-layer capacitance (EDLC) and pseudocapacitive charge storage, leading to enhanced energy and power densities.[2] Among these, MXenes (transition metal carbides and nitrides) stand out due to their high capacitance, rapid charge transfer, and excellent structural stability.[3] In particular, molybdenum carbide-based (Mo_2C) MXenes have demonstrated remarkable potential as electrode materials for supercapacitors,[4] offering a unique combination of metallic conductivity and hydrophilic surface terminations that enhance ion accessibility.[3,5] In this study, Mo_2C MXene-based electrodes, having a composition of 90% Mo_2C, 5% few layer graphene (FLG), and 5% carboxymethyl cellulose:Styrene-Butadiene Rubber (CMC:SBR) (Mo_2C/FLG/CMC:SBR) were tested in aqueous electrolytes, *e.g.* sulfuric acid and sodium sulfate, to investigate the effect of different electrolyte ionic radius on the performance of supercapacitors. The obtained results have shown that the gravimetric capacitance of the Mo_2C/FLG/CMC:SBR electrode in sulfuric acid electrolyte (136 F g^{-1} at a 50 mV s^{-1}) was higher than sodium sulfate electrolyte (35.5 F g^{-1} at a 50 mV s^{-1}). This is due to the larger cationic mobility of hydrogen ions and higher conductivity compared to the sodium ions. The large ionic mobility and small hydration sphere radius of hydrogen ion are due to the jumping transference mode between water molecules by hydrogen bonds.[6] Furthermore, after 12000 galvanostatic charge-discharge cycles at 5 A g^{-1}, the assembled cell demonstrated 94% gravimetric capacity retention, confirming the excellent cycling stability of the produced electrode. These findings highlight the potential of Mo_2C MXene-based electrodes for high-performance supercapacitor applications in aqueous electrolytes.

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