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Synthesis and Characterization of Hybrid Poly (N, Ndimethylacrylamide) Composite Hydrogel Electrolytes and Their Performance in Supercapacitor

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Abstract: Hydrogel materials are receiving increasing research interest due to their intriguing structures that consist of a crosslinked network of polymer chains with interstitial spaces filled with solvent water. This feature endows the materials with the characteristics of being both wet and soft, making them ideal candidates for electrolyte materials for flexible energy storage devices, such as supercapacitors that are under intensive studies nowadays. In this study, hybrid poly (N, N-dimethylacrylamide) (PDMA) hydrogels were prepared through free radical mechanism. Ammonium persulfate was used as a free radical initiator while sodium montmorillonite was used as a crosslinker. Magnesium trifluoromethanesulfonate (MgTf2) and cobalt oxide (Co3O4) nanoparticles were added to provide the conduction pathway. The synthesized hydrogels were characterized using Fourier transform infrared spectroscopy (FTIR), X-ray diffraction analysis (XRD), thermogravimetric analysis (TGA), and field emission scanning electron microscopy (FESEM). The presence of Co3O4 nanoparticles in the hybrid hydrogel was confirmed using energy dispersive X-ray spectroscopy (EDX). The ionic conductivity study was performed using electrochemical impedance spectroscopy (EIS). The ionic conductivity study revealed that hydrogel containing MgTf2 and Co3O4 nanoparticles (DMA3) has the highest ambient ionic conductivity (9.4 × 10-3 S/cm, respectively), dielectric permittivity, and lowest activation energy (0.094 eV). Furthermore, electrochemical performance of the synthesized hydrogels in electric double layer capacitor (EDLC) was examined using activated carbon electrode.

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