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High-Ionic Conductive Polymer Electrolytes for Metal-Doped MoS_2 Flexible Supercapacitors

Nafees Ibne Alam, Angshu Ghosh, Md. Rasel Islam, Debraj Nath, Md. Maruf Ripon and Kazi Mamunur Rahman Rifat
Materials Science and Engineering
Rajshahi University of Engineering & Technology
Bangladesh
nafeesneon@gmail.com, angshu.ghosh2004@gmail.com, mdraselislam2013027@gmail.com, debrajnath119@gmail.com, riponmaruf14@gmail.com, mamunurrahman987@gmail.com

Abstract

The efficiency of a supercapacitor depends on the performance of the electrode and electrolyte. The physical and chemical properties of the electrolyte influence the supercapacitor's capacity, power density, rate performance, cyclability, and safety. Transition-metal-doped molybdenum disulfide (MoS_2) has emerged as a promising electrode material due to its enhanced electronic conductivity, increased active sites, and robust structural stability, enabled by dopants such as nickel and zirconium. However, under the bending and stretching conditions the overall performance depends on the choice of electrolyte. High-ionic conductive polymer electrolytes offer a viable route to overcome the limitations of conventional liquid systems by eliminating leakage risks, improving electrode–electrolyte interfacial adhesion, and enabling operation in flexible solid-state configurations. This review highlights recent advances in polymer electrolyte systems—including Gel polymer electrolytes (GPEs), Solid polymer electrolytes (SPEs), and Composite polymer electrolytes (CPEs) and their compatibility with metal-doped MoS_2 electrodes. Key design strategies such as polymer–dopant interfacial engineering, incorporation of inorganic fillers, and network tailoring for enhanced ion transport are critically discussed. A comprehensive comparison of electrochemical performance from recent literature is presented to identify structure–property relationships and technological trends. Finally, current challenges and future research opportunities are outlined with a focus on self-healing capability, mechanical durability, wide-voltage window operation, and sustainable fabrication routes. This review provides scientific insights and practical guidelines for advancing next-generation flexible solid-state supercapacitors.

Keywords

Super capacitor, Molybdenum disulfide (MoS_2), Gel polymer electrolytes (GPEs), Composite polymer electrolytes (CPEs), Solid polymer electrolytes (SPEs).