

The pressing challenges of environmental pollution and efficient energy storage necessitate sustainable solutions that surpass the limitations of conventional batteries and supercapacitors. To meet these demands, asymmetric hybrid supercapacitors have emerged as a promising approach, combining capacitive and battery-type electrodes within a single device. Among the different electrode materials studied, metal-organic frameworks (MOFs) are distinguished by their exceptional porosity, extensive surface area, plentiful redox-active centers, and low density, which render them highly suitable for energy storage systems. Within this research, an iron-based MOF (Fe-SIP-BPY@MOF) was synthesized via a sonochemical route using 5-sulfoisophthalic acid sodium salt as the primary ligand and 2,2'-dipyridyl as the co-ligand. The material's photonic and structural features were determined by using FTIR, TGA, XRD, UV-Vis, and photoluminescence spectroscopy, confirming successful coordination, optical properties and framework stability. Electrochemical testing involved CV, GCD, and EIS analyses performed under dual (two-electrode) hybrid and triple (three-electrode) arrangements. The Fe-SIP-BPY@MOF electrode exhibited pseudocapacitive behavior, arising from a combination of capacitive and diffusive charge storage, with capacitive contribution increasing at higher scan rates by employing Dunn's method. Furthermore, a hybrid supercapacitor device (Fe-SIP-BPY@MOF//AC) was assembled, achieving a specific capacity of 10.03 C g^{-1} , specific capacitance of 6.96 F/g energy density of 2 Wh kg^{-1} , and power density of 395.87 W kg^{-1} , while maintaining excellent cycling stability (99.13% coulombic efficiency after 3000 cycles). These results establish Fe-based MOFs as potential contenders for next-generation energy storage devices especially hybrid supercapacitors, offering structural versatility, optical responsiveness, and enhanced electrochemical performance.