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Unveiling the Potential of PANI@MnO2@rGO Ternary Nanocomposite in Energy Storage and Gas Sensing

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Abstract : The development of advanced materials for energy storage and gas sensing applications has gained significant attention in recent years. In this study, we synthesized and characterized PANI@MnO2@rGO ternary nanocomposites (NCs) to explore their potential in supercapacitors and gas sensing devices. The ternary NCs were synthesized through a multi-step process involving the hydrothermal synthesis of MnO2 nanoparticles, preparation of PANI@rGO composites and the assembly to the ternary PANI@MnO2@rGO ternary NCs. The structural, morphological, and compositional characteristics of the materials were thoroughly analyzed using techniques such as XRD, FESEM, TEM, FTIR, and Raman spectroscopy. In the realm of gas sensing, the ternary NCs exhibited excellent performance as NH3 gas sensors. The optimized operating temperature of 100 °C yielded a peak response of 15.56 towards 50 ppm NH3. The nanocomposites demonstrated fast response and recovery times of 6 s and 10 s, respectively, and displayed remarkable selectivity for NH3 gas over other tested gases. For supercapacitor applications, the electrochemical performance of the ternary NCs was evaluated using cyclic voltammetry and galvanostatic charge-discharge techniques. The composites exhibited pseudocapacitive behavior, with the capacitance reaching up to 185 F/g at 1 A/g and excellent capacitance retention of approximately 88.54% over 4000 charge-discharge cycles. The unique combination of rGO, PANI, and MnO2 nanoparticles in these ternary NCs offer synergistic advantages, showcasing their potential to address challenges in energy storage and gas sensing technologies.

Keywords : paniI@mnO2@rGO ternary NCs, synergistic effects, supercapacitors, gas sensing, energy storage
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