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Synthesis of 2D flake-like MnO_2 and MoS_2 pseudo materials for high energy density supercapacitors

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Abstract: Supercapacitor has been in great demand in the past few years, primarily due to its superior features of having fast charge discharge rates, long cycle life, and high energy storage capability. Depending on the mechanism involved during the functioning of the supercapacitor, they are classified as electrochemical double layer capacitor (EDLC), and pseudo-capacitor. Those based on carbon materials alone and undergo non-faradaic reactions are categorized as EDLCs, while transition metal oxides, nitrides, sulfides, and conducting polymers that undergo faradaic reactions fall under pseudo-capacitor. MnO_2 and MoS_2 have a potential to exhibit better capacitive properties because of their flake-like morphology, high surface area, and better ionic transferability. Higher intrinsic ionic conductivity than oxides and higher theoretical capacity than graphite made MoS_2 a preferential choice for pseudo-capacitor applications. While for MnO_2, its peculiar tunnel like feature at the structural level has gained much attention, which enables the ions of the electrolyte to be stored inside these tunnels. The current work is aimed at utilizing the features of 2D-layered structure and high surface area of MoS_2 and MnO_2 as electrode for supercapacitor. The materials were synthesized using one step hydrothermal technique under specific conditions such as temperature and time to obtain the flake like morphology. They have been characterized using x-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), energy dispersive x-ray spectroscopy (EDX) and electrochemical analyzer (cyclic voltammetry). XRD results show that MoS_2 and MnO_2 have hexagonal structure with excellent crystallinity. FESEM micrographs exhibit layered flakes-like structure. The electrochemical analysis using aqueous electrolyte has resulted in the specific capacitance of 205 F/g and 145 F/g at 5 mV/s from cyclic voltammetry, and 255 F/g and 176.44 F/g at 0.25 A/g from galvanostatic charge discharge for MoS_2 and MnO_2 respectively. The ESR values are found to be 0.67 Ω and 1.37 Ω for MoS_2 and MnO_2 respectively. The energy density values are 35.50 Wh/kg and 24.50 Wh/kg for MoS_2 and MnO_2 at a current density of 0.25 A/g.

Keywords*: supercapacitor, hydrothermal process, pseudo materials, cyclic voltammetry, galvanostatic charge discharge, energy density.*

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