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Manganese dioxide thin films deposited by chemical bath and successive ionic layer adsorption and reaction deposition methods and their supercapacitive performance

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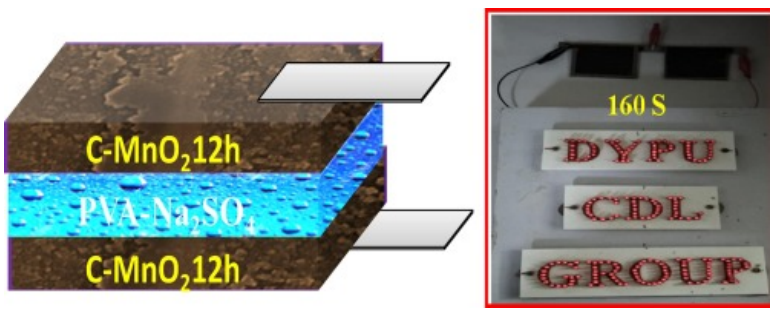
Abstract

In present work, MnO_2 thin films with tetragonal and birnessite-phases are deposited using chemical bath deposition (CBD) and successive ionic layer adsorption and reaction (SILAR) methods. The surface morphology of MnO_2 film is modified using different deposition parameters. These films are characterized by X-ray diffraction (XRD), fourier transform infrared (FTIR) spectroscopy, field- emission scanning electron microscopy (FE-SEM), Brunarer-Emmett-Teller (BET) and Barrette-Joynere-Halenda (BJH) method. The electrochemical properties are studied using cyclic voltammetry, galvanostatic charge–discharge and electrochemical impedance spectroscopy techniques in 1 M Na_2SO_4 electrolyte. The CBD method exhibits excellent electrochemical performance with maximum specific capacitance of 757 F g^{-1} at scan rate 5 mV s^{-1}, energy density of 74 Wh kg^{-1} at power density of 1.5 kW kg^{-1}. The large area solid state symmetric devices fabricated with CBD MnO_2 film electrodes exhibit maximum specific capacitance of 128 F g^{-1} with energy density of 14 Wh kg^{-1} at power density of 0.2 kW kg^{-1} with capacitive retention of 90% after 5000 CV cycles. Such device is able to glow 211 red LEDs for the period of 160 s, showing it's possible potential for commercialization.

Graphical abstract



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