

Enhanced Performance of Supercapacitor Based on Boric Acid Doped Polyvinyl Alcohol-H₂SO₄ Gel Polymer Electrolyte System

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Abstract : Recently, Proton Conducting Gel Polymer Electrolytes (GPEs) have drawn much attention in supercapacitor applications due to their physical and electrochemical characteristics and stability conditions for low temperatures. In this research, PVA-H₂SO₄-H₃BO₃ GPE has been used for electric-double layer capacitor (EDLCs) application, in which electrospun free-standing carbon nanofibers are used as electrodes. Introduced PVA-H₂SO₄-H₃BO₃ GPE behaves as both separator and the electrolyte in the supercapacitor. Symmetric Swagelok cells including GPEs were assembled via using two electrode arrangements and the electrochemical properties were searched. Electrochemical performance studies demonstrated that PVA-H₂SO₄-H₃BO₃ GPE had a maximum specific capacitance (Cs) of 134 F g⁻¹ and showed great capacitance retention (%100) after 1000 charge/discharge cycles. Furthermore, PVA-H₂SO₄-H₃BO₃ GPE yielded an energy density of 67 Wh kg⁻¹ with a corresponding power density of 1000 W kg⁻¹ at a current density of 1 A g⁻¹. PVA-H₂SO₄ based polymer electrolyte was produced according to following procedure; Firstly, 1 g of commercial PVA was dissolved in distilled water at 90°C and stirred until getting transparent solution. This was followed by addition of the diluted H₂SO₄ (1 g of H₂SO₄ in a distilled water) to the solution to obtain PVA-H₂SO₄. PVA-H₂SO₄-H₃BO₃ based polymer electrolyte was produced by dissolving H₃BO₃ in hot distilled water and then inserted into the PVA-H₂SO₄ solution. The mole fraction was arranged to ¼ of the PVA repeating unit. After the stirring 2 h at RT, gel polymer electrolytes were obtained. The final electrolytes for supercapacitor testing included 20% of water in weight. Several blending combinations of PVA/H₂SO₄ and H₃BO₃ were studied to observe the optimized combination in terms of conductivity as well as electrolyte stability. As the amount of boric acid increased in the matrix, excess sulfuric acid was excluded due to cross linking, especially at lower solvent content. This resulted in the reduction of proton conductivity. Therefore, the mole fraction of H₃BO₃ was chosen as ¼ of PVA repeating unit. Within this optimized limits, the polymer electrolytes showed better conductivities as well as stability.

Keywords : electrical double layer capacitor, energy density, gel polymer electrolyte, ultracapacitor

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