Ceramics for Supercapacitors: B_4C and ZnO

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The problem of energy storage will be one of the most urgent scientific and technological challenges of the 21st century due to increasing demand for the use of renewable energy sources. Supercapacitors (SCs) can deliver considerable amount of energy at high power in a very short time owing to their much higher power density, considerably faster response times and much longer cycling life when compared to batteries. The main drawback of SCs is their low energy density. Hence, the development of new device configurations and novel nanostructured electrode materials is necessary because the working mechanism of SCs is highly dependent on the device design, the type of electrode materials, morphology, crystal size and defect structures.

In this work, a novel SC design comprising boron carbide (B_4C) and zinc oxide (ZnO) based electrode materials will be presented. Recent studies showed that semiconductor ZnO nanocrystals exhibit hybrid supercapacitor mechanism due to their intrinsic defects [1]. On the other hand, in addition to its superior thermal and chemical properties, B_4C is known as the hardest material produced in tonnage quantities for commercial applications [2]. Although there are a few studies in literature on its use in electronics and energy applications, there is very limited information regarding its use as an electrode material for SCs. It is reported that both B_4C and ZnO are semiconductors and have interesting defective and capacitive properties [1, 3]. In this study, B_4C powder was synthesized via modified sol-gel process at low temperatures (≤1500°C). The defective properties of the B_4C and ZnO were investigated using state-of-art Electron Paramagnetic Resonance (EPR) and optical techniques such as photoluminescence (PL) and UV-Visible spectroscopies. Electrical measurements of SCs were performed via potentiostatic electrochemical impedance spectroscopy (PEIS), cyclic voltammetry (CV) and galvanostatic cycling with potential limitation (GCPL) techniques. The electrochemical performance of the SCs will be discussed.

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References

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