Nickel Oxide Nanoflower Supported on Carbon for Supercapacitor Applications

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Supercapacitors, having higher power density than batteries and higher energy density than conventional capacitors, have promising characteristics such as long life cycle and fast charge/discharge mechanisms to bridge the gap between batteries and capacitors. Supercapacitors are classified into two types: electric double-layer capacitor (EDLC) and pseudocapacitor. The former physically stores electric charges at the interface of electrode/electrolyte where the latter utilizes fast faradaic redox reaction on the active electrode [1]. For pseudocapacitors, ruthenium oxide (RuO_2) is the most researched material with the capacitance reported around 1500 F/g; however, due to the high cost and toxicity, research is been conducted to seek for alternative pseudocapative material [2].

In search of pseudocapactive material, nickel oxides (NiO) have grabbed the attention for low cost, high theoretical capacitance (~2500F/g), and easy availability [3]. To improve the capacitance of nickel oxides, one needs to synthesize the desired morphology of the material with definite pore structures and increased surface area [3]. Variety of methods can modify the morphology of the nickel oxide. In this study, hydrothermal method is used with nickel precursor and additives to synthesize nickel hydroxide particles. The nickel hydroxide particles are calcined at desired temperature for a certain length of time to vaporize the water and form the final product: nickel oxide.

The scanning electron microscope (SEM) image shows the surfaces of NiO have been rippled, resembling a flower-like structure. The rippled surface is a promising morphology because the surface areas for the faradaic reaction to occur have greatly increased. The mechanisms behind the flower morphology are still elusive, but NiO nucleates undergoing coalescence and Ostwald ripening could be the explanation for forming this flower morphology [2].

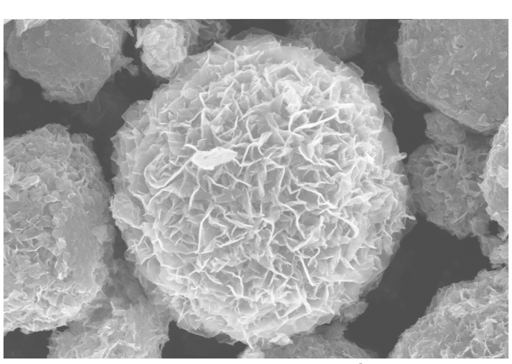

Figure 1: SEM image of NiO

Conducting electrochemical testing such as Galvanostatic charge and discharge determined the capacitance of the nickel oxide. The material is coated on glassy carbon and testing is run in 2M KOH electrolyte. Non-linear charge/discharge curves are seen for NiO which is an expected behavior for pseudocapacitive material where EDLC's would behave linearly (Figure 2). The specific capacitance values calculated from the curves are 639.7 F/g, 539.6 F/g, and 393.2 F/g for 1A/g, 2A/g, and 5A/g, respectively. Due to the poor conductivity of the nickel oxide, the capacitance values decrease as applied current increase. To retain the performance at higher current, conductive material, such as carbon, needs to be combined with the nickel oxide. Further research is planned to successfully support the nickel oxide on carbon material to enhance the capacitance.

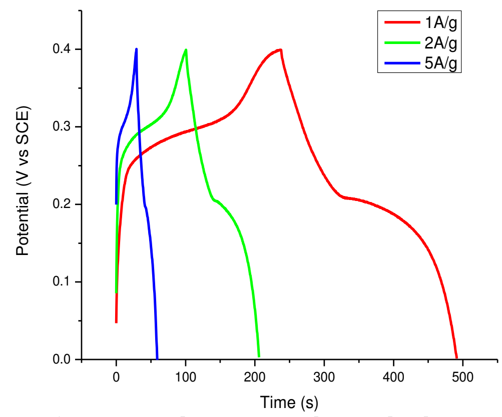

Figure 2: Galvanostatic charge/discharge curve for NiO at specific current

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