Electrochemical performance of ZnCo₂O₄ nanoparticle

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Supercapacitors have much more interesting field because of its comparable high energy density and power density. Transitions metal oxides are having multiple oxidation states, good electrochemical property and catalytic property. For this reason researchers preferred transition metal oxide based material for the pseudocapacitance application. Metal oxides like MnO₂, Co₃O₄, MoO₂, NiO, CuO based materials shows the good capacitive nature. Co₃O₄ is one of the materials having high electrochemical and catalytic property. The incorporation of one or more transition metal with Co₃O₄ will change its oxidation state to form MCo₂O₄ (where M=Zn, Cu, Ni, Fe) structure and enhance its pseudocapacitive property.

ZnCo₂O₄ material prepared by thermal decomposition method and annealed at 500 °C for 3 h. The annealed samples were characterized using XRD, FTIR, SEM and electrochemical studies. XRD pattern is matched with the standard JCPDS No: 23-1390 and some impurity peaks are also obtained. SEM image shows the agglomerated spherical shaped particle.

Figure 1: Cyclic voltammetric curve

The supercapacitor studies were carried out using three electrode system. The electrode material was coated in the nickel foil, it is used as the working electrode and its specific capacitance was calculated using the formula [1].

$$C_s = \frac{\int_i i(v)dv}{mv\Delta V} \quad (1)$$

The highest specific capacitance from the CV curve is 412 F/g at a scan rate of 2 mV/s. The redox process of the material are clearly shown in the cyclic voltammetric curve and charge-discharge studies confirm the pseudocapacitive behavior of the material.

Figure 2: Charge-discharge studies of the ZnCo₂O₄

While increasing the scan rate (Figure 1) or current density (Figure 2) the specific capacitance value decreases, because the electrolyte ions do not have the enough time to complete the redox reaction with the electrode material.

Reference

1. S. Vijayakumar, S-H Lee, K-S Ryu, *Electrochim. Acta.*, 182 (2015) 979-986.