

EXPLORING THE ELECTROCHEMICAL PERFORMANCE OF NiCo₂O₄ BASED NANOCOMPOSITE SUPERCAPACITOR APPLICATION.

One of the main obstacles to developing more effective renewable energy solutions is the demand for energy storage. Due to the depletion of fossil fuel resources, population growth, and technological advancements, humanity faces an energy crisis. Growing pollution compels us to consider energy and energy management strategies. Power electronics and energy management researchers have focused mostly on creating energy storage systems with increased dependability, efficiency, extended lifespans, and reduced costs. Fuel cells, batteries, and electrochemical capacitors (ECs) are examples of electrochemical energy storage and conversion technologies that have been recognized as important. High power density and long life are two important benefits of electrochemical capacitors, often known as supercapacitors (SCs) or ultracapacitors. Presently, there are several novel applications utilizing electrochemical capacitors (ECs) for both stationary and on-board use. Numerous electro-active materials are being researched that can store energy through rapid redox reactions at the interface between the electrode and electrolyte, improving the energy density while preserving good power density and cycle stability qualities. The high energy/power ratio of hybrid-type supercapacitors (HSs), often referred to as supercapacitor–battery hybrid systems, has garnered interest when contrasted with conventional electron double-layer capacitors (EDLC). Several oxides have been investigated as potential electrode materials, including MnO₂, NiO, ZnO, and Co₃O₄. RuO₂ is also notable for having a specific capacitance of up to 1580 F/g. However, due to its high price and rarity, commercialization does not appear promising. As opposed to single metal oxides, binary metal oxides, such as NiMn₂O₄, NiFe₂O₄, ZnMn₂O₄, ZnCo₂O₄, and NiCo₂O₄, exhibit robust electrochemical

performance, ease of availability, and environmental friendliness. These attributes have led to their primary consideration as supercapacitor electrode materials in recent times. Among these, NiCo_2O_4 has attracted a lot of attention lately because to its great availability, low toxicity, and high theoretical specific capacitance. What's more, it has been reported that large surface area NiCo_2O_4 nanosheets can be used as a scaffold to create 3D hierarchical hybrid nanostructures with other highly active electrode materials. NiCo_2O_4 spinel is currently widely employed in the domains of lithium-ion batteries, magnetic materials, and electrocatalysts. Notably, spinel nickel cobaltite (NiCo_2O_4) ternary material from an epoxide-driven sol-gel method exhibits an ultrahigh specific capacitance of 1400 F/g under a mass loading of 0.4 mg/cm². The high theoretical capacitance, low cost, natural availability, and benign nature of NiCo_2O_4 have since sparked increased interest in it as an electrode material for supercapacitors. Moreover, NiCo_2O_4 has far better electronic conductivity (at least two orders of magnitude higher) and much stronger electrochemical activity than single NiO or Co_3O_4 . Consequently, spinel NiCo_2O_4 is a potentially more affordable option than RuO_2 for electrode materials in real-world supercapacitors. In this research, NiCo_2O_4 Supercapacitor applications can benefit from the use of nanocomposites for electrodes, which have been developed and show good reversibility and improved specific capacitance.