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Hydrothermal Synthesis of V_2O_5-Carbon Nanotube Composite for Supercapacitor Application

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Abstract : The transition to renewable energy sources is essential due to the finite limitations of conventional fossil fuels, which contribute significantly to environmental pollution and greenhouse gas emissions. Traditional energy storage solutions, such as batteries and capacitors, are also hindered by limitations, particularly in capacity, cycle life, and energy density. Conventional supercapacitors, while able to deliver high power, often suffer from low energy density, limiting their efficiency in storing and providing renewable energy consistently. Renewable energy sources, such as solar and wind, produce power intermittently, so efficient energy storage solutions are required to manage this variability. Advanced materials, particularly those with high capacity and long cycle life, are critical to developing supercapacitors capable of effectively storing renewable energy. Among various electrode materials, vanadium pentoxide (V_2O_5) offers high theoretical capacitance, but its poor conductivity and cycling stability limit practical applications. This study explores the hydrothermal synthesis of a V_2O_5-carbon nanotube (CNT) composite to overcome these drawbacks, combining the high capacitance of V_2O_5 with the exceptional conductivity and mechanical stability of CNTs. The resulting V_2O_5-CNT composite demonstrates enhanced electrochemical performance, showing high specific capacitance of 890 F g^{-1} at 0.1 A g^{-1} current density, excellent rate capability, and improved cycling stability, making it a promising candidate for next-generation supercapacitors, with significant improvements in energy storage efficiency and durability.

Keywords : cyclability, energy density, nanocomposite, renewable energy, supercapacitor
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