V₂O₅ @ rGO nano composite: An electrode material for hybrid supercapacitors

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In the past decade, the each and every minute of human life moves parallel with the fast growing technology (portable electronic devices). Concurrently this technology development seeks energy storage devices. In this regard batteries of different kinds and high performance capacitors are the focus of current scientific research. The alternative to energy storage with batteries is electrochemical capacitive storage, which offers fast charge and discharge operation, longer cycle life and significantly higher power density than batteries. The supercapacitor utilizes the fast faradaic process involving reversible electrochemical redox reaction occurs at the electrode- electrolyte interface, which leads to energy storage. The most common devices which incorporate pseudocapacitive materials are hybrid asymmetric capacitors which typically have a carbon electrode as the cathode and the pseudocapacitor material as the anode.

Among various transition metal oxides V₂O₅ has been widely investigated as the appropriate material, because of its layered structure, variable oxidation states, low cost highly abundant resources and high specific capacity. Even though it has many properties, its low energy density and poor electronic conductivity limits the performance. The enhancement in the performance of supercapacitors can be achieved by two ways either by reducing the size of V₂O₅ materials to nanoscale or by making composite with highly conductive carbon based matrix. Thus, V₂O₅-rGO nanocomposite is a promising candidate as an electrode material for hybrid asymmetric capacitors. V₂O₅-rGO composite has been prepared by sol- gel method. Figure 1 shows the XRD pattern of the materials. The diffraction peak obtained at $2\theta = 10.56^\circ$ indicates that the formation of GO phase, and this peak is shifted to $2\theta = 25.15^\circ$ for rGO gives an evidence that the graphene oxide was reduced by sodium borohydride. Meanwhile, it can also observe that the peaks of graphene oxide become broadened after reduction, which is a typical pattern

for amorphous carbon structure, revealing that the stacking of graphene sheets is substantially disordered. The XRD pattern of V₂O₅ matches well with the ICDD database (01-077-2418) with a space group of Pmmn (59). No impurity peaks were observed in the sample. XRD pattern confirms highly crystalline nature of the material with orthorhombic structure. It is important to note that the stacking peak of graphene nano sheets usually located at 26° , which was not detected in V₂O₅-rGO composite indicating that V₂O₅ particles uniformly dispersed on rGO sheets and the intensity of V₂O₅ peaks diminish the rGO diffraction. The materials were also characterized by using different structural characterization techniques viz., Thermo Gravimetric Analysis (TGA), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDAX), Surface area analysis (BET) and Transmission Electron Microscope (TEM) etc.

Figure 1: XRD Pattern of GO, rGO, V₂O₅ and V₂O₅- rGO composite

The results ensure that V₂O₅-rGO can be used as an electrode material for hybrid asymmetric capacitors.

References

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