Investigation on rare earth doped metal oxide/tungstate for high energy density super capacitor application

The rapid increase of depletion of fossil-fuels and environment pollutions are major concerns to the modern society over the past few years. Recently, scientists and engineers are involved to develop various kinds of sustainable and renewable energy storage devices with the help of modernized technology. Electrochemical super capacitor (SC) is one of the most promising energy storage devices and commercially used for various applications such as portable electronic devices, hybrid electric vehicles, industrial power systems and military etc due to its unique properties of high-power density, fast charge/discharge time and long cycle stability. Recently, it has gained great attention with research interests to improve the functional performance.

In general, SCs can be classified into two kinds according to charge storage mechanism such as electrical double-layer capacitors (EDLCs) and pseudo capacitors. In EDLCs, the charge has been stored physically at the electrode/electrolyte interface and high surface area with carbonaceous materials such as graphene oxide, activated carbon and single/multi-wall carbon nanotubes are commonly used for electrode materials. However, its low energy density and specific capacitance restricts the wide range of practical applications. On the other side, pseudo capacitors have fast and highly reversible faradic redox process occurring at the electrode surface of the active metal oxide/electrolyte interface. Transition metal oxides/hydroxide such as RuO_2, MnO_2, Co_3O_4, NiO, $Ni(OH)_2$, $Co(OH)_2$ are used for pseudo capacitor electrode materials which can provide high specific capacitance than EDLCs. Among them, MnO_2 receives great attention due to its low cost and high electrochemical performance. Rather than metal oxides, metal tungstate-based researches getting huge attention due to their high electro catalytic activity and stability.

Based on the literature, the metal tungstate ($CoWO_4$, $CuWO_4$, $MnWO_4$ and $NiWO_4$) are composited with MnO_2 nanorods to achieve the high surface area. Further, the electrochemical performances will be enhanced by doping rare earth metals (Ce, Sm, Gd, Dy, Ho). This may lead to the enhanced electrochemical performance of super capacitor electrode material for commercial applications.