

### Supercapacitor electrode based on $\text{MnO}_2$ composited of graphene and carbon nanotube

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Supercapacitors have been investigated for excellent power density and cycle life for the past decades. Pseudocapacitors utilize fast and reversible Faradic reactions occurring on the surface of metal oxides or conducting polymers. Among the metal oxides for pseudocapacitors electrode, manganese dioxide( $\text{MnO}_2$ ) is considered as very promising materials due to high specific capacitance and low cost. However high resistance and poor cyclic stability limit potential application.

In this research,  $\text{MnO}_2$  is composited of graphene and carbon nanotube in order to overcome poor electrical conductivity. Graphene and carbon nanotube serve as conductive nanosheets and nanochannel individually to enhance electron transfer. Therefore, it is expected that specific capacitance and cyclic stability are greatly enhanced due to graphene and carbon nanotube. Morphology and crystallinity of graphene and carbon nanotube composited of  $\text{MnO}_2$  were analyzed by transmission electron microscopy(TEM) and X-ray diffraction (XRD). Electrical properties and cyclic stabilities were characterized by cyclic voltammetry(CV) and charge/discharge curves.