Hybrid Supercapacitor with Various Metal Oxides Cathode and Anodized Al Anode

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Over the past two decades, the electrochemical supercapaictors are receiving growing attention due to their possible applications as power backup in electronic equipment and electrical vehicles. The tantalum oxide or aluminum oxide cathode electrode in an electrolytic capacitor was replaced by a ruthenium oxide (RuO_2, MnO_2, CoO_2) electrode for improving the energy density. Order-of-magnitude increases in volumetric energy density over electrolytic capacitors have been reported. Also in contrast to electrochemical capacitors, where cell voltage is limited to the stable potential window of the electrolyte, the hybrid capacitor cell voltage depends on the breakdown voltage of the anode dielectric, which is orders-of-magnitude higher than that of electrochemical capacitors.

In this work, we have studied on possibility of hybrid capacitor constructed of aluminum oxide anode and MO_2(M= Co, Ru, Mn) cathode. Also, we have applied gel electrolyte for this hybrid system.

Preparation of metal oxide electrode: Metal oxide mixed with 5wt% PTFE form as binder and 20wt% carbon black as conductor in zirconia bowl. After mixing, mixture put on metal mesh (Ni, Al) and press. In the case of Al foil, we paste carbon paste on Al foil to increase adhesive with metal oxide.

Anodizing: Etched Al film (AC etched and DC etched) used as anodizing electrode material. Anodizing condition was 5 Volt for 30 min in boric acid.

Electrochemical measurement: The performance of the capacitors was analyzed at room temperature by cyclic voltammetry. Working electrode was metal oxide electrode. Pt plate (2*2 cm^2 size) and Ag/AgCl electrode used as counter electrode and reference electrode. 0.5M H_3BO_3 containing 0.05M $Na_2B_4O_7$, 0.1M Na_2SO_4, 0.1M H_2SO_4 were used as electrolyte.

To find optimum current collector, we compared various current collector, Ni-mesh, Al-mesh, polished Al-foil and etched Al-foil (Fig. 1). In the case of 0.1M Na_2SO_4 electrolyte, polished Al-foil showed the largest capacitance in the range of –0.2 ~ 0.5 V (Fig. 1-a). Otherwise, in the case of 0.5M H_3BO_3 containing 0.05M $Na_2B_4O_7$ electrolyte, polished Al-foil was similar to Ni-mesh. Al mesh has higher capacitance in 0.5M H_3BO_3 containing 0.05M $Na_2B_4O_7$ than 0.1M Na_2SO_4 electrolyte.

Acknowledgement

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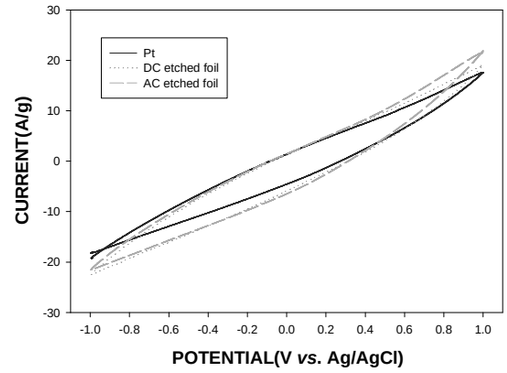

Fig. 1. CV changes of Hybrid capacitor compared with different counter electrode
((MnO_2 75%, AB 20%, PTFE 5%) C.E: Anodized Al foil)- electrolyte 0.5M H_3BO_3 containing 0.05M $Na_2B_4O_7$ and scan rate 10mV/s

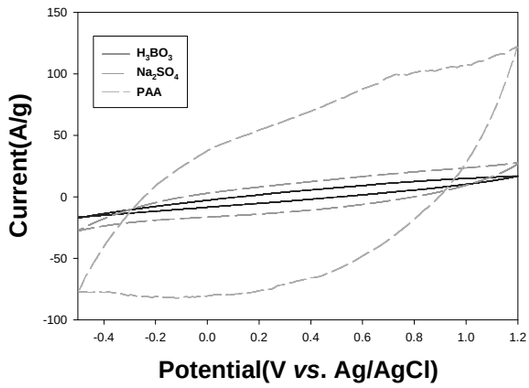

Fig. 2. CV changes of Hybrid capacitor compare with different electrolyte (MnO_2(75%), AB(20%), PTFE(5%)) - etched Al-foil and electrolyte Na_2SO_4 and scan rate 10mV/s

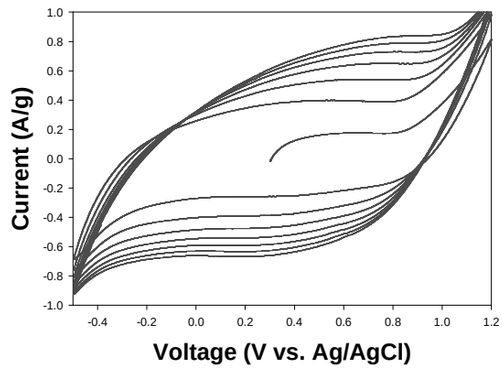

Fig. 3. CV changes of Hybrid capacitor with gel electrolyte (MnO_2(75%), AB(20%), PTFE(5%)) - etched Al-foil and scan rate 10mV/s