DEVELOPMENT OF AQUEOUS POLYMERIC GEL ELECTROLYTE FOR PSEUDOCAPACITOR

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Electrochemical capacitors are charge-storage devices that possess high power density, excellent reversibility, and very long cycle life. Potential applications of electrochemical capacitors include load-leveling functions for batteries in electric vehicles and burst-power generation in electronic devices such as cellular phones, camcorders, and navigational devices. Carbon-based systems are thought to function as double-layer capacitors due to their high specific surface areas (about 2000 m^2/g).

While the utility of CoO_2 in batteries was recognized and well established [1], its potential application as an electrode material for ultracapacitors is not yet extensively studied. So, we have studied on nanostructed cobalt oxide electrode for supercapacitor[2]. We succeeded to make nanostructured cobalt oxide electrode that have large capacitance over than 400 F/g (specific capacitance) and good cycleability. But, It have serious demerits of low voltage range under 0.5V and low power density. Therefore, we need to increase voltage range of cobalt oxide electrode. we report here on the electrochemical properties of sol-gel-derived nanoparticulate cobalt xerogel in 1M KOH solution and aqueous polymeric gel electrolyte.

A three-electrode system was used for the electrochemical measurements. The working electrode was prepared by mixing CoOx xerogel with 5 wt% PTFE binder and 5 wt% acetylene black, followed by pressing at 400 kg/cm^2 on nickel mesh using hand press. Nanostructured cobalt oxide powder was prepared by our previous work[3]. In solution electrolyte state test, Platinum plate served as a counter electrode and Ag/AgCl as a reference electrode. A 1M KOH solution was used as the electrolyte. In gel electrolyte state test, Platinum plate served as a counter electrode and Ag wire was used as a reference electrode. Aqueous polymeric gel containing 1M KOH was used as the electrolyte. All of the electrochemical measurements were conducted at room temperature

Cobalt oxide had large internal resistance. So, Addition of conducting material increased capacitance. Fig. 1. are shown to effect of conducting material & binder material content ratio on electrochemical characteristics of cobalt oxide in 1M KOH solution. Current density was 2.5mA/cm^2 and voltage range was between 0.0～0.5 V. Lack of conducting material shows only surface electric double layer capacitance. Enough of conducting material, however, shows electric double layer capacitance and pseudocapacitance between 0.2 and 0.3 V range. The electrode (containing Co 75 wt%, AB 20 wt%, PTFE 5wt%) had over than 240 F/g capacitance. Therefore, we decided to use this electrode composition for all of electrochemical behavior measurements of cobalt oxide electrode.

To increase voltage range, we prepared aqueous polymeric gel electrolyte containing 1M KOH. Until now, there is no paper related pseudocapacitor using metal oxide electrode and polymeric electrolyte. Above mentioned, Cobalt oxide electrode showed low voltage range performance in aqueous solution electrolyte. Fig. 2 shows electrochemical behavior of cobalt oxide electrode by different electrolyte types. In solution electrolyte, cobalt oxide electrode had over than 250 F/g capacitance consisted of EDLC and pseudocapacitance. In gel electrolyte, cobalt oxide electrode had around 100 F/g capacitance. This capacitance was only surface EDLC. In this point, we needed to imagine that cobalt oxide electrode structure consisted of resistive layer and active layer. In solution electrolyte, potassium ion as working ion reacted with both of layers easily. However, In gel electrolyte, reacted with only surface-active layer. Its very hard to reach resistive layer. Therefore, we have studied on pretreatment of electrode to contain working ions easily. In near future, we'll report more details.

Reference

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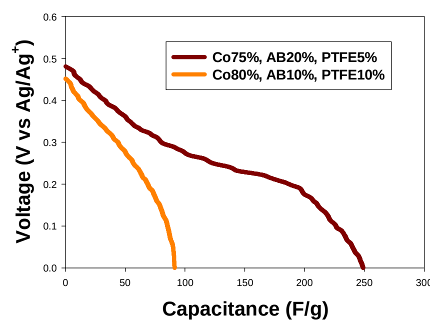

Fig. 1. Effect of conducting material & binder material content ratio on constant current discharge

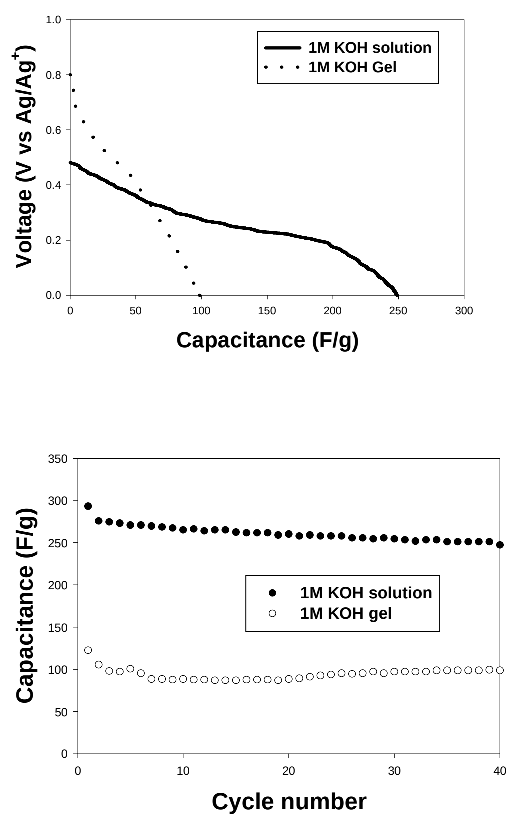

Fig. 2. Effect of different electrolytes on constant current discharge (up) and cycleavility (down)