

Pseudocapacitive Performance of Manganese Iron Oxide Films Prepared by Sol Gel Process

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Electrochemical capacitors or pseudocapacitors have been considered to be promising devices for various energy applications. Manganese oxides with its multi-valence characteristics, easy to be obtained, environmental friendly, and relatively low cost is highly potential and have attracted increasing R&D attentions. In the present study, manganese iron oxide electrodes were prepared by sol-gel technique. The effect of iron oxide addition and post heat treatment on the electrochemical performance were addressed.

Figure 1 shows the XRD patterns of manganese oxide film with 1.0% iron oxide addition as a function of heat treating temperature. It can be noted that an amorphous phase exhibited if the annealing temperature is lower than 250 °C. After annealing at temperatures ranged from 300 °C to 400 °C, the heat-treated film exhibited a mixture of Mn_3O_4 (major phase) and Mn_2O_3 (minor).

Synchrotron XAS technique was used to reveal further structural change before and after CV tests. Figure 2 shows the EXAFS spectra at Mn K edge of 350 °C heat-treated 1.0% MnFeOx film before and after CV tests. Except for the peak at ~6.37 keV (indicated by an arrow shown in Fig. 2), no obvious difference can be revealed. However, the absorption edge shifted to the right by 2.0 eV can be noticed after CV tests. This can be attributed to an increase of manganese valence after CV tests. The insert figure of Fig. 2 shows the corresponding RDFs. No significant differences can be revealed at the first strong peak (representing Mn-O bond). While an obvious increase in the second peak amplitude (representing Mn-Mn bond) can be noticed. This suggests the repetitive CV tests changed the crystallinity of manganese iron oxide films.

Figure 3 shows the variation in specific capacitance as a function of CV test cycles. It can be noted that the specific capacitance increased significantly at the beginning, from the initial 158.3 F/g to a maximum of 233.1 F/g after 85 cycles. A gradual decrease in specific capacitance can be observed and the specific capacitance was 170.3 F/g after 1200 cycles. Unadded manganese oxide film was also shown in Fig. 3 for comparison. Similar trend can be noticed for unadded film. After 1200 CV cycles, the specific capacitance was 58.4 F/g and ~50.7% of its maximum. The addition of iron oxide into manganese oxide film not only increase the specific capacitance but improve its stability.

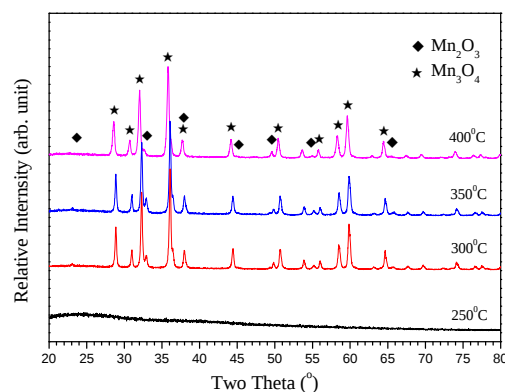


Fig. 1: XRD patterns of manganese oxide film with 1.0% iron oxide addition at various heat treating temperatures.

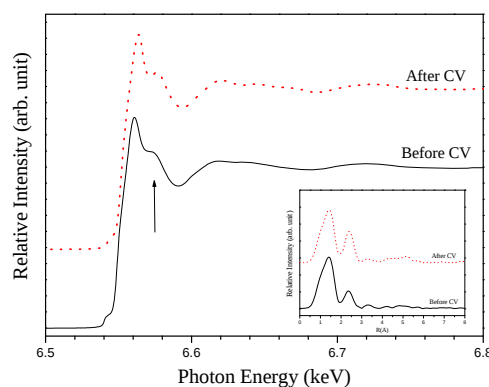


Fig. 2: EXAFS spectra at Mn K edge before and after CV tests. The insert figure shows the corresponding RDFs.

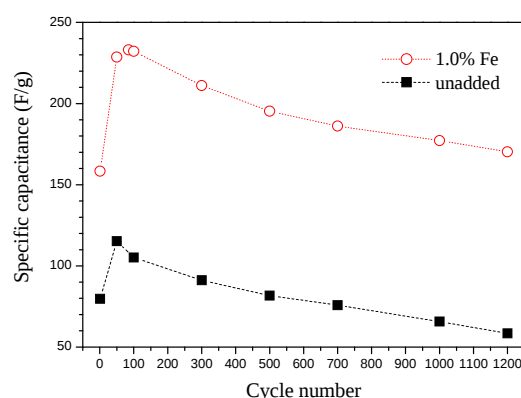


Fig. 3: Variation of the capacitance for manganese oxide films without or with 1.0% iron addition.