Electrochemical properties of mesoporous manganese oxide sphere obtained by aerosol-assisted self-assemble process

Chun-Jou Lin,[a] **Te-Wang Chen,**[a] **Ya-Hsuan Liou,**[b] **Chin-Jung Lin** [a,*]

[a] *Department of Environmental Engineering, National Ilan University, Ilan,260, Taiwan*

[b] *Department of Geosciences, National Taiwan University, Taipei, 106, Taiwan*

**E-mail: lincj@niu.edu.tw*

Abstract:

In this study, we fabricated electrode by mixing mesoporous manganese oxide particle obtained by Aerosol-Assisted Self-Assemble(AASA) process and Polytetrafluoroethene (PTFE) as binder in a thin sheet-like formulation for capacitive deionization process (CDI). The properties of electrode materials have a great impact on the CDI process. Manganese oxide characterized by scanning electron microscopy(SEM), transmission electron microscopy(TEM), X-ray diffraction(XRD). The electrochemical properties were further conducted using cyclic voltammetry and galvanostatic charge/discharge experiments.

Keywords: mesoporous, manganese oxides, Aerosol-Assisted Self-Assemble.

1. Introduction

The seawater is an abundant source; therefore, development of the seawater desalination method for desalination is merit. Electrochemical method is a promising water treatment method that is more energy efficient than conventional processes such as RO.[1] The electrosorption capacity of the CDI process depends on the physical properties and structure of the electrode materials. Besides the surface area, chemical stability, wettability characteristic and electrochemical performance is one of the basic features for the optimal electrode. The specific capacitance and energy density of the metal oxides are higher than active carbon (AC). The rubidium oxide also known as metal oxide, which has best electrochemical performance but it's too expensive to quantified product. The Manganese oxides are relative cheap and environmental-friendly, so that reduce production cost.

2. Experimental

Mesostructured spherical particles was prepared using a commercial ultrasonic atomization. (a) Cetyltrimethylammonium bromide (CTAB) dissolved in de-ionised water at 348 K. After 15 min HCl added to above solution under stirring. After more 15 min added Manganese (II) acetate solution at 303 K under 15 stirring. (b) In a continuous, temporary process, the aerosol particles are dried, heated and collected. (c) The powder was obtained from filter, calcinated by muffle at different temperatures. The Manganese oxide electrode for electrosorptive deionization was constructed by mixing manganese oxide powder and polytetrafluoroethene (PTFE) polymer binder in DI-water. The slurry was painted onto a titanium plate and dried in a 120 °C oven for 1 h to removed water in sheet.

3. Results and discussion

Figure (1) is the SEM images of the prepared samples. The morphologies of the samples are different. The sample (c) shows spherical particles with mseoporous and the average diameter of aggregated particle is about 300~900nm.With calcinated temperature increasing to around 823 K, the quantity of surface pore are decreasing. As the temperature increases above 923 K, the surface became smooth and the particles stuck together. Theoretically the aggregation results in surface decrease at high temperature. Fig.2 is the TEM images of powder calcinated at 923, 823 and 723 K, respectively. This HRTEM image shows pore structure in material was influenced by calcinated temperature.

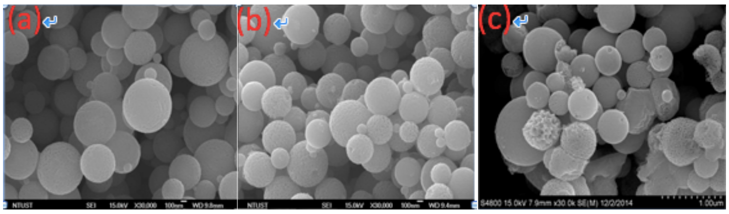

Figure 1. SEM images of powder was calcinated at (a) 923 K, (b) 823 K, and (c) 723 K.

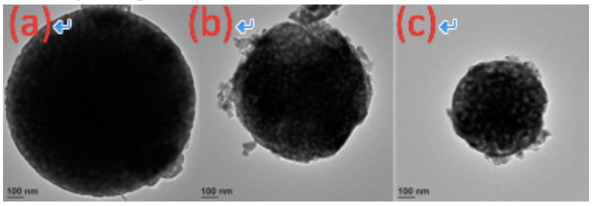

Figure 2. TEM images of powder was calcinated at (a) 923 K, (b) 823 K, and (c) 723 K.

The electrochemical properties of different samples were examined. Fig. 3 shows the typical CV curves and the calculated specific capacitances are compared in Fig. 6. For Fig. 4, symmetric curves with respect to the X axis were observed, indicating that the capacitive process is a highly reversible and reliable process. The rectangular shapes implied the excellent electrochemical double layer (EDL) capacitance behavior.

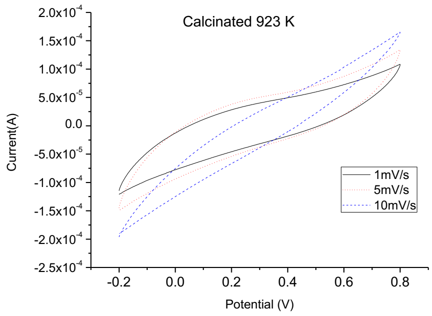

Figure 3. CV of powder was calcinated at 923 K

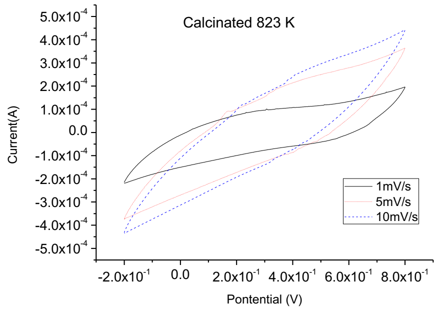

Figure 4. CV of powder was calcinated at 823 K

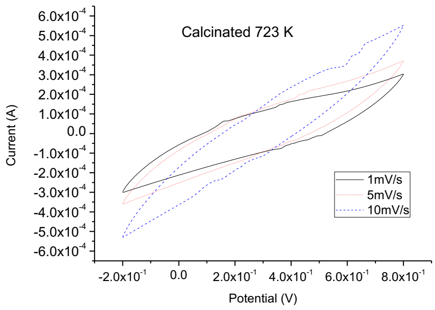

Figure 5. CV of powder was calcinated at 723 K

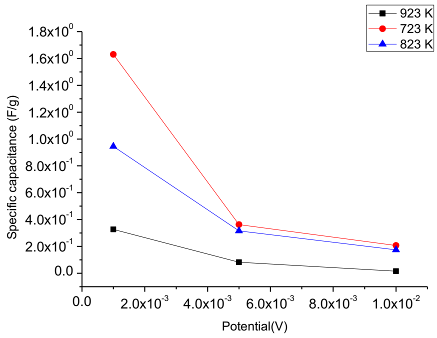

Figure 6. Specific capacitances of powder was calcinated at difference temperature

4. Conclusions

In summary, the SEM images show spherical particles with mseoporous and the average diameter of aggregated particle is about 300~900nm.With calcinated temperature increasing to around 823 K, the quantity of surface pore are decreasing. As the temperature increases above 923 K, the surface became smooth and the particles stuck together. The TEM images show pore structure in material was influenced by calcinated temperature. The symmetric curves with respect to the X axis were observed, indicating that the capacitive process is a highly reversible and reliable process.

References

1. Ober, C. K.; Wegner, G. Adv. Mater. 1997, 8, 17-31.