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INFLUENCE OF METAL IONS (Co^{+2}) ON THE CAPACITANCE PERFORMANCE OF $SrFeO_3$ MATERIAL AS A SUPERCAPACITOR

V.P. AKHARE

P.G. Department of Physics, Shri Shivaji Sc. College, Amravati (M.S) 444602. India

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Electro-chemical supercapacitor possesses the unique energy storage performance, such as greater power density and longer cycle life than secondary batteries. Nano sized $SrFeO_3$ has been prepared by sol-gel citrate method and calcined at 300°C. The influence of doping of Co^{+2} ions in $SrFeO_3$ on specific capacitance has been investigated. Also the effect of annealing temperature on specific capacitance value has been studied.

KEYWARDS : Supercapacitor, Sol-gel method, $SrCoFeO_3$, capacitance.

INTRODUCTION

Besides carbon, metal oxides, Sr-Fe oxides are important materials for supercapacitors due to their superior pseudo capacitive behavior. Sr-Fe oxides present an attractive alternative as an electrode materials because of high capacitance and low resistance. Carbon based supercapacitor has low energy density (Jampani P.. *at. al.* 2010) [1]. Cong H.P., *et. al.* (2013) [2] reported that conducting polymer base supercapacitor has poor cyclic capability. In the present investigation, we have reported the synthesis, capacitive behavior, capacitance value, and effect of doping Co^{+} ions on capacitance value of $SrFeO_3$ and effect of annealing temp.

EXPERIMENTAL

Analytical grade strontium nitrate, iron nitrate, cobalt nitrate and citric acid used to prepare $SrFeO_3$ by sole-gel method. These metal nitrates and citric acid were dissolved in minimum of ethyl alcohol with 1 : 1 molar ratio. The mixture was heated at 80°C for 12 hours to remove excess alcohol. On further heating, the dried gel burnt in a self propagating combustion manner until all the gel completely converted to floppy loose powder. Cobalt nitrate was added during process for doping Co^{+2} with concentration, x = 0, 0.2.

The electrochemical response of electrode was evaluated by Cyclic Voltammetry (CV). Cyclic voltammetry measurements were made with help of computer controlled CHI6002C instrument at different scan rate 0.05. A platinum rod served as the counter electrode and saturated calomel electrode was used as reference electrode. Voltammetric curves were recorded in 0.1 M KCl solution at different scan rates for all electrode samples. The galvanostatic charge-discharge study was performed. To prepare electrode for electrochemical, prepared powder (sample material) and polyvinyl alcohol were mixed in water to form slurry. The slurry was then pasted on gold plate by dip coating and dried at room temp. The mass of loaded material was noted. 1M KCl solution was used electrolyte solution. The potentials were applied between reference and working electrodes and currents were measured between working and counter electrode.

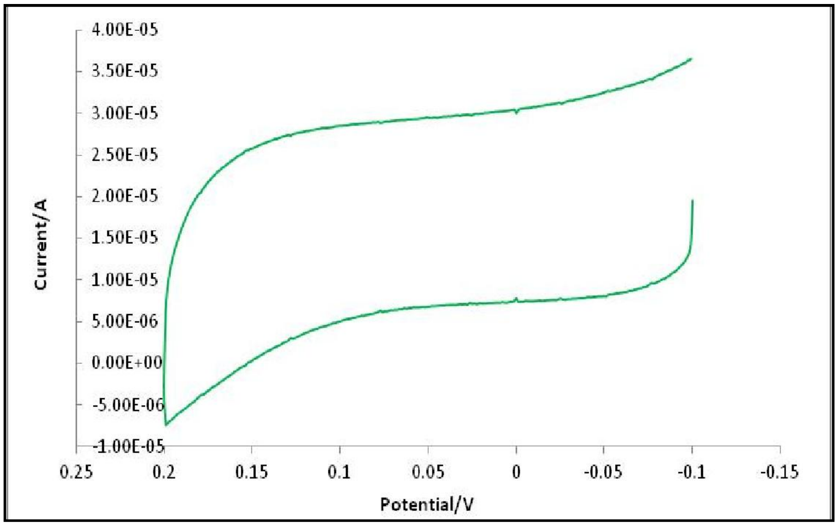

Fig. 1(a). Cyclic Voltammogram for $SrFeO_3$ at temperature 350°C.

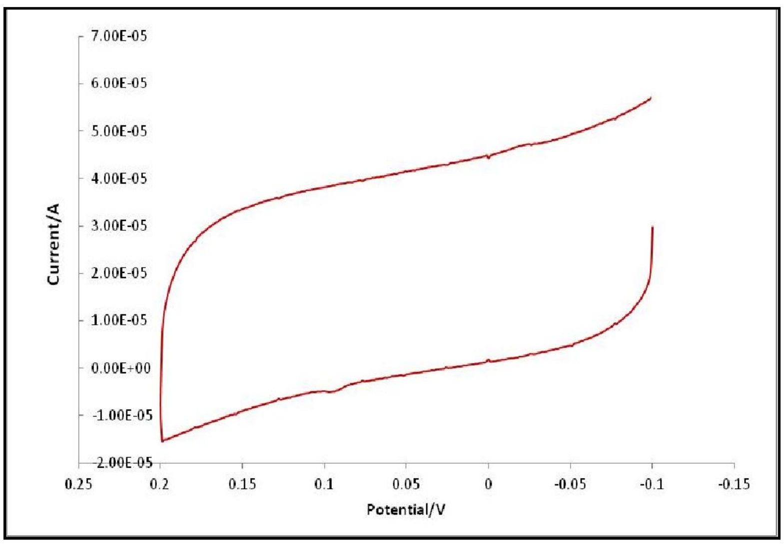

Fig. 1(b). Cyclic Voltammogram for $SrCoFeO_3$ at temperature 350°C

Cyclic voltammetry measurement (at temp. 350°C) at scan rate 0.05 v/s and charge-discharge characteristics were done for $SrFeO_3$ (series-1A) and $SrCoFeO_3$ (series-1B) samples. The curves are shown in Fig. 1(a), 1(b), Fig. (3) and Fig. (4). CV measurement was also done for series 1B at temp. 550°C. CV at temp. 550°C is shown in Fig. 2.

The capacitance values were evaluated by using the relation,

$$\text{Capacitance} = i/s$$

where i = Current, S = Scan rate.

Specific capacitance = i/mxs

where m = mass of active material.

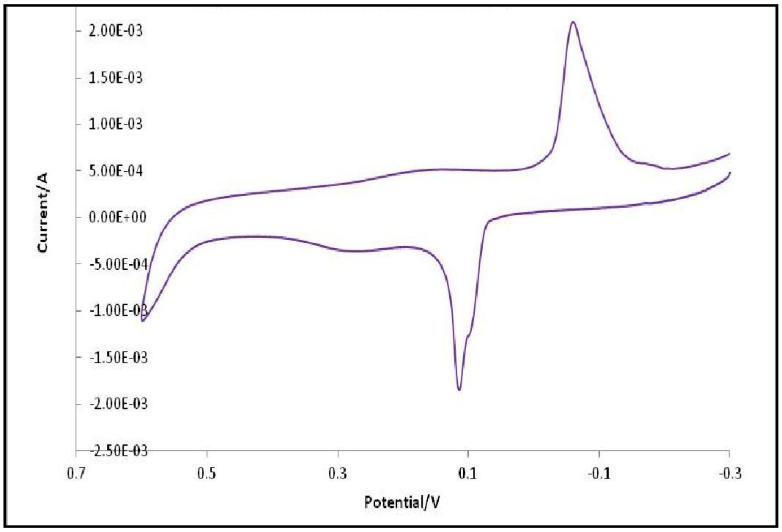

Fig. 2. Cyclic Voltammogram for $SrCoFeO_3$ at temperature 550°C

RESULT AND DISCUSSION

Fig. 1 (a) shows the linear sweep voltammogram of $SrFeO_3$ scan rate 0. Cell 05V/S and Fig. 1(b) shows the linear sweep voltammogram of at $SrCoFeO_3$ at scan rate 0.05 V/S. At constant scan rate, the current response is ideally a rectangle, when capacitance is constant and close to an ideal shape of rectangle. This indicates the capacitive behavior of the capacitor cell. The increase in current is more for $SrCoFeO_3$ cell compared to $SrFeO_3$ cell. This indicates that Co doping has increased the capacitance of electrode of $SrFeO_3$. The specific capacitance of $SrFeO_3$ is found to be equal 600 F/g and the specific capacitance of $SrCoFeO_3$ is found to be equal 900 F/g. The reason of improvement in capacitance of a sample may be that doping of Co has changed the crystal structure of $SrFeO_3$. The improved structure may be more suitable for the process of faraday pseudo capacity. The more capacitance of doped sample can aisobe observed from large specific area of CV diagram for $SrCoFeO_3$ sample. Deepak Kumar, *et. al* (2015) [3] has reported large capacitance 500 F/g for grapheme oxide cell.

The Fig. 2 shows CV diagram for $SrCoFeO_3$ cell at annealing temp 550^c. The Shape is different from rectangular shape. Two peaks, anodic and cathodic are appeared in CV diagram. The specific capacitance is found to be less 420 F/g at temp. 550^c than sp. capacitance at temp. 350°C for same $SrCoFeO_3$ sample. The decrease may be due to change in material structure.

Fig. 4. shows charging discharging curve for cell $SrFeO_3$ and Fig. 5 shows charging-discharging curve for cell $SrCoFeO_3$. The capacitor cells have been tested with constant charge-discharge method. The linear portion of discharge characteristics have confirmed the capacitive behavior of both these cells.

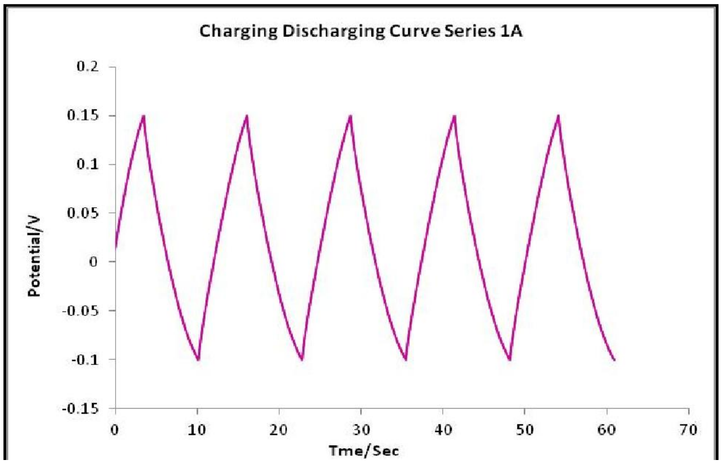

Fig. 3. Charging-discharging curve for $SrFeO_3$ cell

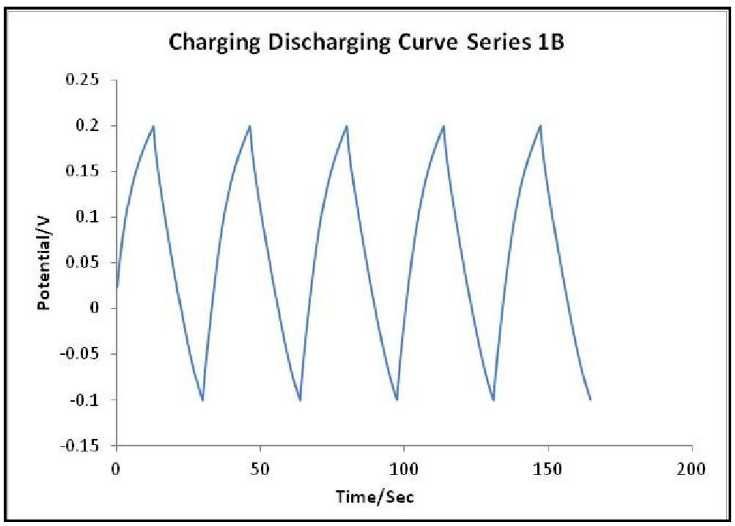

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Fig. 4. Charging-discharging curve for $SrCoFeO_3$

Conclusions

The nanomaterial has been synthesized successfully for capacitive cell. The specific capacitance of cell is increased due to doping of Co ions in $SrFeO_3$. The charge-discharge characteristics has again confirmed the capacitive behavior of the cell. The annealing temp decreased specific capacitance value of the cells.

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