Research Journal of Chemical Sciences E-ISSN 2231-606X
Vol. **6(12),** 54-55, December **(2016)** *Res. J. Chem. Sci.*

Short Communication

$SrCe_2O_3$ Nanoparticles as Electrolyte Material for Proton Conducting Fuel Cell

Manish M. Fukate*, A.B. Bodade and G.N. Chaudhary
Department of Chemistry Shivaji Science Nanotechnology Laboratory, Amravati, MS, India
manishfukate@gmail.com

Available online at: www.isca.in, www.isca.me
Received 22th March 2016, revised 26th November 2016, accepted 12th December 2016

Abstract

$SrCe_2O_3$ nano particles are synthesised as electrolyte catalyst material for Proton conducting fuel cell. The material is synthesised by sol gel method. Phase stability structure were analysed by X ray diffraction. The surface structure was analyzed by scanning electron microscopy (SEM). The electric conductivity behaviour of $SrCe_2O_3$ calcined pellets was determined by electrochemical impedance spectroscopy. The DC conduction (Eσ) calculations indicates that the charge carriers responsible for conductivity. The application for PCFC was studied by variation of conductivities at different temperature. In the temperature range of 550^0C-750^0C, which showed that the conductivity of $SrCe_2O_3$was mainly due to the incorporation of water and the maximum conductivity was found to be 1.3S cm^{-1}. It is found that at 650^OC, presence of water in $SrCe_2O_3$ matrix which increases jumping that facilitates the increases the conductivity.

Keywords: $SrCe_2O_3$, Nanoparticles, Electrolyte, Proton, Fuel, Cell.

Introduction

In recent years SOFC comes with source of clean power, which have high energy conversion efficiency and can be used against various fuels. In general SOFC required have operating temp. In recent years many researchers have been tried to lower the operating temperature[1]. ABO_3 are the most researched and investigated pervoskites where A alkaline earth metal. B sight doped by tetravalent element like Ce and Zr[2,3]. Some Y-dopes barium cerate and Y-doped barium zirconate has been studied by researchers but shows good chemical stability but found that they reacts with CO_2 and SO_2. And Y-doped barium zirconate shows insufficient proton conductivity[4]. The strontium cerate as electrolyte and electrolyte based material is studied in this paper and found good result for crystalinity.

Materials and Methods

Material Preparation: Perovskite nanopowder of $Sr_{0.7}Ce_{0.3}O_3$ was prepared using a sol gel citrate method[5]. $Sr(NO_3)_2$, $Ce(NO_3)_3$ taken into stoichometric quantity then it is mixed and finely triturated with equal amount of citric acid with ethyl alcohol . The mixture is stirred for 3 hours at 80^OC on magnetic stirrer. The gel thus formed is then transferred to pressured vessel and kept at 125^0C for over 12 hours. The product thus formed is calcined for 6 hours at 400^0C in muffle furnace. Then it is grinded and pressed at 10 tones of pressure to form pellets. Then pellets are subjected to Impedance spectroscopy by using Japanese Haoki A.C. Impedance spectrometer. The material structure is identified with X ray defractoemeter and Scanning electron microscopy.

Results and Discussion

X Ray Defraction Analysis: The crystalinity and phase study is done by XRD analysis. Figure-1 shows the XRD pattern of the $Sr_{0.7}Ce_{0.3}O_3$ electrolyte. The sample shows single pervoskite phase and without any impurity. It is observed that that the sample is in single pervoskite phase which does not contain any impurity. The XRD peak of $Sr_{0.7}Ce_{0.3}O_3$ broaden which predict the particles with small crystalline size. The small crystalline diffraction peak at 42^O The crystalline size calculated using debay sherar formula T(T = 0.89 λ/ βcosθ which is found as 35.2 nanometer. So it is also concluded that citric acid is good chelating agent. And also distributed Sr and Ce ion through sol gel method. The gas generated in sol gel method due to combustion of citrate and nitrate gel combustion so it is responsible for very fine nano particles..

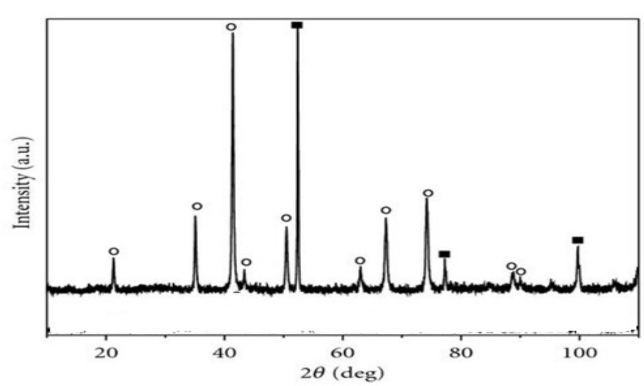

Figure-1
XRD of electrolyte material

SEM Analysis: Figure-2 shows scanning electron microscopy (SEM) image shows the dense structure which could separate both electrode. The anodic and cathodic material the image also gives the micro porous material of nanocrostructure of electrolyte, which is essential for good diffusion of fuel gas or hydrocarbon feed.

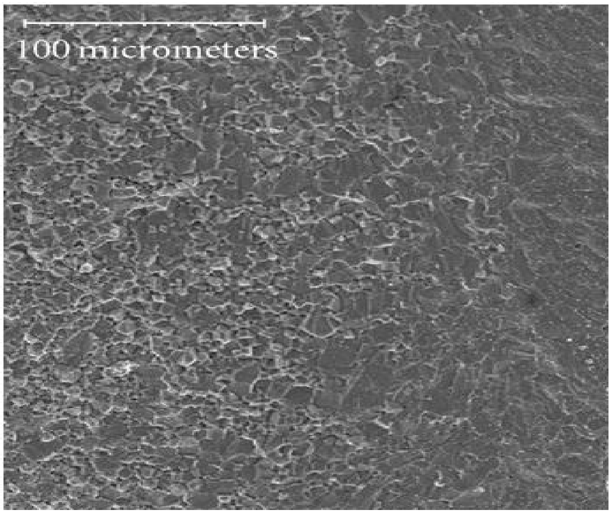

Figure-2
The SEM Image of electrolyte

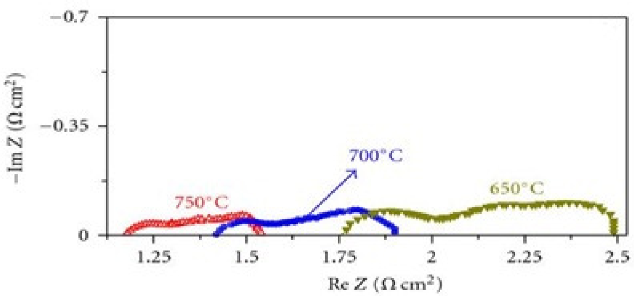

Figure-3
Electrochemical Impedance spectra of $SrCe_2O_3$

Impedance analysis: Electrochemical performance of $Sr_{0.7}Ce_{0.3}O_3$ conductivity of novel electrolyte was measured in between temperature range from 550^0C to 750^0C using janpnese made hokai impedance analyser. By using OCV mode i.e. open circuit condition. In Figure-3 shows the intercept at high frequency which represent the overall resistance within the cell .The difference of high frequency and low frequency intercept with real axis gives interfacial polarisation of cell. The electrolyte resistance were 1.18, 1.41 and 1.76 in dry air. The impedance arc electrolyte decreased significantly with increase with temperature shown in Figure-4 Power densities of open circuit voltages (OCV) of 0.97 V, 0.91 V, and 0.75 V at 750^0C, 700^0C, 650^0C respectively reveals that electrolyte is dense and impermeable.

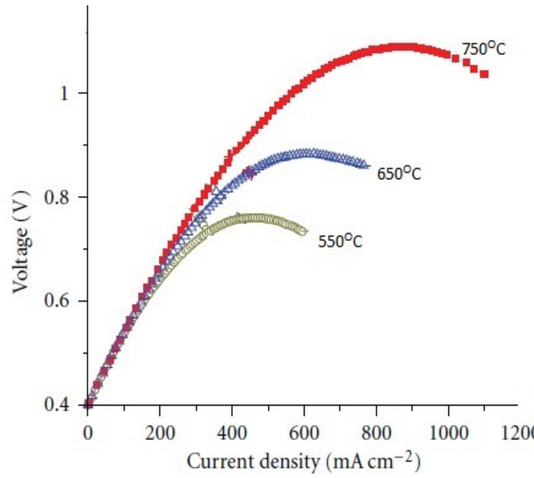

Figure-4
Power density output of $SrCeO_3$ at different temperature

Conclusion

The sol gel method enhances the homogeneity at the nanoscale, improves ionic conductivity properties of strontium cerate electrolyte which results in conduction a even at low temperature. The XRD index analysis predict the cubic fluorite structure. Electrolyte exhibit 1.3 Scm-1 ionic conductivity in air atmosphere. Which indicate that it is good electrolyte or good electrolyte base material which can be used for protonic fuel cell electrolyte exhibits 1.3 Scm^{-1}.

References

1. Livage J. (1997). Sol-gel processes. *Current Opinion in Solid State and Materials Science*, 2(2), 132–138, 1997. J.D. Mackenzie and E.P. Bescher, Chemical routes in the synthesis of nanomaterials using the sol-gel process, *Accounts of Chemical Research*, 40(9), 810–818,
2. JH Li, XZ Fu, GH Zhou, JL Luo, KT Chuang (2011). $FeCr_2O_4$ Nanoparticles as Anode Catalyst for Ethane Proton Conducting Fuel Cell Reactors to Coproduce Ethylene and Electricity. *Advances in Physical Chemistry*,
3. Katahira K., Kohchi Y., Shimura T. and Iwahara H. (2000). Protonic conduction in Zr-substituted $BaCeO_3$. *Solid State Ionics*, 138(1-2), 91–98.
4. Tao Z., Hou G., Xu N., Chen X. and Zhang Q. (2014). Pr Doped Barium Cerate as the Cathode Material for Proton-Conducting SOFCs. *Fuel Cells*,
5. Fabbri E., Pergolesi D. and Traversa E. (2016). Electrode materials: a challenge for the exploitation of protonic solid oxide fuel cells. *Science and Technology of Advanced Materials*, 11(4), article 044301.