FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF AUTOMOBILE ENGINEERING
SRM Nagar, Kattankulathur, Kancheepuram District - 603203. Tamil Nadu, India

IEEES-11
SRM IST INDIA

IEEES-11
11th International Exergy, Energy and Environment Symposium

The 11th International Exergy, Energy and Environment Symposium (IEEES-11)

BEST PAPER AWARD

~~Mr~~/Ms/~~Dr~~ RAKSHA RAO

This Best Paper Award is presented to you for your Outstanding Paper entitled:

SYNTHESIS OF PRASEODYMIUM DOPED CERIA BASED ELECTROLYTE BY HYDROTHERMAL METHOD

Which was presented at the 11th International Exergy, Energy and Environment Symposium (IEEES-11), held during July 14 – 18, 2019, conducted by the Department of Automobile Engineering, SRM Institute of Science and Technology, Chennai- 603203.

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY

Dr. V. EDWIN GEO	Dr. F. ALOUI	Dr. M. LEENUS JESU MARTIN	Dr. C. MUTHAMIZHCHELVAN
Symposium Chair	Symposium Co-Chair	HOD Automobile	Director (Engg. & Tech.)


BEST
PAPER
AWARD
IEEES-11
11th International
Exergy, Energy and
Environment Symposium
SRM IST INDIA
Thanks for your Support
The 11th International Exergy,
Energy and Environment
Symposium
July 14th -18th 2019
SRM
SRM INSTITUTE OF SCIENCE AND
TECHNOLOGY
Chennai, India

"Synthesis of Praseodymium Doped Ceria based electrolyte material by Hydrothermal Method"

Raksha Rao, Keerthana Kamath, Irfana Shajahan, Priyanka R, Hari Prasad Dasari

Department of Chemical Engineering, National Institute Of Technology Karnataka, Srinivasnagar, Surathkal, Mangalore-575025, India

* E-mail:energyhari@nitk.edu.in

Abstract

Praseodymium-doped ceria (PDC) based electrolyte materials for SOFCs has been prepared by the hydrothermal method. The as-synthesized powder was characterized by X-ray diffraction, Raman spectroscopy and Scanning electron microscopy analysis to find out the crystallinity, phase, nature and structural morphology. Linear shrinkage and linear shrinkage behaviour of PDC powder at high temperatures were performed by dilatometer studies. Crystallographic parameters such as crystallite size, lattice parameter, and lattice strain were calculated from XRD data. Raman spectroscopy analysis revealed the characteristic peak at 460cm^{-1} which is attributed to the F_{2g} peak of cubic fluorite structure of ceria and the peak at 550cm^{-1} is attributed to intrinsic oxygen vacancies confirmed the formation of ceria praseodymium solid solution.

Keywords: SOFC, Praseodymium Doped Ceria, Hydrothermal Method, Dilatometer Study, Linear Shrinkage.

I. Introduction

With the increasing industrialisation, energy demand has emerged as one of the major problems. Hence, there is a need for efficient energy production, which can be met by fuel cell (Ravi Chandran and Arjunan 2015). The electrocatalytic reaction makes fuel cell more efficient than an internal combustion engine, where the combustion of a fuel occurs (Ma et al. 2010). Solid Oxide Fuel cell uses solid oxide material as an electrolyte, which conducts oxygen ions from cathode to anode (Goodenough and Huang 2007). Rare earth (RE) doped ceria (Gadolinium-doped Ceria (GDC), samarium doped Ceria (SDC)), yttrium stabilized zirconia (YSZ) etc are the various electrolyte materials used in SOFC. Among them, doped ceria-based electrolyte materials have been considered as the better electrolyte due to the good compatibility with anode and cathode and also due to high ionic conductivity at a lower temperature (Steele 2000; Yin et al. 2014).

RE (rare earth) doped ceria is considered as a better electrolyte material compared to YSZ since it reduces the activation energy and also enhances ionic conductivity at a lower temperature(Shajahan et al. 2018a). Increasing the ionic conductivity at a lower temperature improves the cell's performance. Praseodymium-doped CeO_2 powders can be prepared by different methods such as flux method (Bondioli et al. 2000), hydrothermal method (Shuk and Greenblatt 1999), microwave-assisted hydrothermal method, co-precipitation method (dry or wet) (Reddy et al. 2009), EDTA-citrate method (Shajahan et al. 2018b), electrochemical method etc. In the present work, hydrothermal method is being preferred. This being a low-temperature method involves wet chemical technique and ultrafine homogeneous powder with maximum purity can also be achieved through this method.

SOFC being high-temperature fuel cell often results in higher fabrication cost; thereby reducing the operating temperature has become a major challenge. The cell's performance can be increased by lowering the sintering temperature. As reported in the literature, conventionally prepared PDC material has a high sintering temperature of about 1500°C. By using different synthesis methods, powder properties can be altered and can result in lower sintering temperature. As a result, reducing the sintering temperature results in lower fabrication cost as co-firing of electrolyte with anode or cathode can be achieved at a much lower temperature. Synthesis technique/method plays an important role in the electrochemical properties and densification of the electrolyte material. Shajahan et al prepared praseodymium doped ceria which gave a sintering temperature >1500°C due to the hard agglomerates present in the sample and was reported that by altering the synthesis method or by co-doping chemistry the sintering temperature can be lowered (Shajahan et al. 2018a). In fact, Shuk and Greenblatt have reported that due to the presence of smaller sized particles in the powder, the sintering temperature has been reduced to 1300ºC (Shuk and Greenblatt 1999).

From literature, it is observed that the optimal doping concentration of 10 mol% of gadolinium oxide and 10 mol% of samarium oxide to cerium dioxide enhances its ionic conductivity (Arabaci 2015; Inaba et al. 1999). Based on these considerations, in the present work 10 mol% PDC is synthesised by hydrothermal method and are characterised by various techniques such as