Xyyzz

Combined effects of A-site non-stoichiometry, crystal structure and microstructure for enhanced catalytic activity of (La,Sr)(Co,Fe)$O_{3-\delta}$ cathodes for IT-SOFCs

Ozden Celikbilek (1,2), Cam-Anh Thieu (3,4), Fabio Agnese (5), Eleonora Cali (2), Christian Lenser (6), Norbert H. Menzler (6), Ji-Won Son (3,4), Stephen J. Skinner (2), Elisabeth Djurado (1)

(1) Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, LEPMI, 38000, Grenoble, France
(2) Department of Materials, Imperial College London, Prince Consort Road, London SW7 2BP, United Kingdom
(3) Center for Energy Materials Research, Korea Institute of Science and Technology (KIST), Hawolgok-dong, Seongbuk-gu, Seoul 02792, Korea
(4) Division of Nano & Information Technology, KIST School, Korea University of Science and Technology (UST), Hawolgok-dong, Seongbuk-gu, Seoul 02792, Korea
(5) Univ. Grenoble Alpes, INAC-SyMMES, F-38054 Grenoble Cedex 9, France.
(6) Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research: Materials Synthesis and Processing (IEK-1), 52425 Jülich, Germany

+447378171611
o.celikbilek@imperial.ac.uk

Abstract

The high oxygen reduction reaction (ORR) activity of A-site deficient $(La_{0.7}Sr_{0.3})_{0.95}(Co_{0.2}Fe_{0.8})O_{3-\delta}$ (LSCF) film makes an excellent cathode material for intermediate temperature solid oxide fuel cell (IT-SOFC) application. The cathode was deposited by the Electrostatic Spray Deposition (ESD) technique which provided microstructural details at the nanometre length scale (~100 nm).[1] The area-specific resistance values of as low as 0.037 and 0.1 Ω cm^2 were measured in a symmetrical cell and power density at 0.7 V of 0.87 and 0.50 W cm^{-2} in a Ni/YSZ anode-supported cell at 650 and 600 °C, respectively. The oxygen transport parameters estimated from the electrochemical impedance spectra show an increase by one-to-two-orders of magnitude in the oxygen surface-exchange coefficient in comparison to nominally stoichiometric, state-of-the-art $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$. The A-site deficiency resulted in the precipitation of a B-site spinel phase composed of $CoFeO_x$ (CFO), while the perovskite structure of LSCF was modified to closely related two-phase perovskite structures. Detailed microstructural analyses showed that well-dispersed, nanoscale (~10-20 nm) CFO phase decorated the LSCF surfaces. Such substantial increase in the oxygen surface-exchange coefficient was attributed to the catalytically active and nanostructured CFO precipitates and to the very high active surface area of the ESD film.

1. O. Celikbilek, C.-A. Thieu, F. Agnese, E. Cali, C. Lenser, N. H. Menzler, J.-W. Son, S. J. Skinner and E. Djurado, *J. Mater. Chem. A*, 2019, **7**, 25102–25111.