【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Creation of Novel Fast Oxide Ion Conductor Based On Nano Structure Control of Interface and Application for Fuel Cells

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Research Area : Materials, Inorganic Functional Materials
Keyword : Nanoionics, Fuel Cell, High Energy Conversion Efficiency

【Purpose and Background of the Research】

Recently, there are attracting attentions on ion conductivity at interface between different ion conductors. It is expected that extraordinary fast oxide ion conductivity will be appeared at the interface between two fast ion conductors because of a relaxed lattice of crystal by matching different lattice parameters. Since there is no fast ion conductor based on such relaxed lattice, there is a possibility to achieve a improved oxide ion conductivity by structure control of interface between two fast oxide ion conductors with different lattice parameter. In this study, we will prepare the hetero interface between pure oxide ion conductor and mixed oxide ion conductor with two dimensional ion conductivity like K2NiF4 structure and change ionic conducting property at or close to interface will be studied systematically. By applying the nanostructure oxide based on nano ionic effects will be applied for solid oxide fuel cell operated at intermediate temperature.

【Research Methods】

Preparation of nano structure control film was performed by pulse laser deposition method, accumulation of nano sheet, and not only two dimensional nano composite but also three dimensional structure control film will be prepared. In particular, in this study, we will focus on three dimensional regular structure so-called "double columnar structure" as shown in Fig.1. Change in oxide ion conductivity as well as electronic conductivity will be measured as a function of temperature and also oxygen partial pressure. Change in charge carrier density will also be measured with Hall and Seebeck effect. Morphology at interface will be analyzed with STEM and diffusivity of oxygen will also be analyzed with SIMS, EELS, and ^{17}O NMR. Application of the developed materials for electrolyte of reversible solid oxide fuel cell or novel metal-air battery will be performed. Since lattice oxygen is highly active for deep oxidation, the materials with nano structure controlled interface for new concept of environmental catalyst will also be tried.

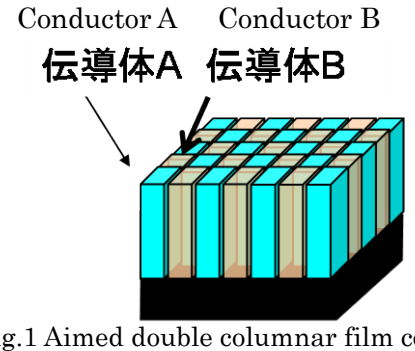

Fig.1 Aimed double columnar film consisting of pure ionic and mixed ionic conductor

【Expected Research Achievements and Scientific Significance】

This study may open a new concept of oxide ion conductor by controlling electronic conductivity. In particular, three dimensional tensile stressed materials lead to the new area of ionic conductor. Based on the results of this study, we expect the novel solid oxide fuel cells with high efficiency and low temperature operation. Low temperature operation fuel cell may open an new concept of metal-air battery which is strongly requested from electric vehicle and electric power storage.

【Publications Relevant to the Project】

・S. Nuansaeng, M. Yashima, M. Matsuka, and T. Ishihara," Mixed Conductivity, Nonstoi-chiometric Oxygen, and Oxygen Permeation properties in Co-Doped $Sr_3Ti_2O_{7-\delta}$", Chemistry a European Journal 2011 No.40 pp11324-11331
・Y.W. Ju, T.Inagaki, S. Ida, and T. Ishihara, "Sm(Sr)CoO_3 Cone Cathode on $LaGaO_3$ Thin Film Electrolyte for with IT-SOFC High Power Density", J. Electrochem. Soc., 158 (7) B825-B830 (2011)

【Term of Project】FY2012-2016

【Budget Allocation】154,700 Thousand Yen

【Homepage Address and Other Contact Information】

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