Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary information

Room temperature fabrication of highly proton conductive amorphous zirconia-based thin films achieved by precise control of nanostructure

Makoto Takayanagi[1,2], Takashi Tsuchiya[1]*, Daiki Nishioka[1,2], Tohru Higuchi[2]*, and Kazuya Terabe[1]

[1] Research Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science (NIMS), 1-1 Namiki, Tsukuba, Ibaraki, 305-0044, Japan.
[2]Department of Applied Physics, Faculty of Science, Tokyo University of Science, Katsushika, Tokyo 125-8585, Japan

*Email: TSUCHIYA.Takashi@nims.go.jp, higuchi@rs.tus.ac.jp

Supplementary discussions

1. XRD patterns of YSZ thin films deposited under various P_{O_2} conditions.

Figure S1 shows partial magnification XRD patterns of Fig. 3(a). There is almost no difference in the position and FWHM of the Pt (111) peak, which indicates that the crystallinity did not differ between the samples. Therefore, the crystallinity of the Pt electrode can be excluded as the reason for the observed variation in the conductivity of the YSZ thin films in this study.

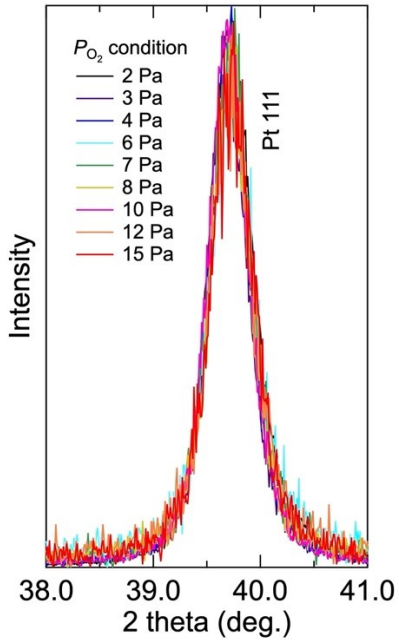

Figure S1. Magnified XRD patterns around the Pt (111) peak.

2. Ac impedance spectroscopy of Pt/YSZ/Pt two terminal

Electrical conductivity measurements was performed by AC impedance spectroscopy with a frequency response analyzer (Solartron 1260) and a high impedance interface (Solartron 1296). The AC voltage and frequency range were determined to be 100 mV and 1 MHz-100 mHz, respectively. We show representative Cole-Cole plots of |Z| of the Pt/YSZ/Pt cell in Fig. S2. In order to analyze the impedance spectra, the fitting to the experimental data was performed by assuming an equivalent circuit. R_C, R_B and C_B represents contact resistance, resistance and associated capacitance in the bulk element of YSZ. R_{CT} and C_{DL} represent the charge transfer resistance and the associated capacitance. The good agreement of the fitting results with the experiments supports the validity of the fitting. Based on the R_B obtained by the fitting, we calculated conductivity of YSZ thin film.

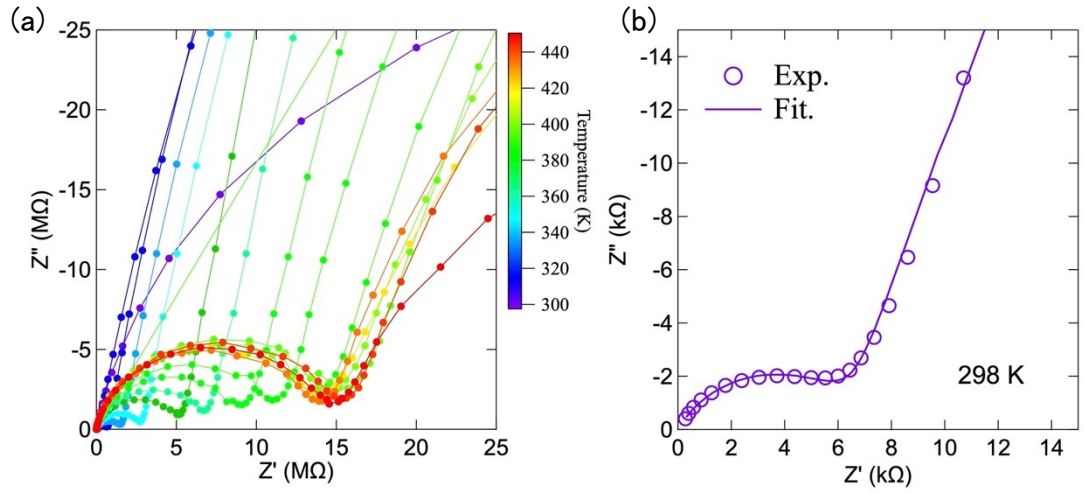

Figure S2. (a) Cole-Cole plots of AC impedance spectroscopy for a Pt/YSZ/Pt cell under varisou temperature region. The YSZ thin film was deposited under P_{O_2} of 10 Pa. (b) Cole-Cole (solid black circles) and fitting (solid red line) plots of the Fig. S2(a) at 298 K.