In situ study of anode reaction in intermediate temperature solid oxide fuel cells

Amir H. Tavabi, Shunsuke Muto, Takayoshi Tanji, Rafal E. Dunin-Borkowski

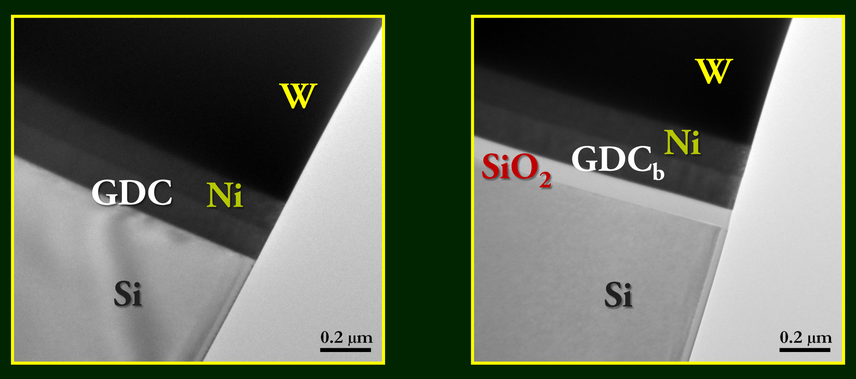
a.tavabi@fz-juelich.de

Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons ER-C | JÜLICH FORSCHUNGSZENTRUM | EcoTopia Science Institute NAGOYA UNIVERSITY

Theme

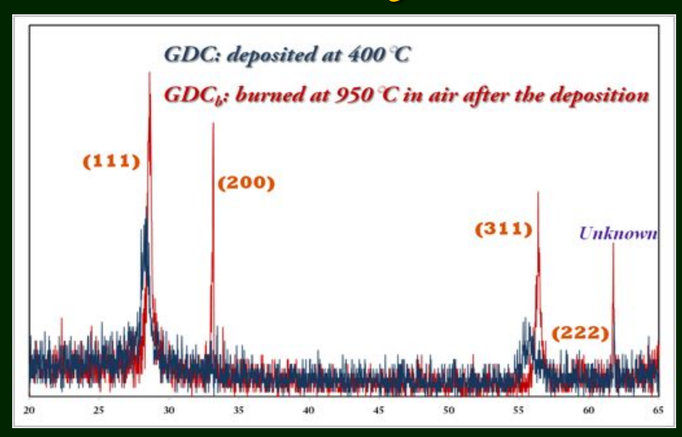
Oxygen evolution reaction (OER) has been studied by *in situ* EELS at the anode side of the intermediate temperature solid oxide fuel cells (IT-SOFC). $Gd_{0.2}Ce_{0.8}O_{2-\alpha}$ electrolyte films were fabricated by PLD method at two different levels of crystallinity. TEM specimens of GDC-Ni anodes were prepared by the FIB micro-sampling technique.

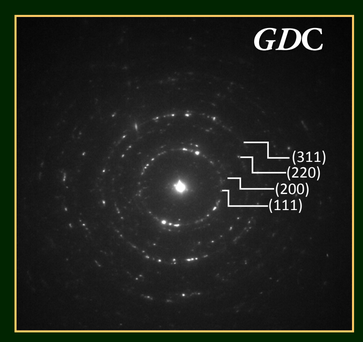
IT-SOFC Anodes' Microstructure

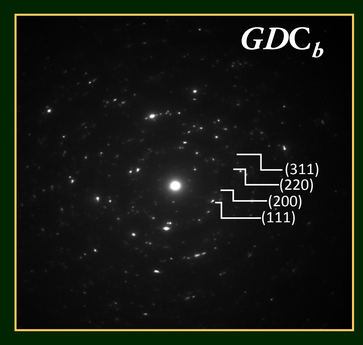


Low resolution images of modeled half cells. A uniform 86 nm SiO_2 layer has been formed during the burning process of electrolyte, GDC_b.

GDC Electrolyte Characterization



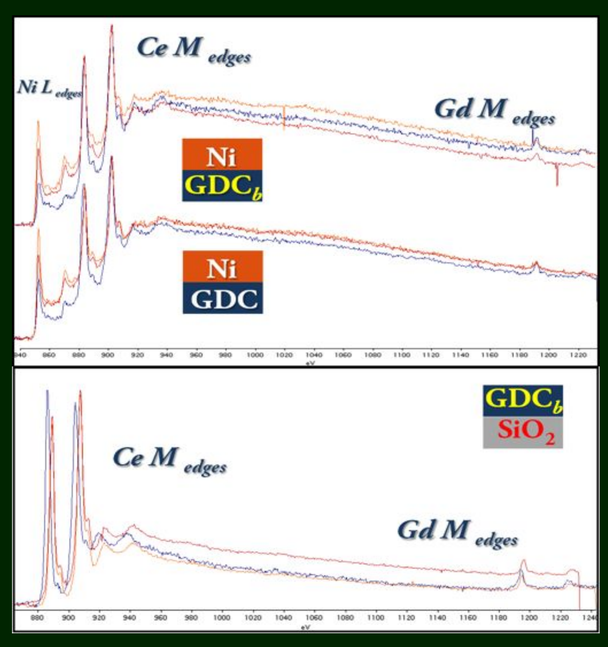


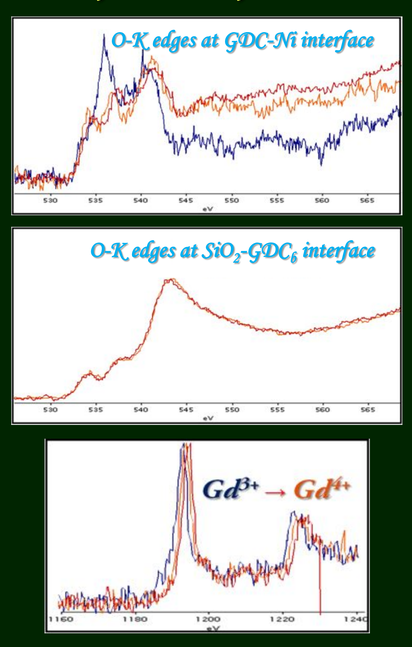


Both as deposited and burned electrolytes showed typical characteristics of fluorite cubic structure. However, higher crystallinity and grain growth in GDC_b are obvious in the XRD and nano electron diffraction patterns.

In situ EELS

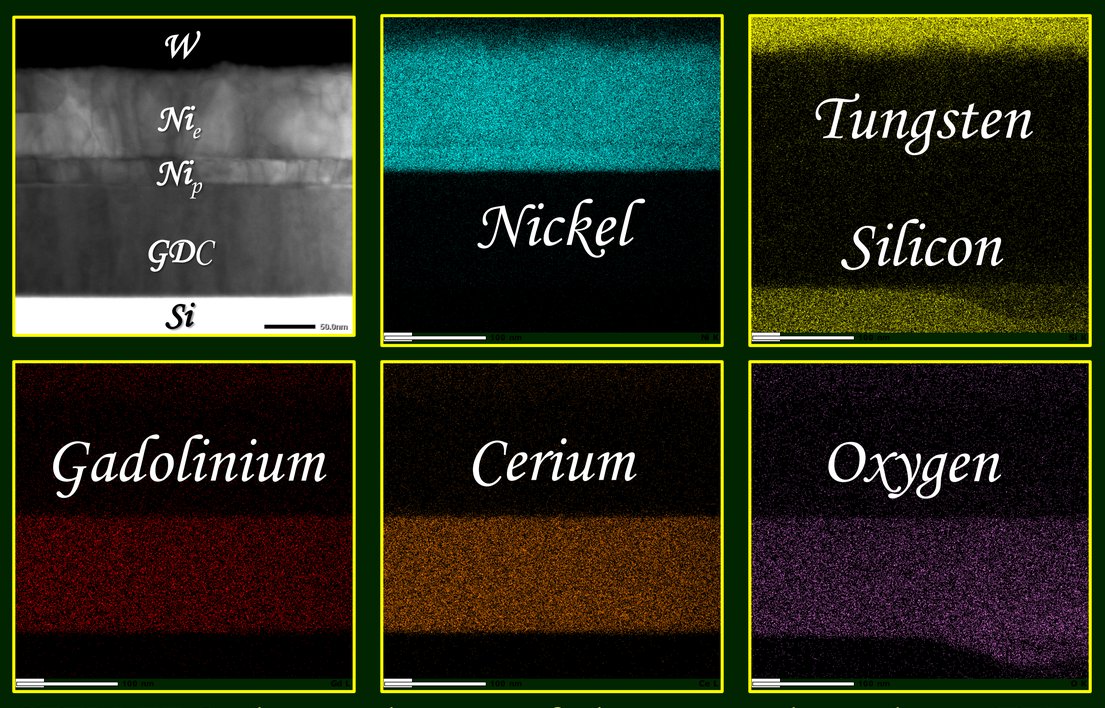
R.T., 200°C, 400°C





Ni-L edges changes in both studied anodes showed NiO formation at elevated temperatures. However, cerium cations remained at *tetra-valent* state and gadolinium cations were partially oxidized from *tri-valent* to t*etra-valent* cations. O-K edges at GDC-Ni interface showed the specific features of CeO_2 at elevated temperatures. Also, O-K edges at SiO_2-GDC_b interface showed the overlapped spectra of SiO_2 and CeO_2.

Ex situ EDS



STEM-EDS elemental maps of the operated anode in TEM showed no interdiffusion between electrolyte-electrode components during the OER.

Conclusion

OER was detected by EELS in IT-SOFC' anodes at intermediate temperatures as low as 200°C. Nickel electrodes were oxidized as the oxygen anions migrate from the electrolyte to the electrode. The OER mechanism showed no difference between two GDC electrolytes. No interdiffusion was found between the cell components in the operated anodes.