

## Electrode reaction routes analyses of modified Ni-BCZY anode via distribution relaxation times: 1-D interpretation

### Abstract

Proton ceramic fuel cells (PCFCs) represent a promising avenue for energy conversion, with their electrochemical performance heavily relying on the architecture of the cell particularly at the electrode counterparts. One of the measurements used to study their underlying chemical processes is via the electrochemical impedance spectroscopy (EIS) technique. This study aims to interpret 1-D electrode reaction routes of a single cell decorated with unmodified BCZY (p-BCZY) as an electrolyte, Ni-modified  $\text{BaCe}_{0.54}\text{Zr}_{0.36}\text{Y}_{0.1}\text{O}_{2.95}$  (Ni-m-BCZY) as anode substrate, Ni-p-BCZY (10:90) as anode functional layer 1 (AFL1), Ni-p-BCZY (30:70) as anode functional layer 2 (AFL2), and  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Co}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  (LSCF) as cathode side. Distribution relaxation times (DRT) corroborate with complex non-linear least squares (CNLS) analyses are being applied to illustrate 1-D electrode reaction routes within the fabricated cell. This approach allows for the precise elucidating of rate-limiting polarization processes and distinguishing between anodic and cathodic reactions. The extracted eight sub-processes represented by respective peaks are adopted to depict an illustration of the charge carrier's pathway for underlying understanding. At an operating temperature of 700 °C, the polarization resistance ( $R_p$ ) obtained via DRT and CNLS is  $1.02 \Omega \text{ cm}^2$  and  $1.13 \Omega \text{ cm}^2$  respectively. To establish the CNLS and DRT analyses and 1-D interpretation of the cell; (a) impedance data at  $T = 600 \text{ °C}$  and  $T = 500 \text{ °C}$  and (b) cross-section FESEM images are also discussed.

### Keywords

Anode layers; Charge carrier transport; Distribution relaxation times; Proton ceramic fuel cell