

Supplementary Information

# Densification and Proton Conductivity of $\text{La}_{1-x}\text{Ba}_x\text{ScO}_{3-\delta}$ Electrolyte Membranes

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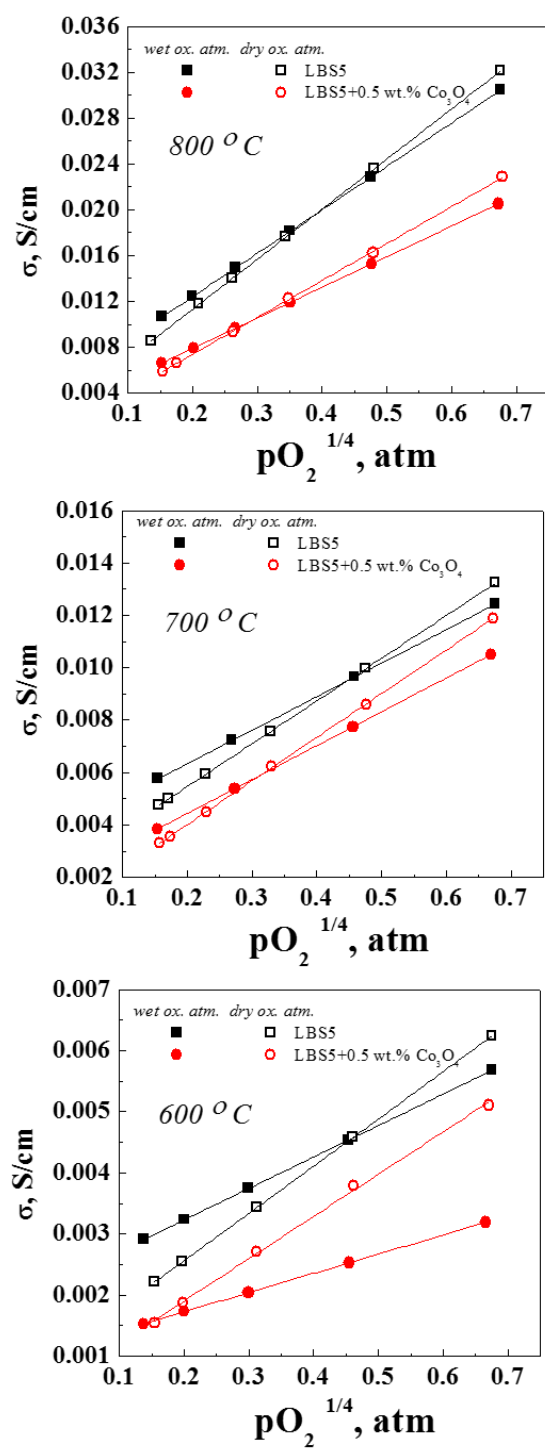
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*pO<sub>2</sub>* – dependencies of conductivity

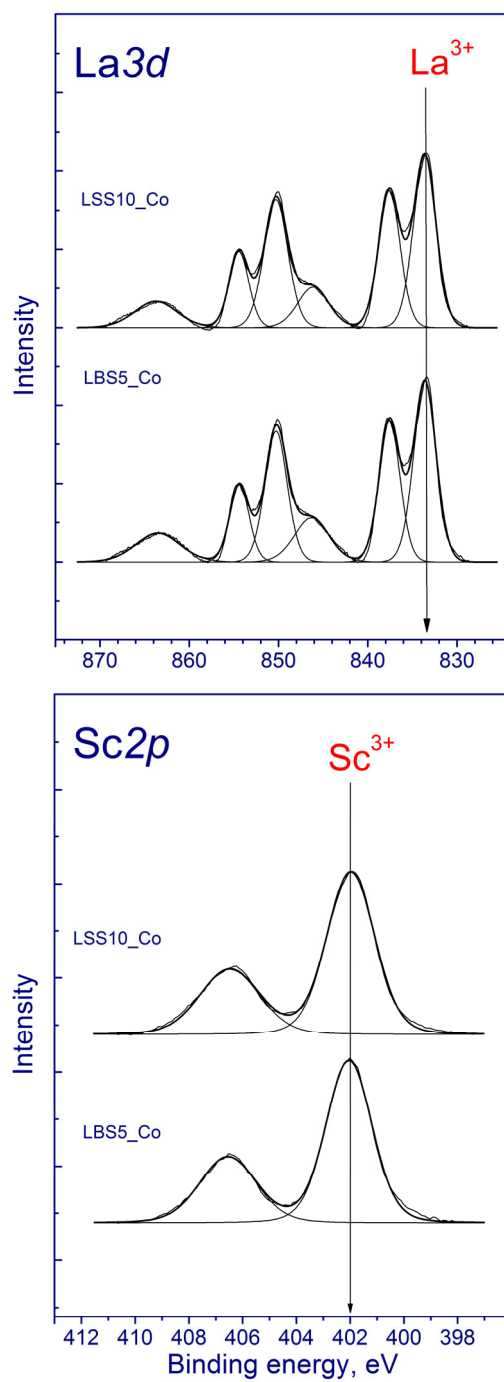


**Figure S1.** Conductivity of ceramics as a function of  $(p\text{O}_2)^{1/4}$  under wet ( $p\text{H}_2\text{O} = 2.8$  kPa) and dry ( $p\text{H}_2\text{O} = 0.1$  kPa) conditions.

### XPS analysis

The  $\text{La}3d$  level splits into two sublevels as a result of the spin-orbit interaction, which leads to the appearance of a doublet  $\text{La}3d_{5/2}$  -  $\text{La}3d_{3/2}$  (~16.8 eV). Each  $\text{La}^{3+}$  component in the  $\text{La}3d$  spectra is accompanied by intense 'shake-up' lines of the satellites. The main  $\text{La}3d_{5/2}$  peak for  $\text{La}_2\text{O}_3$  is located in the region of 833.2–834.0 eV. For lanthanum carbonate  $\text{La}_2(\text{CO}_3)_3$ , slightly higher binding energies of  $\text{La}3d_{5/2}$  are observed in the range of 835.0–835.5 eV, and for lanthanum hydroxides  $\text{LaOOH}$  and  $\text{La}(\text{OH})_3$  it is about 834.8 eV. In our case,  $\text{La}^{3+}$  is in the form of  $\text{La}_2\text{O}_3$  or  $\text{LaSrO}_x$ .

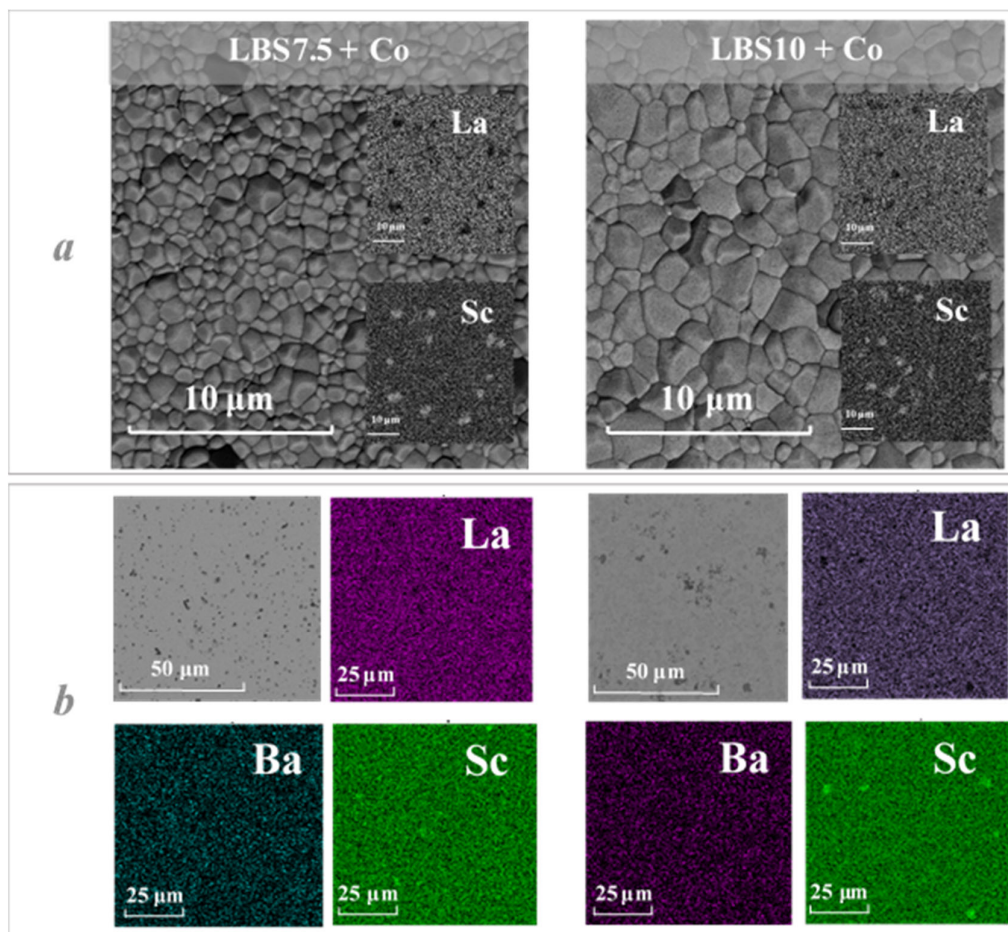
The  $\text{Sc}2p$  level splits into two sublevels  $\text{Sc}2p_{3/2}$  and  $\text{Sc}2p_{1/2}$  (4.46 eV) due to the spin-orbit interaction. In the literature, the binding energy values of  $\text{Sc}2p_{3/2}$  for  $\text{Sc}^{3+}$  are given in the range 401.7–402.5 eV, and in  $\text{ScOOH}$  it is 403.0 eV. The  $\text{Sc}2p$  spectra are described by a single doublet with a  $\text{Sc}2p_{3/2}$  binding energy 402.0 eV (taking into account the correction of the binding energy by +1.9 eV). Thus,  $\text{Sc}^{3+}$  is in the form of  $\text{Sc}_2\text{O}_3$  or  $\text{ScSrO}_x$ .



**Figure S2.** *La3d* and *Sc2p* core-level spectra  $\text{La}_{0.95}\text{Ba}_{0.05}\text{ScO}_{3-\delta}$  + 0.5 wt%  $\text{Co}_3\text{O}_4$  and  $\text{La}_{0.9}\text{Sr}_{0.1}\text{ScO}_{3-\delta}$  + 0.5 wt%  $\text{Co}_3\text{O}_4$  samples.

### Phase equilibria (Ba-Co)

The Sc-enriched phase is formed predominantly on the surface of ceramic samples, while its concentration in the bulk of the samples is low.



**Figure S3.** SEM-images of the surface (a) and cross-sections (b) of  $\text{La}_{0.925}\text{Ba}_{0.075}\text{ScO}_{3-\delta} + 0.5 \text{ wt\% Co}_3\text{O}_4$  and  $\text{La}_{0.9}\text{Ba}_{0.1}\text{ScO}_{3-\delta} + 0.5 \text{ wt\% Co}_3\text{O}_4$  ceramics with EDX maps of cations distribution.