

## Impact of spin coating rates on the surface chemistry and electrochemical performance evolution of (La,Ca)CoO<sub>3</sub> solid oxide cell electrodes

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Solid oxide cells (SOCs) can potentially remedy the intermittency problem of solar and wind-based energy conversion systems. For these devices to be commercially available, the long-term performance loss related to changes that occur in their components at relatively high temperatures of 600-800 °C must be mitigated. One such change that causes performance degradation is the segregation of the A-site dopant, Sr<sup>2+</sup>, at the surfaces of ABO<sub>3</sub>-type (La, Sr)CoO<sub>3</sub> oxygen electrocatalysts, forming resistive SrO/Sr(OH)<sub>2</sub>/SrCO<sub>3</sub> phases. The root cause of Sr surface segregation has been identified as i) electrostatic attraction between the positively charged oxygen vacancies at the electrocatalyst surface and the negatively charged Sr at the La position and ii) elastic strain caused by the larger Sr<sup>2+</sup> at the smaller La<sup>3+</sup> sublattice [1].

Recently, we have attempted to replace Sr<sup>2+</sup> with Ca<sup>2+</sup>, which would serve the same purpose of generating additional oxygen vacancies, while minimizing the lattice strain due to the similarity of the cation size of the latter to that of La<sup>3+</sup>[2]. Our experiments on (La, Ca)CoO<sub>3</sub> (LCC) thin film electrodes prepared by liquid precursor deposition revealed that their long-term performance stability depended on surface chemistry evolution, which was determined by the pre-heat treatment temperature [2].

In this work, we investigate whether long-term performance stability of LCC is affected by the fabrication parameters, the rate at which liquid precursor is spun onto the electrolyte substrate in this particular case. Figure 1 shows how area specific resistances of LCC electrodes deposited using different spin coating rates changes upon long-term exposure to 700 °C. Evidently, high spinning speed results in electrodes with higher electrochemical performances that do not change significantly with time. On the other hand, LCC electrodes prepared by higher speed spin coating exhibit poorer initial performance and long-term stability.

Through scanning electron microscopy and x-ray photoelectron spectroscopy studies, it was determined that initial deposition rate determines the amount of surface cracks in the film, which influences the rate at which carbonaceous gases are released during drying. This, in turn, has a significant impact on the surface chemistry evolution, and thus, performance degradation rate.

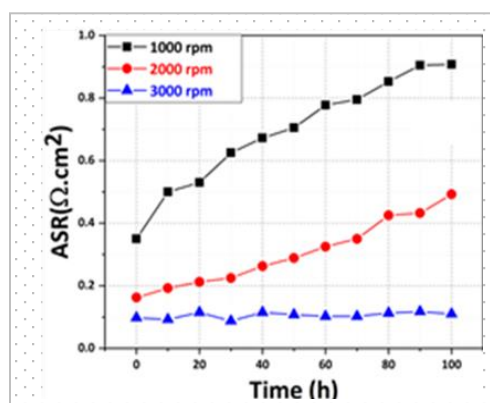


Figure 1. Changes in the area specific resistances of LCC electrodes deposited using different spin coating rates with time at 700 °C.

### References

- [1] Z. Cai, M.Kubicek, J. Fleig, B. Yildiz, Chem Mater, 24 (2012) 1116-1127.
- [2] M. Sezer, I. Oztoprak, A. Ahsen, A. Y. Oral, A. Buyukaksoy, J Electrochem Soc, 167 (2020) 124508.



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