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Exploring Solvent-Free Citrate-Nitrate Auto-Combustion for the Synthesis of SOFC Electrocatalysts

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Abstract – A new synthesis route, the "Solvent-Free Citrate-Nitrate Auto-combustion" (SFCNA), was used for the preparation of two cobalt-perovskite electrocatalyst powders, $La_{0.7}Sr_{0.3}Co_{0.8}Fe_{0.2}O_{3-x}$ (LSCF) and $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-x}$ (BSCF), and compared with the Citrate-Nitrate Auto-combustion method (CNA). The structural, microstructural, redox, catalytic, and electrochemical properties were studied by XRD analysis, SEM, temperature programmed techniques, methane oxidation catalytic tests, and electrochemical impedance spectroscopy, respectively. The results are discussed to evaluate the applicability of these materials as electrocatalysts for single chamber solid oxide fuel cells feeded with methane/air mixtures.

The "Solvent-Free Citrate-Nitrate Auto-Combustion" (SFCNA) method, a modification of the Citrate-Nitrate Auto-Combustion (CNA) method previously optimized by some of the authors for cobalt-perovskite compounds [1], was explored for the synthesis of $La_{0.7}Sr_{0.3}Co_{0.8}Fe_{0.2}O_{3-x}$ (LSCF) and $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-x}$ (BSCF) to be applied in single chamber solid oxide fuel cells (SC-SOFCs) as potential anode and cathode materials, respectively. Moreover, the same powders were prepared both by SFCNA and CNA methods using microcrystalline cellulose as a template [2]. To the best of our knowledge, only one paper reports an auto-combustion synthesis method without using water [3]. Compared to the CNA method, the SFCNA synthesis route has the main advantage of considerably reducing the processing times, although this may penalize some of the useful properties of the studied materials. The as-combusted powders were further calcined at T ≥ 600℃ in order to burn out any carbon impurities and to obtain the pure perovskite-type phase. The absence of water for the SFCNA method implies that the contribution of metal cation complexation is completely altered. The importance of metal complexation in water solution to tailor the powder properties was investigated. Measurements of the powder reactivity to methane were performed to determine the applicability of the investigated materials in SC-SOFCs, since one of the selection criteria for SC-SOFC electrodes is the material ability to react with the fuel [4]. Figure 1 shows the methane conversion as a function of temperature for LSCF and BSCF powders, both prepared with CNA and SFCNA methods. The different properties of the two materials will be discussed in view of their applicability as SC-SOFC anode and cathode materials. Figure 2 shows the SEM micrographs of the BSCF powders prepared by the two methods. The characterization of the materials will be used to discuss advantages and disadvantages of the new synthesis route proposed.

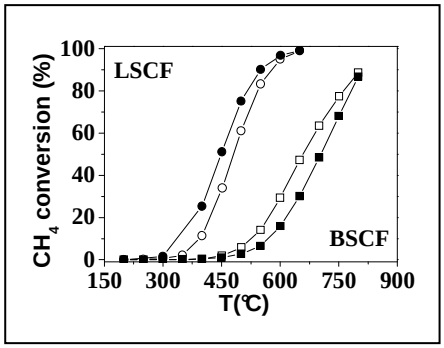

Figure 1: CH_4 conversion for LSCF (circles) and BSCF (squares), with (closed symbols) and without (open symbols) water.

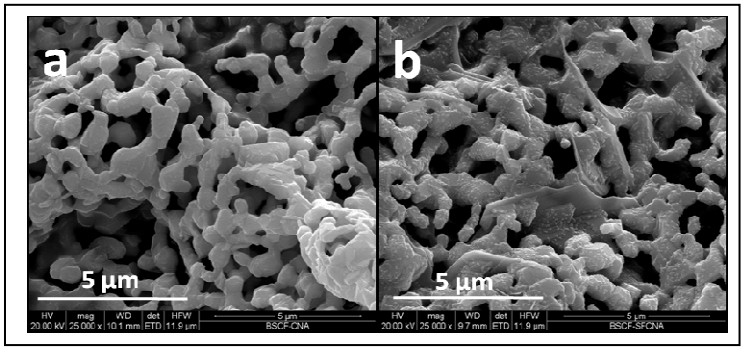

Figure 2: comparison between SEM micrographs of BSCF a) with and b) without water, after calcining at 850℃ for 5h.

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