Spray-flame-synthesis of Mn and V substituted perovskite-type LaCoO3

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Reducing the environmental impact of chemical processes and water electrolysis is one of the most important challenges for a sustainable future. Heterogeneous catalysts play a major role in energy-intensive processes, so they provide a great opportunity for improvements in energy efficiency by exploring novel and highly active materials. Especially transition metal-based perovskites with the general composition ABO_3 are highly versatile catalysts due to their compositional flexibility. $LaCoO_3$ in particular has one of the highest catalytic activities for oxygen evolution reaction (OER) [1] and substitutional doping of A- and B-site cations in $LaCoO_3$-type structures is widely used to tailor their electronic properties for OER [2].

Spray-flame synthesis (SFS) is an elegant alternative compared to wet-chemical methods for obtaining nanoscale, ligand free mixed metal oxide particles in one step via gas-phase synthesis. SFS of such materials including substitutional doping will be discussed. Characterization was conducted by X-ray diffraction (XRD), Raman spectroscopy and transmission electron microscopy (TEM) for structural and morphological investigation as well as by X-ray photoelectron spectroscopy (XPS) for confirmation of elemental composition. Typically, the particles show high crystallinity and count median diameters below 10 nm. Rietveld-refinement of the X-ray diffractograms proved phase purity for all materials except for Vanadium contents above $LaCo_{0.9}V_{0.1}O_3$. Catalytic tests of the perovskite materials for alcohol oxidation and oxygen evolution reaction (OER) showed highest conversion of cyclohexane for $LaCo_{0.5}V_{0.5}O_3$, greatest OER activity utilizing $LaCoO_3$. $LaCo_{0.5}Mn_{0.5}O_3$ was the material with highest conversion and selectivity for thermal ethylene glycol oxidation while $LaCo_{0.95}V_{0.05}O_3$ was the most promising one for electrochemical ethylene glycol oxidation.

[1] T.Yun et al. Nat. Commun. 2021, 12, 824, 10.1038/s41467-021-21055-0
[2] C. Sun et al., Adv. Energy Mater. 2021, 11, 2000459, 10.1002/aenm.202000459