

Comparison of lanthanum strontium manganite and lanthanum strontium cobaltite perovskite oxide catalytic properties for application as bifunctional gas-diffusion electrodes for secondary Zn-air batteries

Gergana Raikova¹, Elena Mihyalova-Dimitrova¹, Blagoy Burdin¹, Konstantin Petrov¹, Tania Malakova², Petar Tzvetkov³, Kiril Krezhov²

¹*Institute of Electrochemistry and Energy Systems "Acad. Evgeni Budevski", Bulgarian Academy of Sciences, Acad. G. Bonchev, Bl.10, 1113 Sofia, Bulgaria*

²*Institute of Electronics "Acad. Emil Djakov", Bulgarian Academy of Sciences, 72, Tzarigradsko chaussee blvd, 1784, Sofia, Bulgaria*

³*Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, 1113 Sofia "Acad. G. Bonchev", Bl.11, Sofia, Bulgaria*

Recently the perovskite-based oxides are intensively studied because of their high efficiency for both the oxygen reduction reaction (ORR) during discharge and the oxygen evolution reaction (OER) during charge of secondary metal-air batteries with alkaline media. Most papers reported about their reduction activities, as the ORR is the kinetically slower process than OER and it is governing the practical application of these materials. In this paper we investigate both oxygen reactions ORR and OER of $\text{La}_{0.80}\text{Sr}_{0.20}\text{MnO}_{3-\delta}$ (LSM) and $\text{La}_{0.60}\text{Sr}_{0.40}\text{CoO}_{3-\delta}$ (LSC) perovskite oxides, which are widely applied as cathode materials for fuel cell and electrolysis devices, but for energy storage, more especially for metal-air batteries its electrocatalytic properties is still subject of interest for many researchers. The presented here GDE electrodes are produced by classical technology, using Teflonized (60 wt.% Teflon) carbon blacks (Vulcan XC-72) as gas-diffusion layer (GDL) and perovskite powders, mixed with poly tetra flour ethylene (PTFE) emulsion, and catalytic layer (CL) hot pressed onto the GDL together with a nickel mesh (as a current collector). Half-cell testing was carried out in 6 M KOH in three-electrode cell with nickel mesh counter electrode and Reversible Hydrogen Electrode (RHE) as reference electrode. To eliminate the carbon corrosion during charge the loading of carbon blacks was decreased and compared with electrodes containing perovskite alone, i.e. monolithic design. A comparison of electrocatalytic activities of LSM and LSC perovskite with and without carbon support was done as many electrochemical techniques including impedance spectroscopy were applied. The results show that the contribution of carbon is more pronounced at ORR where the increase of the carbon content leads to suggestion for series $2\text{e}^-+2\text{e}^-$ pathways mechanism of the oxygen reduction. Additionally, the need of activation time is registered. The perovskite electrodes that did not contain carbon possess an increased mechanical stability and potential for the electrode recovery after 200 charge/discharge cycles. Better stability, catalytic activity and electronic conductivity was registered for LSM electrode which works at conditions 1.7 to 1.8 V (vs. RHE) during OER, while LSC is limited by Co^{3+} reduction at these potential values.