Nanoporous Co-Ni-Based Materials for Electrocatalysis Applications

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Abstract. The development of porous materials based on 3d-transition metals (TM), which are abundant and substantially cheaper in comparison with noble metals, is highly desirable for electrocatalyst applications. Porous metals and (more importantly) porous multicomponent alloys regardless of components' chemical activity can be fabricated by the vapor-phase dealloying (VPD) method, which is based on the selective removal of a component with a high partial vapor pressure (usually Zn) from an alloy precursor. This method has been applied to fabricate porous Co-Ni-based alloys using as-quenched $(Co_4Cu)_5Zn_{21}$, $(Co_3NiCu)_5Zn_{21}$, $(Co_2Ni_2Cu)_5Zn_{21}$, $(CoNi_3Cu)_5Zn_{21}$ and $(Ni_4Cu)_5Zn_{21}$ precursor alloys. It may be noted that adding Cu to precursor alloys results in their considerably better ductility. The SEM micrographs of the fabricated porous alloys revealed a spongy microstructure with large (500 nm) and small (less than 200 nm) pores. The specific surface area of porous alloys calculated according to the multi-point BET method using data from the N_2 adsorption/desorption experiment was in the range of 3 to 17 m^2/g. XRD analysis of the precursor as-cast ribbons showed that their microstructure is very complex based on ε-$CuZn_5$, Co_3Zn_{17}, $CoZn_{13}$, and Ni_3Zn_{22} intermetallic compounds. XRD investigations indicate the formation of two solid solutions with FCC structure during VPD treatment of Co-Cu-Zn and Co-Cu-Ni-Zn precursor alloys. In the case of the VPD treatment of the Ni-Cu-Zn as-cast ribbon, a single-phase FCC solid solution was formed. The XRD analysis has also revealed that the surface of fabricated porous alloys is covered by ZnO. The results of the study of the electrocatalytic activity of prepared porous alloys in the HER and OER reactions indicated that the best activity was demonstrated by porous alloys, where the main component is cobalt with low nickel content.

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