Modification of the Oxygen Evolution Reaction Using Iridium (IV) Oxide Combined with Precious Metals through the Dip-Coating/Calcination Reaction, a Sixth Year Study

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A primary problem of gathering hydrogen from electrolysis of water today is the high overpotential associated with the O2 evolution reaction. Research into anodic catalyst formation and composition has focused on IrO2 for its combination of stability and high catalytic activity. In acid Ye et al.(2010) found an increase in stability and activity when combined with Pt. The purpose of this experiment was to combine Ni with IrO2(NiIr) and evaluate it against the Pt-IrO2(PtIr) complex in acidic and basic environments. Following the procedures of Ye et al., H2PtCl6(0.5mM), H2IrCl6(0.5mM), and NiCl2(0.5mM) solutions were prepared and mixed in ratios of 7:3 Ir:Ni/Ir:Pt. Stainless steel plates with an active area=2.1 cm2 were dipped in solution, dried 5 minutes at 90°C, baked 10 minutes at 450°C in N2 and annealed for 1 hour at 450°C in N2 after 5 dip/bake cycles. Characterization occurred physically by SEM with EDS, and electrochemically by cyclic voltammetry(CV) and derivation of exchange current density(ECD) using Tafel curves through chronoamperometry. It was hypothesized that NiIr should have similar composition to PtIr and have greater ECDs in base. PtIr showed uniform morphology of 3mol-Pt:2mol-Ir. NiIr showed two distinct morphologies: cracked layering (1mol-Ni:19mol-Ir) and geometric-prism/crystal lattices (4mol-Ni:5mol-Ir). NiIr ECDs were higher than PtIr for both H2SO4(1.16E-03:5.33E-04)(A/cm2) and KOH(1.75E-04:6.50E-05)(A/cm2), however the difference was only statistically significant in KOH (KOH:p=0.042; H2SO4:p=0.344). This supported the hypothesis, however KOH-NiIr did not significantly outperform H2SO4-NiIr (p=0.233), possibly due to the differing NiIr morphologies. Variations in bake conditions and binding agents may increase uniformity and performance further.

Awards Won:
Fourth Award of $500