

## Application of Rare earth metal Pt Alloy for Hydrogen Evolution Reaction (HER) Catalysts in Polymer electrolyte membrane water electrolyzers (PEMWEs)

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Platinum is the most active electrocatalysts for the hydrogen evolution reaction (HER). However, the high price and scarcity of platinum are the major factors preventing the large-scale application of PEMWE. In this work, Pt-Sc, Y, La alloys on carbon supports were synthesized by an electron beam method. Nanoparticles of 10 nm or less platinum alloy catalysts are confirmed by XRD and TEM analysis. Catalytic activities were measured with a PEMWE single cell. Pt<sub>3</sub>La was excluded from the single cell analysis because of its low durability in half-cell analysis. From the half-cell, Pt<sub>3</sub>La/C showed the highest mass activity but the lowest stability. On the other hand, Pt<sub>3</sub>Sc/C showed highly improved stability than Pt/C. In the single cell, current density 1mA/cm<sup>2</sup> was measured at 2.2V with 2mg/cm<sup>2</sup> for anode and 0.5mg<sub>Pt</sub>/cm<sup>2</sup> for cathode. As the anode overpotential is dominant, so the effect of the platinum alloy did not appear prominently. However, similar activity and durability were measured by using platinum alloy catalysts, which effectively reduced the amount of platinum loading.