Understanding Structure to Property Relations for IrOx Amorphous and Crystaline Catalysts for PEM Water Electrolyzers

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Proton exchange membrane (PEM) water electrolyzers carry a promise to decarbonize hydrogen production sector. One of the largest cost components of these technologies is the PEM water electrolyzer stack. Within the stack membrane electrode assemblies (MEAs) rely on expensive and rare IrOx catalyst for oxygen evolution reaction. To reduce the cost of the stack and use of IrOx the loadings have to be reduced. However, there are many challenges associated with reduction of the IrOx loadings [1]: durability challenge, poor in-plane electric conductivity, poor contact with the porous transport layers. Micro-porous layers (MPLs) that consist of finer titanium particles can alleviate contact resistance problems but these layers are not yet commercially available. Another approach consists of supporting IrOx onto a metal oxide support to enable thicker catalyst layers to ensure good in-plane electric conductivity. However, degradation mechanisms of IrOx, whether it is dissolution or nanoparticle precipitation into membrane or cathode for the low-loading catalyst layers are not well understood.

In this study we perform thorough MEA evaluation of low-loading catalyst layers consisting of various commercially-available IrOx catalysts and present results for beginning of life and end of life. We correlate the electrolyzer-level testing results with the structure to property relations of these catalysts. Through various x-ray and electron characterization methods combined with electrochemical methods we unveil the important structural parameters that control the layer durability.

References

1. C. Wang, K. Lee, C.P. Liu, D. Kulkarni, P. Atanassov, X. Peng, I.V. Zenyuk, “Design of PEM Electrolyzers with Low Iridium Content”, International Materials Review, 09506608231216665, 2023