Au STABILIZATION EFFECT ON Pt CATALYSTS FOR OXYGEN REDUCTION REACTION

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Hydrogen-fueled proton-exchange membrane fuel cells (PEMFCs) are promising renewable energy due to the only by-product is water and low operating temperature [1]. In the last decades, It has been proved that platinum is the most efficient catalyst for oxygen reduction reaction in the application of PEMFCs [2]. However, the less abundance and high cost of Pt hampers the commercialization of fuel cell technology. Therefore, it is important to increase the activity, stability and utilization efficiency of Pt catalyst.

Among those factors, the poor stability of Pt-based catalysts has become the center challenge. One of degradation mechanism for Pt-based catalysts in cathode acidic environment is the dissolution/re-deposition of Pt, which lead to the Ostwald ripening and further causing in low-stability [3]. In order to address this issue, incorporating specific elements into platinum catalysts has been recently proven favorable for their stability by inhibiting platinum dissolution. Among alloying elements, gold has been reported as one of the most promising choices so far [4]. However, a significant drawback exists. The gold is inactive for the oxygen reduction reaction (ORR) running at PEMFC cathode. Moreover, its alloying with Pt makes it unfavorable for ORR geometrical modifications. The effectiveness of Pt–Au for both activity and stability thus strongly depends on the alloy structure as well as the compositional profile and, therefore, should be balanced through precise catalyst engineering.

Targeting that aim, small amount of Au introduced into Pt by magnetron sputtering technique form Pt-Au alloy. Three compositions of Pt-Au alloy catalysts were investigated by various techniques. The promising stability improvement of Pt-Au catalyst, manifested in suppressed platinum dissolution with increasing Au content, was confirmed over an extended potential range up to 1.5 VRHE. On the other hand, at elevated concentrations Au showed a detrimental effect on ORR activity. A systematic study involving a set of complementary characterization techniques, and electrochemistry enabled us to gain a comprehensive understanding of the composition-activity-stability relationship to find an optimum Pt-Au alloying for maintaining the activity of platinum and improving its resistance to dissolution.

References

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