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Oxygen Reduction Reaction Activity for Pt/Zr/Pt(111) Model Catalyst Surfaces Prepared by Arc-plasma deposition

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Oxygen reduction reaction (ORR) activity enhancement mechanisms of Pt-based alloy (Pt-M) catalysts is a key for developing highly-efficient cathode catalysts for polymer electrolyte fuel cell. In particular, the relation between the outermost structure of the Pt-M catalysts and electrochemical (EC) properties, e.g., ORR activity is a key issue. In this study, ORR activities are investigated for Pt/Zr model catalysts prepared on Pt(111) substrate through alternative arc-plasma depositions (APD) of Pt and Zr nano-meter-thick-layers.
The UHV-APD-EC apparatus is described elsewhere [1]. Nano-meter-thick Pt and Zr layers were alternately deposited onto a clean Pt(111) substrate by the APD method. Structural analysis for the prepared model nano-structures are performed by using in-plane XRD, cross-sectional STEM. For the ORR activity evaluation, the UHV-prepared samples were transferred to an N2-purged glove box without air exposure. Cyclic voltammetry (CV) and linear sweep voltammetry (LSV) were conducted in N2-purged and O2-saturated 0.1M HClO4 in the glove-box.
Surface strain that estimated by the in-plane XRD depended on the deposition thickness ratios of Pt and Zr layers: tensile strain worked on the topmost Pt(111) shell. Estimated ORR activity enhancement factors vs. clean Pt(111) are determined by the tensile surface strain and chemical effects of the topmost Pt(111) layers induced by underlying Zr.
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[1] S.Kaneko et al., JPCLett. 8, 5360 (2017).

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