

Potential Dependent Structures at Pt(111) Single Crystal Electrode/Perchloric Acid Electrolyte Interface Studied by Surface X-ray Scattering

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Introduction.

Platinum is one of the most important materials for various applications, and structure and properties of low index surfaces of single-crystal platinum have been extensively studied not only in ultrahigh vacuum (UHV) [1,2] but also in electrochemical environments [3-5]. It is very important to know potential dependent structures at Pt single-crystal electrode surface, especially in pre-oxide potential region, *in situ*, because of application for polymer electrolyte fuel cell (PEFC) as a cathode catalyst. Since there are few surface techniques to investigate the interfacial structures *in situ*, however, they have not been made clarified yet.

The surface X-ray scattering (SXS) technique is one of the best methods to investigate the three-dimensional (3D) interfacial structure at an atomic level. Many *in situ* structural studies at electrode/electrolyte interfaces using the SXS technique have been carried out in the last 2 decades. For example, we determined the potential dependent structures at Au(111) and Au(100) single-crystal electrode/sulfuric acid electrolyte interfaces using this *in situ* technique [6].

In this study, the potential dependent structures of single-crystal Pt(111) electrode in perchloric acid electrolyte solution in the potential regions between 0 V and +0.8 V (vs. Ag/AgCl) were investigated by *in situ* SXS measurements.

Experimentals.

Prior to each measurement, the Pt(111) disk was annealed at 1600°C for 1 hours using induction heater under argon/hydrogen flow, and then quenched by ultrapure water saturated with argon/hydrogen. After that, the Pt(111) disk was set to the home-made SXS cell [7],

the SXS cell was set to the 6-axes diffractometer, which was installed at undulator beamline BL3A in Photon Factory, and then *in situ* SXS measurements were carried out.

Results and Discussion

Figure 1 shows (00) rods of the Pt(111)/HClO₄ interface measured at 0 V and 0.8 V. Based on the fitting of these data, we confirmed that at 0 V in hydrogen UPD potential region, layer distance between first and second outermost Pt layers is expanded by ca. 3 % because of strongly adsorbed hydrogen. We also found that at 0.8 V where pre-oxidation is completely finished, oxygen species are adsorbed at an atop site on the Pt(111)-(1×1) surface with a (1×1) structure. Detailed structure analyses at the other potentials and their dynamic studies are now under investigation.

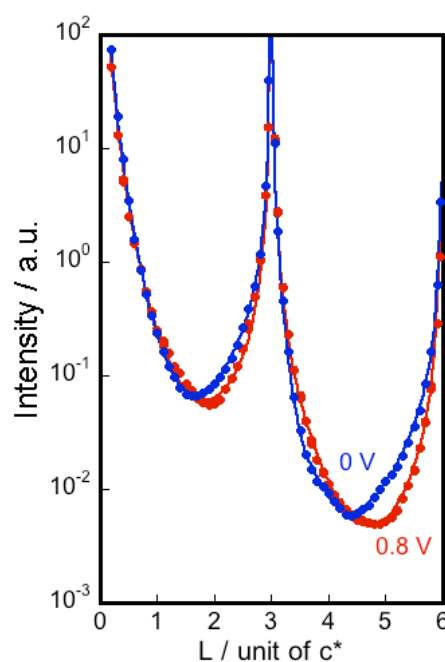


Figure 1. (00) rods at Pt(111)/perchloric acid solution interface measured at 0 V and 0.8 V. Circles and solid line represent data points and fitting curves, respectively.

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