In Situ Structural Studies on Pt Ultra-thin Layers on Au(111) Single Crystal Surfaces by RSXS

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Introduction

Ultra-thin metal layers on the foreign metal substrates have been attracting interests because of their unique physical and chemical properties, particularly their high electro-catalytic activities. Such special catalytic activity is due to surface atomic arrangements and/or surface energy. Thus, the atomic arrangements should be determined. Pt is one of the best catalysts for the various catalytic reactions. In this report, atomic arrangements in the Pt layers electrochemically deposited on the Au single crystal surfaces were investigated by resonance surface X-ray scattering (RSXS).

Experimentals

After annealing and quenching the Au single crystal disk, the Au disk was contact with 0.1 M $HClO_4$ electrolyte solutions containing several concentrations of Pt complex ions at open circuit potential (OCP) and Pt layers were deposited by controlling deposition potential and/or deposition time. After that, the circuit was disconnected, which means the potential was at OCP, the electrolyte solution thickness became minimum at ca. 30 μm, and then the in situ RSXS measurements were carried out at the BL4C beamline in Photon Factory and RSXS measurements. Incident X-ray energy was selected between 11.40 and 11.75 keV, which are so closed to absorption edge energy of Pt L_{III}.

Results and Discussion

Just after dipping the Au disk into the electrolyte solution at OCP, the Pt complex ions were arranged in order by scanning tunneling spectroscopy (STM). Based on the RSXS results, we confirmed those arranged structures. The Pt complex was also covered with the deposited Pt surface and structures of electrodeposited Pt layers prepared on a Au(111) surface under a certain condition was that an atomically flat Pt monolayer were formed on the Au(111)-(1×1) surface. Pt atoms of the atomically flat monolayer were found to be situated at the three-fold hollow cubic closest packing (ccp) site of the Au(111)-(1×1) surface.