Effect of Potential on Stability of Pt (111) Electrode Surface

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Introduction: Platinum has been widely used as a catalyst in fuel cells. During the fuel cell operation, the active area of platinum catalyst decreased may be due to the dissolution. This is a serious problem for the fuel cell to be used widely. Therefore, it is important to study the details of the degradation mechanism. Electrochemical oxidation/reduction cycle is considered to be one of the main factors that accelerate the loss of the active area. In this study, the effect of potential on the structural change of low index planes of single crystalline platinum electrodes was investigated under various electrochemical conditions.

Experiment: A Pt single crystalline bead was prepared according to the Clavilier method. The bead was cut along the specified plane, followed by polishing with 3 μm and 0.5 μm diamond slurries. The platinum substrate was annealed in an induction heater for 10 hours at 1600 °C under Ar/H2 flow. Prior to each electrochemical experiment, the electrode was treated similarly but annealed only for 30 minutes, followed by quenching in a pure H2O saturated with Ar/H2 after cooled in Ar/H2 flow for 2 minutes. The electrochemical measurements were carried out in the hanging meniscus configuration.

Result: Figure 1 shows cyclic voltammograms (CVs) of Pt (111) electrode in 0.1M H2SO4 solutions during continuous potential cycling between -0.2 V and 1.1 V vs. Ag/AgCl electrode with a scan rate of 50 mV/s. In the first cycle between hydrogen and oxygen evolution regions, the CV showed a typical behavior of Pt (111). However, after some cycles, the charge of hydrogen adsorption/desorption increased with the number of cycles, new peaks appeared at around -0.15 V and the well known butterfly peaks of Pt (111) diminished. This result suggests that the Pt (111) surface was roughened and new phases appeared by oxide formation/reduction. This phenomenon was not observed when the positive potential limit was more negative than 1.1 V.