Reconstructed Pt(100) Electrode Surface in Gases and in Solution

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Introduction The electrochemical behavior and the structure of the reconstructed Au(100) surface in solution have been well characterized, whereas the analogous reconstruction of Pt(100) produced somewhat contradictory results.[1-6] We investigated the structural change and electrochemical behavior of Pt(100) surface in contact with H_2 gas, Ar gas, and H_2SO_4 solution by cyclic voltammetry in solution and low-energy electron diffraction and scanning tunneling microscopy in ultrahigh vacuum (UHV).[7]

Experimental Experiments were carried out in a system consisting of analysis, preparation, and dosing chambers in UHV and an electrochemical chamber.[7] The analysis chamber was equipped with STM, LEED and AES. The dosing chamber was equipped with a heating stage and could be backfilled with H_2. A laser-beam reflection method was employed to determine the orientation of the single crystal bead to expose the (100) plane, which was then mechanically polished with diamond pastes. Commercial ultra pure Ar (99.9999 %) was further purified by a Ti-getter purifier, and the purified ultrapure Ar contained less than 10^{-5} ppm of impurities. H_2 (99.99999 %) was used for the dosing experiment without further purification. The 1 mM H_2SO_4 solution was prepared with ultra pure H_2SO_4 and ultra pure water.

Results The clean and well-defined Pt(100)-hex-R0.7° surface was prepared in UHV (Fig. 1). Upon being exposed to H_2 gas, the surface was transformed into Pt(100)-(1 × 1) with many monoatomic islands. On the contrary, the Pt(100)-hex-R0.7° structure remained unchanged when exposed to Ar gas. Fig. 2 shows CVs on Pt(100)-hex-R0.7° in 1 mM H_2SO_4. The CVs in the first and the second cycles were different, indicating that the surface structure changed in the first cycle. By using LEED and STM, it was demonstrated that the reconstructed Pt(100)-hex-R0.7° surface was stable in 1 mM H_2SO_4 in the potential range more anodic than that for hydrogen adsorption. The structural transition from hex-R0.7° to (1 × 1) was observed at cathodic potentials where hydrogen atoms are adsorbed on the Pt electrode surface. Fig. 3 shows the Pt(100) surface obtained after the emersion at 0.2 V. The hex-R0.7° and (1 × 1) structures are simultaneously observed on Pt(111).

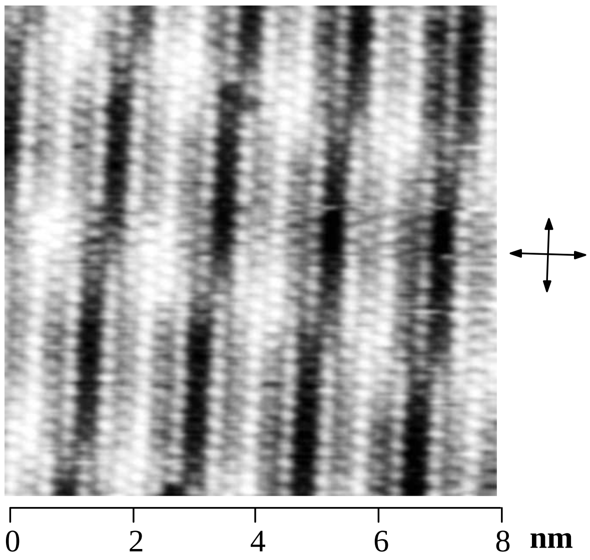

Fig. 1 STM image of Pt(100)-hex-R0.7° acquired in UHV.

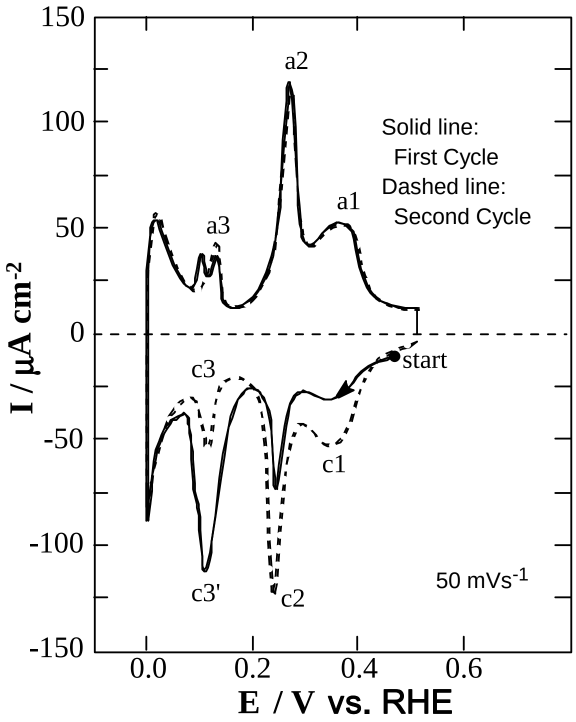

Fig. 2 CV on Pt(100)-hex-R0.7° in 1 mM H_2SO_4.

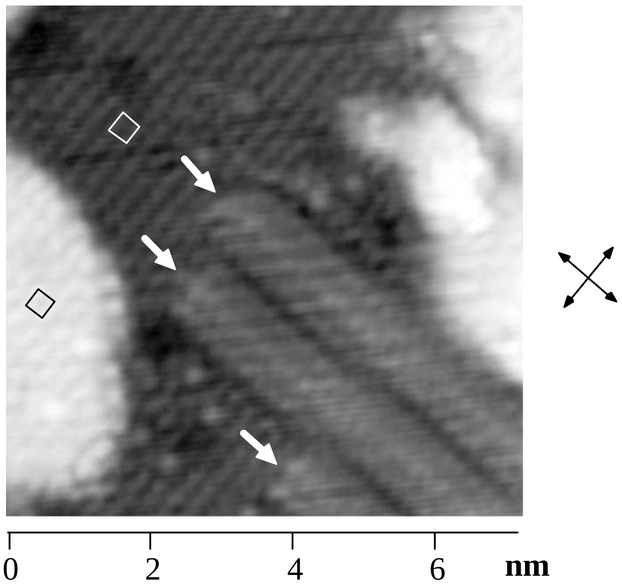

Fig. 3 STM of Pt(100) emersed at0.2 V from H_2SO_4.

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