Surface X-ray Scattering Observation of High-Density CO Monolayers on Pt(111)

A. MENZEL, Y.V. TOLMACHEV, V. KOMANICKY, A.V. TKACHUK, Y.S. CHU, H. YOU, Argonne National Laboratory — We report on surface x-ray scattering studies of high-density long-range ordered CO adsorbates on Pt(111) in equilibrium with gas phase at near-atmospheric CO partial pressures. We adsorbed CO with an electrochemical method and transferred the sample into a controlled gas atmosphere. At CO partial pressure $P_{\text{CO}} \sim 1$ atm we found long-range ordered (2×2)-3CO, at $P_{\text{CO}} < 0.5$ atm we found ($\sqrt{19} \times \sqrt{19}$)R23.4°-13CO. These structures do not depend on the electrochemically controlled initial coverage, but are only a function of CO partial pressure and temperature. Based on our x-ray studies, we propose a phase diagram of CO monolayers on Pt(111) under near-atmospheric pressure of CO. We will discuss the parallel behavior of CO monolayers in high-pressure atmospheres and those in electrochemical environment. However, there is disagreement between our results and those of recent studies of CO adsorbed from the gas phase, where ($\sqrt{19} \times \sqrt{19}$) has been reported for $P_{\text{CO}} = 1$ atm and room temperature [Longwitz et al. JPCB 108 14497 (2004)]. Similar differences have been reported for studies in UHV when comparing gas adsorbed CO structures and electrochemically prepared structures studied in vacuo [Zurawski et al. JPC 94 2076 (1990)]. We will address plausible causes for these discrepancies.

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