Friction at Au(111) during underpotential deposition (UPD): Effect of potential, normal load and the ionic adsorbate l

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Friction between a sliding AFM tip and the surface of the electrode help us to understand interfacial and tribological behavior on a nanoscale. The measurement of friction in an electrochemical cell allows controlling the interfacial interactions in situ easily. Our interest has focused on the adsorption of foreign metals, ranging from (sub)monolayer (underpotential deposition(UPD)) to multilayer (bulk deposition) and the adsorption of organic adsorbate depending on a potential on single crystal electrodes in aqueous electrolyte[1-3].

In this study, we investigate the interfacial properties on Au(111) in aqueous electrolyte. The structure of Ag UPD layers is extremely sensitive to co-adsorbed anions such as I^- and SO_4^{2-}. We found that the iodine adlayer on Au(111) forms a ($\sqrt{3}\times\sqrt{3}$)R30° structure using the results of atomic stick-slip. It changes to a p(3×3) and ($\sqrt{3}\times\sqrt{3}$)R30° structure after 1st Ag UPD and 3rd Ag UPD, respectively. The results of the friction on potential shows that the incomplete Ag UPD layer on Au(111) leads to relatively high friction. It is in good agreement that for low and moderate coverages, the tip drags the adsorbates along the surface resulting in high friction, whereas for higher coverages the tip slides above the adsorbates resulting in low friction[4]. The results of the friction on load on I-modified Au(111) shows three apparent regimes. Under the low normal load (F_N<30nN), the friction force is independent on Ag UPD, meaning that the tip is interacting with iodine layer. Under critical normal load, the friction shows a rapid increase, which indicates that the tip penetrates into the iodine layer. Under the high normal load (F_N>100), the friction shows moderate increase, which represents that the tip is interacting with Ag UPD layer.

Important is the dependence of the structure as revealed by the LFM images: whereas at low normal load the structure of the anionic adlayer is visible, at higher load the images change to the structure of either the Au substrate or the Ag upd layer. In the case of Cu upd, at higher loads multiple slips occur instead.

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