Ru(0001) Surface Electrochemistry in the Presence of Specifically Adsorbing Anions

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Disentangling the potential dependent surface(electro)chemical processes can be an arduous task, in particular for ill-defined electrode surfaces or when several reactions either coincide or occur without electron transfer. Employing ultrahigh vacuum surface preparation, electrochemical measurements and in situ spectroscopic / structural characterization we have investigated the potential dependent surface processes proceeding on a Ru(0001) single crystal electrode in the absence and presence of specifically adsorbing anions in acid electrolyte. Online differential electrochemical mass spectrometry (DEMS) measurements clearly identify anodic H_2 formation in both cases, a recently reported phenomenon (Scott et al. Catal.Sci.Technol. 10 (2020) 6870), demonstrating that this can be induced not only by OH adsorption, but also by other strongly adsorbing anions such as bisulfate. Furthermore, operando surface X-ray diffraction (SXRD) measurements demonstrate that the composition of the adlayer depends significantly on the potential history of the electrode, where strongly adsorbed hydroxyl species lead to pronounced hysteresis effects. Such complex processes are proposed to be characteristic for strongly interacting electrodes in general, not only for Ru.

Keywords: H_2 evolution, Structure, Hysteresis, Adsorption, Ru(0001), SXRD

Submitted: 30.11.2020

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