CATALYTIC REACTIONS ON NANOSIZED SURFACES: BRIDGING OF THE MATERIALS AND PRESSURE GAP

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The structurally heterogeneous surface of a field emitter tip is formed by differently oriented facets of nm dimensions. Such a formation can be considered as a model catalyst bridging the materials gap since it represents the complex structure of a metal particle of a supported catalyst. In contrast to such a particle, the tip surface can be prepared reproducibly and can be characterized with atomic resolution by Field Ion Microscopy (FIM). Using this and other field emission based techniques, such as field electron microscopy (FEM), and lithium field desorption microscopy (Li-FDM, [1]), one can follow up the dynamic processes on the tip surface with a lateral resolution ≤ 2 nm. In this way surface reactions such as the catalytic CO oxidation or the NO reduction can be visualized *in situ* on well defined nanosized facets. Digitizing and sophisticated processing of the corresponding video-images [2, 3] allows to study the reaction dynamics within the "virtual probe-holes" (regions of interest which correspond to certain surface regions of few nm^2) arbitrarily located on the surface. The "parallel" imaging principle of the field emission based microscopes makes it possible to analyse simultaneously the processes proceeding on the different surface regions of nm-size. The role of the atomic steps, size effects, diffusive coupling and microscopic fluctuations can be studied. Fluctuation-induced transitions between the active and the inactive branch of the reaction were observed using the O_2^+ and Li^+ ions as well as electrons as probing species. It is worth to be noted that electrostatic fields of ca. 4 V/nm applied to the specimen in the FEM mode were proven not to influence the CO oxidation reaction on the tip surface.

By monitoring the local rate of Li^+ ions which are emitted from the probed surface sites the alkali-promoted catalytic reactions can be studied via utilising the ions of the promoter itself. In addition, the microscopic surface mobility of Li atoms during a catalytic surface reaction can be examined *in situ* using the surface density fluctuation approach [2].

The probe-hole technique realised in the FIM mode enables the mass-to-charge resolved potential analyses of the ions originated from the few surface atomic sites. This renders possible the derivation of the binding energy of adsorbed molecules (e.g. CO and O_2 in CO oxidation reaction) in the chosen surface atomic environment [4]. The applied electrostatic fields which are much higher in the FIM than in the FEM or Li-FDM modes (10 – 20 V/nm) cause the local pressure enhancement near to the specimen surface permitting in this way the partial bridging of the pressure gap.

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