

Surface modification of oxides by photon- and electron-stimulated desorption for growth mode control of metal films

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Most metals grow on oxides in form of three-dimensional (3d-) clusters (Vollmer-Weber mode). In order to force them to grow into a low-dimensional form, the surface has to be modified. From first principle calculations it is well known that oxygen vacancies strongly bond individual atoms, in contrast to the defect-free surface, on which the bonding is weak. On many oxide surfaces oxygen vacancies can be produced by photon- or electron-stimulated desorption.

In this talk we illustrate this for Au on TiO₂(110). This system has attracted considerable attention because of the high catalytic activity of small 3d-Au clusters for a variety of chemical reactions. Recently high catalytic activity was reported also for two-dimensional and atomic Au. A comparison with one-dimensional (1d-) Au is the motivation for the present work. We have produced 1d- Au rows by photon- or electron-stimulated desorption followed by Au deposition at 750 K. The experiments were performed using the SPELEEM at the Nanospectroscopy beamline of the synchrotron in Trieste. The vacancies were created by irradiation with 170 eV photons or 60 eV electrons and the Au growth mode was studied with Au 4f μ XPS. Simultaneous deposition on unirradiated regions and regions with different irradiation doses allowed quantitative comparison between them (Fig.1). The amount of low-dimensionally distributed Au was found to be proportional to the vacancy density. At vacancy density of 0.5 monolayers the vacancies arranged in a (1 \times 2) structure (Fig.2), on which the Au atoms formed one-dimensional crystals with up to three atoms per row. These one-dimensional crystals not only promise to shed some light on the catalytic activity of low-dimensional Au but are also ideally suited for the study of 1d- crystals in general because of the negligible coupling between the rows through the oxide.

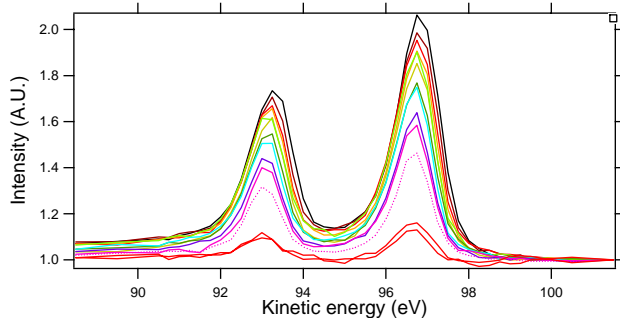


Fig.1. Au 4f spectra as a function of the irradiation dose for 0.5 monolayer Au coverage

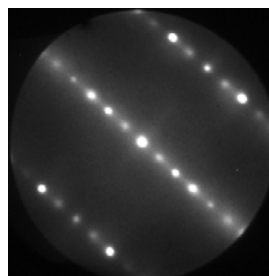


Fig.2. LEED:(1x2) structure