MM 17: Hydrogen in materials

Time: Tuesday 10:15–11:15 Location: H6

MM 17.1 Tue 10:15 H6

Hydrogen absorption in epitaxial Nb-films: a STM-study — •Kai Nörthemann and Astrid Pundt — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The hydrogen absorption and hydride formation in thin epitaxial films is presented in this contribution, using the model system Niobium-Hydrogen.

With the surface sensitive scanning tunneling microscopy (STM) it is possible to study the hydrogen uptake inside a film because of its strong out-of-plane expansion. Since this is proportional to the H-concentration this effect can, especially, be used to study the hydride evolution. It will be shown that the surface topography tells about the hydride shape and microstructure inside the film. Two different types of hydride-related surface topographies were found: smooth hills (early stages) and rough surface pattern (later stages). The shape of the related hydrides were determined with the help of finite-element analysis. The origin of the two different surface topographies will be presented.

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MM 17.2 Tue 10:30 H6

The effect of the structure and the stabilizer on the hydrogen absorption in palladium clusters — •M. Suleiman[1], D. Fritsch[2], C. Borchers[1], R. Kirchheim[1], and A. Pundt[1] — [1]1Instiute of Material physics, University of Goettingen Friedrich-Hund-Platz 1, 37077 Goettingen, Germany. — [2]GKSS Research Centre Geesthacht GmbH, Institute of Polymer Research, Max-Planck-Str. 1, 21502 Geesthacht, Germany

In this work the hydrogen absorption behaviour of two types of Pd-clusters, different in structure, will be presented: First, icosahedral Pd clusters stabilized in tetraoctylammonium bromide (TOAB). Second, cubic Pd clusters (Pd-Teflon AF) stabilized in Teflon AF matrix. The phase transition in these samples was monitored by in situ X-ray diffraction. It is shown that the hydrogen uptake ability depends strongly on the lattice structure which is affected by the type of stabilizer. Teflon AF stabilized clusters show the phase transition which is common for bulk, whereas TOAB stabilized clusters show only weak lattice dilatation upon hydrogen absorption. P-c Isotherms show that the Teflon AF stabilized clusters (the cubic clusters) absorb large amounts of hydrogen both in comparison to bulk Pd and to the TOAB stabilized icosahedral clusters. The measured solubility is higher than that for TOAB-clusters, and even higher than that expected for bulk palladium.. This suggests that surface sites are available for hydrogen in the Pd-Teflon-AF samples which are not accessible for Pd-TOAB-clusters, and that the icosahedral lattice absorbs less hydrogen for similar external pressures.

MM 17.3 Tue 10:45 H6

Temperature dependent FT-IR-spectroscopy on YH_3 — •Stefan Weber and Joachim Schoenes — Institut für Physik der Kondensierten Materie, TU Braunschweig

Thin films of yttrium metal have become known under the term of switchable mirrors. Upon hydrogen loading the metallic films undergo a metal to insulator transition, e.g. the opaque metallic films become transparent semiconductors.

Recent Raman studies [1] showed that $YH_{3-\delta}$ behaves like a doped semiconductor which results in an unusual strong temperature dependence of one particular phonon due to electron-phonon interactions. Fourier-transform-infrared-spectroscopy show peaks that can be attributed to hydrogen vibrations by comparison of samples loaded with either hydrogen or deuterium. One of the apparent phonons displays a much stronger temperature dependence than the others. A careful study of the line shapes of deuterium loaded samples reveals a shoulder which can be attributed to an electronic transition between a donor level and the conduction band of $YH_{3-\delta}$. In hydrogen loaded samples this electronic transition coincides with a phonon which hampers its clear identification. But as it doesn't underlay the isotope shift our additional data confirm the assignment of that spectral structure to an electronic transition. This result supports the model of strong correlations in the electronic structure of $YH_{3-\delta}$ [2].

[1] A.-M. Racu and J. Schoenes, Phys. Rev. Lett. 96, 017401 (2006)
[2] K. K. Ng et al., Phys. Rev. B 59, 5398 (1999)

MM 17.4 Tue 11:00 H6

Hydrogen sensors based on magnesium-x (x = Al, Ti, Fe, V and Zn) thin films — •Andreas Laufer, Baker Farangis, Jennifer Stiebich, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

We investigated hydrogen sensors based on magnesium-x (x = Al, Ti, Fe, V and Zn) thin films with a palladium over-layer operating at room temperature. These thin films prepared by RF-sputter-deposition show a very large change in both reflectance and transmittance during the absorption of hydrogen gas. The decrease in reflectance during hydrogenation was studied by using a GaAs infrared emitter and silicon NPN phototransistor as light source and detector. The change of optical properties is believed to result from reversible formation of MgH_x ($x \leq 2$). The reflectance decrease is proportional to the hydrogen concentration (0.1-4% H_2 in Argon). The response time (0-90% of signal) is under 10 seconds depending on the composition of the Mg-alloy.