ESRF	**Experiment title:** **Hydrogen diffusion in epitaxially grown Y-films**	**Experiment number:** **HS 874**
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Shifts: **12**	**Local contact(s):** **Jürgen Härtwig**	*Received at ESRF:*

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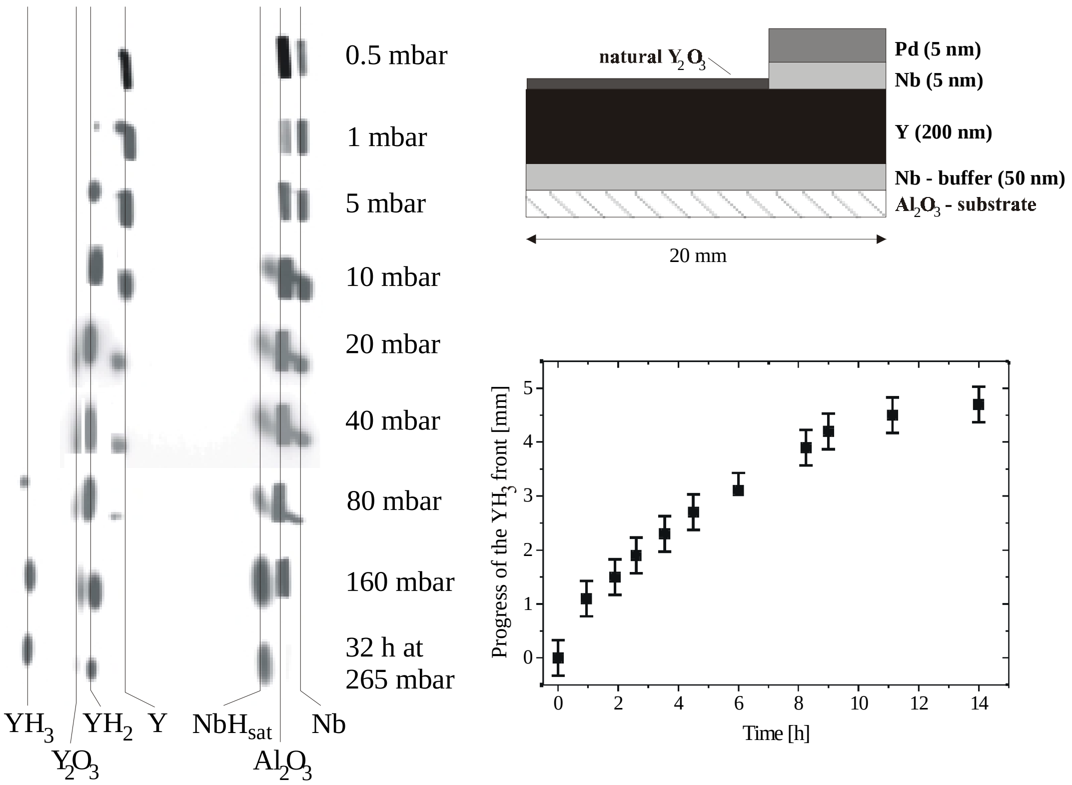
Report: Hydrogen in yttrium is of fundamental interest as a model system for driving metal-insulator transitions including switchable optical properties. By means of x-ray diffraction topography the hydride phase nucleation, the domain sizes as well as the spatial distribution of phases could be observed in single crystalline, epitaxially grown yttrium films [1]. During the β–γ phase transition in Y-H films the sample switches from cubic YH_2 (β- phase, metallic) to hexagonal YH_3 (γ- phase, insulating). Previously this phase transition as well as the influence of the hydrogen upon the epitaxial relation has been studied in detail [2]. The present experiment was intended to follow the lateral hydrogen diffusion in a 200 nm thick Y film in order to examine the effective mobility of the respective phase boundaries. The Y (00.1)- film was grown on a Al_20_3/Nb buffer and capped successively with Nb and Pd. While the buffer guarantees epitaxial growth, the Pd cap layer serves as hydrogen window and as protection against corrosion. To observe lateral diffusion, the sample was just partially Pd-covered. First, the hydrogen penetrates the Pd-covered part of the sample. The structural degradation of the sample as well as the domain formation could be well seen. As soon as saturation is reached, lateral diffusion starts. Al_2O_3 does not solve H, thus its reflection stays at the same position, serving as a reference. Upon hydrogenation, the Nb lattice underneath the Pd- cap expands immediately by 8% and the reflection shifts to the other side of the substrate reflection. Lateral diffusion shifts the H frontier through the sample. At the chosen temperature the Nb-H system does not cross a phase boundary, therefore the hydrogen concentration and thus the lattice expansion varies continuously throughout the sample. Y on the other hand shows distinct phases, resulting in spatially separated reflections on the photographic film. The effictive mobility M_e of the diffusion front can be calculated from distance-time plots. At T=300°C and p=800mbar, M_e equals $5x10^{-6}cm^2/s$. This process can be stopped and reversed by removing the H-atmosphere.



Series of topographies visualizing H- diffusion within the 200 nm thick Y film at 250°C (left). The progress of the diffusion front is depicted below the sample architecture (right).

[1] A. Remhof et al. , ESRF experimental report on HS560
[2] A. Remhof, G. Song, Ch. Sutter, A. Schreyer, R. Siebrecht, H. Zabel, F. Güthoff, and J. Windgasse, Physical Reviev B **59** (1999) 6689.