Physical properties of nano-systems such as thin films are different from their bulk counterparts, both in thermodynamics and in phase formation kinetics. In our work we try to separate the different contributions, originating from micro-structure, substrate-related mechanical stress and the finite size. The contribution of H-induced mechanical stress and the importance of stress-release is addressed in this presentation using several in-situ methods like scanning tunneling microscopy, X-ray diffraction, electrical resistance measurements, electromotive force measurements and optical light transmittance. For epitaxial Nb-H films several critical thicknesses were found. Below about 40 nm, the film transforms coherently into the hydride phase, while above that thickness, incoherent transformations are found. The hydrides morphology during the phase transition changes at this thickness, from growth dominated large hydrides to nucleation dominated small hydrides. In this regime, stress-releasing dislocations are still present. Below a thickness of about 10 nm, ultrahigh stress arises and no phase transition occurs upon hydrogen absorption. This can be attributed to the high stress state which contributes to the chemical potential of the system and reduces the critical temperature of the miscibility gap. We regard these results as being of general nature that account for many gas-atom absorbing nano-systems when fixed to rigid stabilizers.

BIO
Dr. Astrid Pundt is adjunct professor at the Institute of Materials Physics at the University of Göttingen in Germany. Her research interests are the materials physics of nano-scale materials with a focus on hydrogen in metals. Microstructural defects (including interfaces) as well as mechanical stress affect the kinetics and the thermodynamics of nano-systems. Thereby, the storage properties, the sensoric properties and the catalytic properties of the system can be tuned. We are studying thin films, clusters, growth islands and multi-layers, prepared by sputtering, laser-deposition and by wet chemistry on substrates or just free-standing. Defect-rich bulky materials (nano-crystals, highly-deformed material) are chosen to study the impact of mainly one type of defect. Structure property relations are studied by electrochemical force measurements, gas-volumetry and -gravimetry, electrical resistance and optical properties measurements, (in-situ) electron microscopy, atom probe tomography and field ion microscopy, (in-situ) scanning probe microscopy, secondary ion mass spectroscopy, x-ray diffraction at Synchrotron sources, positron annihilation etc.