Hydrogen distribution in nano-sized metals: hydrogen microscopy techniques

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Nano-sized metals offer many sites for hydrogen absorption that differ from the conventional interstitial lattice sites, for example sites at grain boundaries or sites at surfaces and interfaces. Thus, the hydrogen distribution strongly depends on the distribution of these defects. Also, the local stress state influences the distribution of hydrogen and further on, the hydride formation.

Methods are required that allow measuring the local hydrogen concentration, ranging from the nanometer scale to the micrometer scale. Three different methods will be discussed in this presentation: 1) the tomographical atom probe that allows measuring the hydrogen (deuterium) distribution with atomic resolution [1,2], 2) the proton-proton microscopy [3,4] with its ultra-high sensitivity and the hydrogenographical microscopy [5,6] with the largest field of view.

These methods allow a detailed view on local hydrogen concentrations such as those at metal/metal, metal/oxide interfaces or at defects. It will be further shown that hydride formation preferentially happens locally in regions of strong stress-release. The combination of these three methods allows a more detailed view into the hydrogen solution and hydride formation properties of nano-materials.