

NEAR-FIELD OPTICAL MICROSCOPY OF HYDROGEN ABSORPTION AND DESORPTION IN MAGNESIUM-BASED PLASMONIC NANOSTRUCTURES

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Magnesium (Mg) has been widely investigated for solid-state hydrogen storage. It is able to absorb up to 7.6 wt % of hydrogen gas, making it one of the most promising candidates for hydrogen storage and also a model system for other energy storage materials [1]. Upon hydrogenation the metallic Mg forms non-metallic magnesium hydride (MgH_2), thus its electronic and thereby optical properties are drastically altered. Employing the high sensitivity of plasmonic resonances to a change of the local dielectric environment properties, Mg-based plasmonic nanostructures have been recently used to study the dynamics of the hydrogen ab- and desorption [2]. The latter one can be induced by oxygen exposure. This approach also offers new perspectives for active plasmonic metamaterials, as functionalities such as wavelength-selective absorption or optical near-field enhancement can be switched on or off or kept at any intermediate state. Although it beats the diffraction limit, the spatial resolution of this investigation was still limited to the size of the nanostructures. Here, we use the superior resolution of scattering scanning near-field optical microscopy (s-SNOM) to monitor the dynamics of the hydrogen ab- and desorption in Mg-based nanostructures, which is exemplary shown in Fig.1. By an investigation of different plasmonic geometries, which are resonant as well off-resonant relative to the illumination of the s-SNOM, we can study both the change of the local morphology and the plasmonic near-field enhancement. In parallel to the s-SNOM analysis we record the optical far-field spectra of the individual nanostructures by single particle dark-field spectroscopy. Hereby, we can directly compare the change of the morphology, the local composition, and the electronic properties during hydrogen ab- and desorption in Mg.

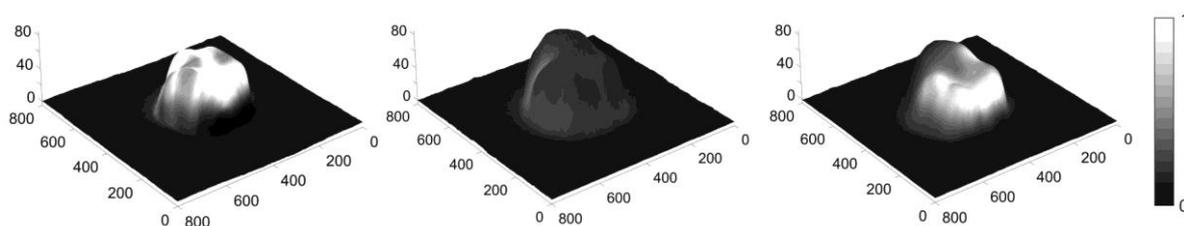


Figure 1: s-SNOM images of a single Mg nanostructure subsequently exposed to H_2 and O_2 , whereby it changes from strongly scattering metallic Mg to weakly scattering dielectric MgH_2 and back to metallic Mg (left to right). Dimensions are depicted in nm. Colorbar: scattering amplitude.

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