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High-Resolution Imaging with Chemical Contrast by Using Hard X-Ray Ptychography

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Summary

Monitoring the chemical state of catalysts on a large range of length scales down to the nanometer scale is crucial to understand and improve their function under realistic working conditions. Ptychographic imaging is reaching unprecedented high spatial resolution better than 10 nm without limitation by pixel or beam size and beam stability. Ptychography is a scanning coherent imaging technique and allows for the unambiguous reconstruction of the complex transmission function, i.e., the absorption and phase shift, of the object by numerical phase retrieval algorithms. We combine hard x-ray ptychography with resonant scattering to determine the elemental distribution of model samples with high spatial resolution. Ptychographic datasets of the sample were recorded for a series of energies around an absorption edge. From these data, the chemical information in form of both an absorption and a resonant scattering spectrum is reconstructed at each location in the sample. In this way we distinguished between two elements - platinum and gold - of a weakly scattering and low absorbing model sample with 20 nm spatial resolution in the phase reconstructions. The maximum resolution depends on the scattering intensity in high scattering angles. To improve the spatial resolution a high incident flux is required. Therefore prefocusing can be used. To increase the accuracy of the phase shift values a better signal-to-noise ratio is achieved by using beamstops. This microscopy approach opens the way to in-situ studies of heterogeneous catalysts on the nanometer scale.

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