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EINLADUNG zum IFP-SEMINAR

Scanning Transmission Electron Microscopy at Atomic Resolution

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Host: Peter Schattschneider

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Seminarraum DC rot 07 (roter Bereich, 7. OG)

Abstract:

Scanning transmission electron microscopy (STEM) has proven to be an indispensable method for mapping the location and identity of atoms in various complex materials. Aberration-corrected STEM images at atomic resolution are now routinely measured using the high-angular annular dark field detector (HAADF). HAADF STEM has tremendous success in the compositional analysis of materials, especially for quantitative mapping of a single heavy element in a lighter element matrix [1].

In the meanwhile it is very well known that atomic-resolution mapping of the individual elements in a material (elemental mapping) can be achieved using either electron energy-loss spectroscopy (EELS) or energy-dispersive X-ray spectroscopy (EDS). Many examples of atomic resolution elemental maps using the STEM have been already published. However, to date these “coloured” maps have only been interpreted qualitatively, due to the elastic, inelastic and thermal scattering of the electron probe, confounding a quantitative analysis.

Therefore we will show how the elemental concentration of individual atomic columns can be explored by using a novel simultaneous EELS and EDS spectrum image acquisition approach with fast scanning rates [2]. “Unit cell counting” was achieved with combining EELS and EDS data with each other and applying the zeta factor method for X-ray quantification [3]. Absolute scale quantification comparisons between experiment and quantum mechanical calculations showed that it is principally possible to determine the number of atoms in the individual atom columns, but only if all scattering effects are fully considered [4,5].

The work presented in this paper will highlight what is actually possible in terms of elemental mapping at atomic resolution. The practical consequences for solving real-world materials problems will be demonstrated through the study of trace elements in aluminium-silicon alloys and the analysis of interfacial chemistry in functional oxides. Finally we will show how electron tomography in the STEM can be used to study the structure and chemistry of individual nanoparticles [6].

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