

- **Materials science session (Auditorium A.01)**

10:30-11:10 Highly efficient phase contrast imaging in STEM with electron ptychography

Tim Pennycook (University of Antwerp)

Radiation damage limits the ability of microscopy to resolve the structure of many types of materials at high resolution. Phase contrast imaging with electrons is recognised as one of the most efficient means of performing low dose imaging at high resolution. Electron ptychography provides a means of efficient phase contrast imaging at atomic resolution in the scanning transmission electron microscope (STEM). The technique relies on the collection of 4D datasets in which the complex details of the scattering of the probe are collected in a 2D image at each probe position in a 2D scan. By performing the Fourier transform with respect to probe position one is able to extract the phase and amplitude of each spatial frequency where the diffracted beam overlaps the direct beam. Using the entirety of these overlap regions one maximizes signal collection while rejecting regions containing only noise, providing phase images with maximal dose efficiency.

11:40-12:00 Investigation of the nanoscale plasticity mechanisms in nanostructured thin metallic glass films using advanced in-situ TEM nanomechanical testing

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Bulk metallic glasses (BMGs) exhibit some outstanding mechanical properties involving high fracture strength, and high elastic strains arising from the liquid-like atomic structure with no grain boundaries, dislocations, and phase segregations, contrary to crystalline materials. However, the early occurrence at room temperature (RT) of shear band instabilities during plastic deformation of BMGs leads to a lack of ductility, thus drastically undercutting potential uses in structural applications. Recent reports have also shown that the brittle-like behaviour is mitigated when the sample size is reduced down to the sub-micron scale with the suppression of catastrophic shear banding. This discovery has opened avenues to study mechanical size effects in thin metallic glass films (TMGFs) with potential impact on a variety of applications in micro-electro-mechanical-systems (MEMS) technology or surface coatings in harsh environments. However, despite extensive research over recent years, the origin of the mechanical size effect in TMGFs is not fully unravelled yet and it can result either from geometric confinement or from a change of atomic arrangement in the films. In the present work, the nanoscale mechanisms controlling the plastic deformation are investigated in CuZr TMGFs exhibiting well-controlled density/chemical heterogeneities at the nanoscale and a high strength/ductility balance. The Local structure of the films is analysed using a new spatially resolved fluctuation electron microscopy (FEM) technique as well as aberration corrected imaging and spectroscopy in TEM. The deformation mechanism are directly analysed by combining FEM and quantitative in-situ nanotensile testing using the Bruker PI 95 TEM PicoIndenter.