

Automated Transmission Electron Microscopy for Particulate Nanomaterials

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Abstract:

The European Commission's recommendation for a definition of a nanomaterial requires the determination of primary particle sizes of the materials under investigation. Electron microscopy is commonly referred to as the confirmatory method for particle size distribution (PSD) determination. However it is also considered labourous, expensive and time consuming analysis method. One of the tasks of the EC funded NanoDefine project was to implement standardized methods for sample preparation and automatized EM image acquisition and analysis of nanoparticles.

The AutoEM-toolbox was written for serial automatic recording of images and coupled with ParticleSizer, enables online segmentation and analysis to obtain PSDs. AutoEM works with JEOL and FEI microscopes; both with TEM and STEM modes. In addition to basic montage imaging of large areas using high magnification, acquisition of elemental resolved PSDs is also possible. Using STEM mode, electron energy loss spectroscopy (EELS) and energy dispersive spectroscopy (EDS) are supported. Using TEM mode, energy filtering (EFTEM) can be used for elementally resolved core loss imaging or thickness mapping, giving access to quasi 3D knowledge of the morphology of the NPs e.g. for plateless. Additionally the end users can implement custom tasks in the acquisition workflow by simple scripting functions.

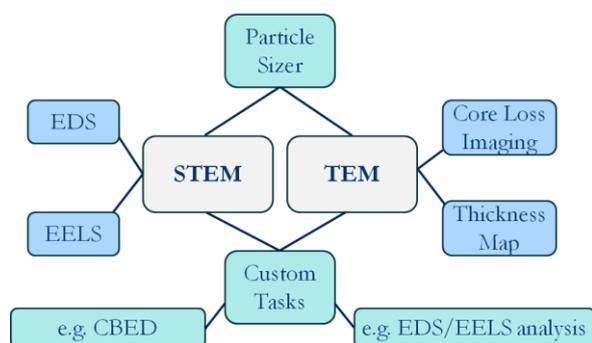


Figure 1: Schematic layout of the AutoEM-toolbox.

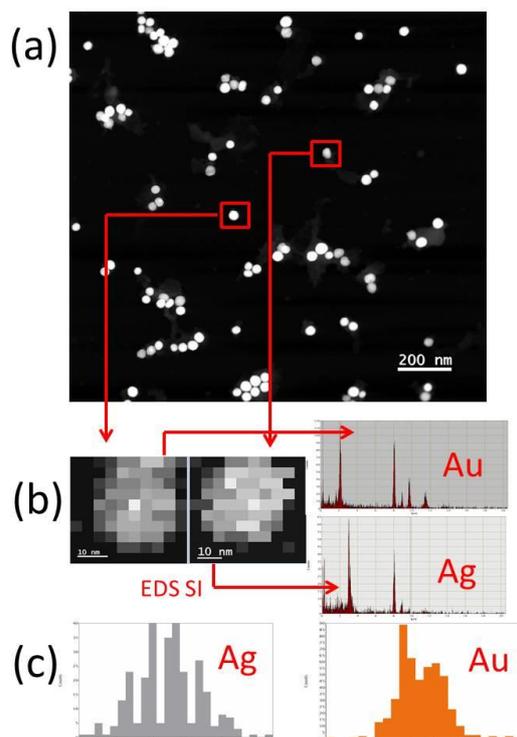


Figure 2: (a) STEM image of Au/Ag nanoparticles. (b) an EDS SI is taken from every particle and the SI is then summed. (c) an elemental resolved PSD is then determined from analysis of the spectra of every particle.

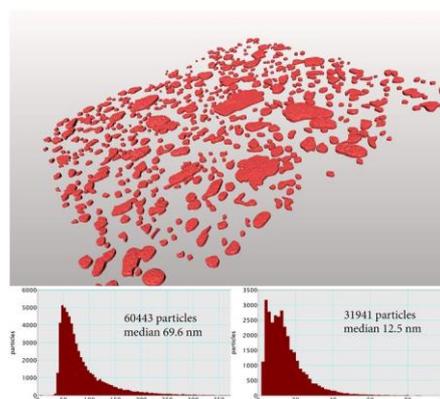


Figure 1: Results of thickness mapping of illite NPs, giving a median of feret min of 69.6 nm in XY direction (normal imaging) and 12.5 nm in Z direction (q3D).