Scanning Transmission Ion Micrsocopy in the Helium Ion Microscope for nanoparticle research

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Studying the interaction of nanoparticles with biological tissue at the nanometer scale in a form as close as possible to the native wet environment is a key challenge in many nano-toxicological questions. The nanomaterial risk identification involves their physico-chemical characterization currently employing a variety of techniques and separate instruments. This makes the characterization an expensive and time-consuming process.

Here, we are developing a new integrated instrument for the ion beam based characterization of nanoparticles. The aim is to improve the efficiency of the nanomaterial characterization workflow by integrating several ion beam based techniques in one single instrument. The npSCOPE instrument is based on the well known Helium Ion Microscope technology [1] combined with cryo capabilities and detectors for secondary electron imaging, a secondary ion mass spectrometer (SIMS) for chemical analysis [2] and a detector allowing the detection of transmitted ions/atoms to obtain in-situ structural/3D visualization data (STIM) [3].

After an introduction to the npSCOPE instrument and its capabilities we will introduce the new STIM detector and present first results obtained with it and other STIM detectors on single and polycrystalline samples as well biological specimen. The latter will focus on different kinds of nanoparticle samples relevant in the field of nano-toxicology.

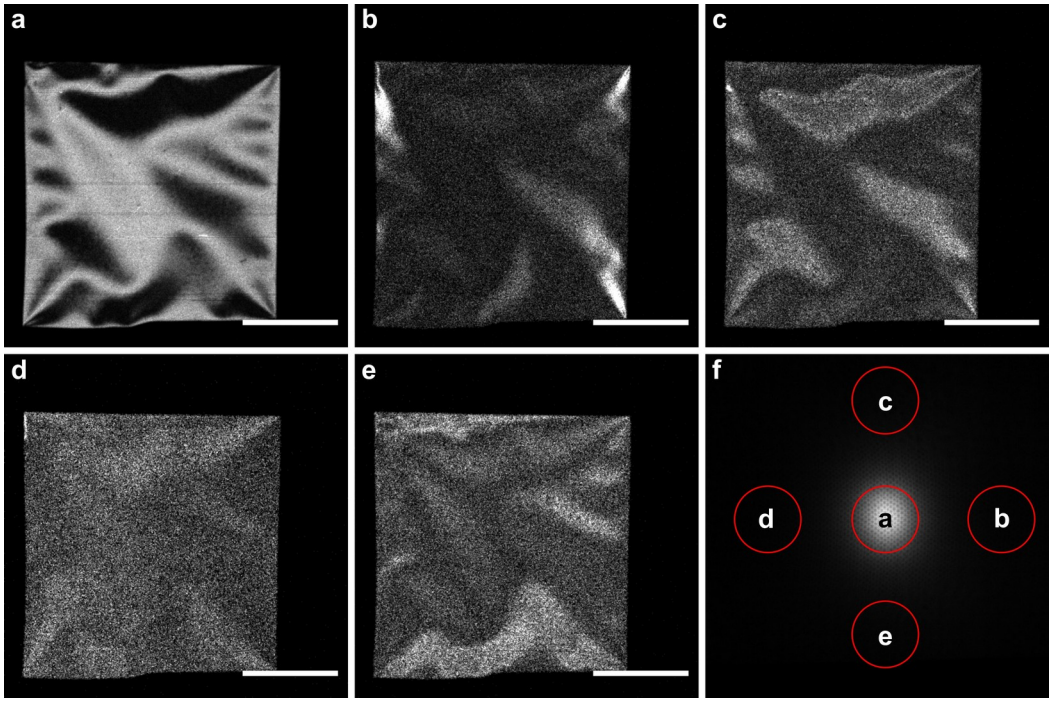

Figure 1: STIM analysis of wrinkled single crystalline Si membrane. The contrast in the selected dark field images is a result of the local tilt of the crystalline membrane.

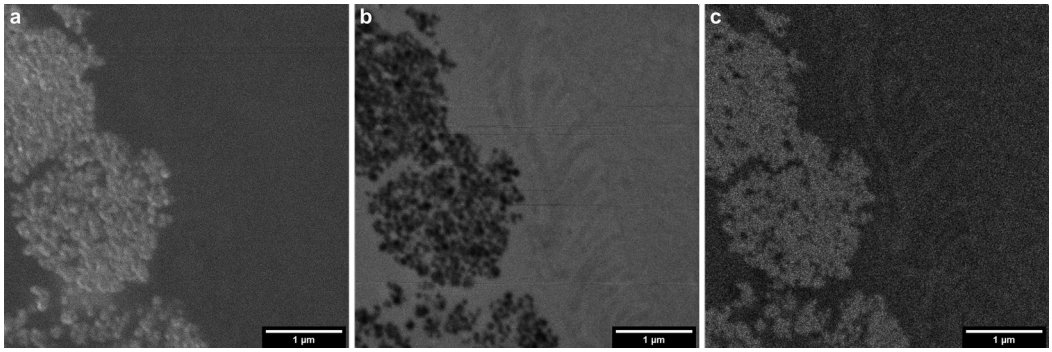

Figure 2: Secondary electron, bright (acceptance angle < 12°) and dark (acceptance angle: 12° - 20°) field image of Daphnia exposed to TiO_2 nanoparticles.

[1] G. Hlawacek, A. Golzhäuser (eds.), Helium Ion Microscopy (2016) Springer.
[2] T. Wirtz, O. De Castro, J.-N. Audinot, P. Philipp, Ann. Rev. Anal. Chem. 12 (2019).
[3] E. Serralta et al., "Scanning transmission imaging in the helium ion microscope using a microchannel plate with a delay line detector," Beilstein Journal of Nanotechnology, vol. 11, pp. 1854–1864, Dec. 2020,

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