Type of presentation: Poster

IT-4-P-2865 Estimation of the resolution in 2D Wet-STEM and Wet-STEM tomography by Monte Carlo simulations

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The microstructural characterization of water-containing materials in conditions closer to their native state is possible through Environmental scanning electron microscopy (ESEM) experiments. Among the possible ESEM imaging modes, Wet-STEM permits to observe nano-objects in suspension in a liquid with a nanometer resolution [1]. This technique is based on STEM (Scanning Transmission Electron Microscopy) configuration in ESEM. In parallel, a device has been developed for the characterization of the 3D structure of non-conductive and low-contrast materials, and it gives a compromise between the resolution level of a few tens of nm and the large tomogram size due to the large thickness of transparency [2]. Very recently, the implementation of a Peltier stage in the tomographic sample holder has enabled the acquisition of image series in wet samples (wet-STEM tomography) [3].
During Wet-STEM experiments, the contrast is influenced by water thickness and the particle size and composition. Furthermore, the thickness of water varies with the tilt angles, which can lead to contrast inversions. When performing Wet-STEM tomography, contrast inversions have to be avoided when tilting the sample since they may lead to reconstruction artifacts.
In the first part of this study, Monte Carlo simulations will be used to calculate the contrast which can be obtained when observing nanoparticles in suspension in water. We will present how the contrast is affected by the position of a Carbon particle, and its dimension compared to the thickness of the water film (see Figure 1). Then, the contrasts in an experimental Wet-STEM image (see Figure 2) and those calculated from Monte Carlo simulations will be compared.
In the second part, the Monte Carlo simulations will be used to define the best suited sample geometry for Wet-STEM tomography experiments. In particular, the conditions to avoid contrast inversion will be defined, and the resolution will be discussed in function of the nanoparticle composition.

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[2] Russias J, J. Am. Ceram. Soc., 91,(2008), 2337-2342. P. Jornsanoh et al., Ultramicroscopy, 111 (2011), 1247-1254.
[3] K. Masenelli-Varlot et al., Microscopy and Microanalysis, 2014. doi:10.1017/S1431927614000105

Acknowledgement: The authors acknowledge the Centre Lyonnais de Microscopie (CLYM) for the access to the microscope, the CSC and Institut Universitaire de France for financial support.

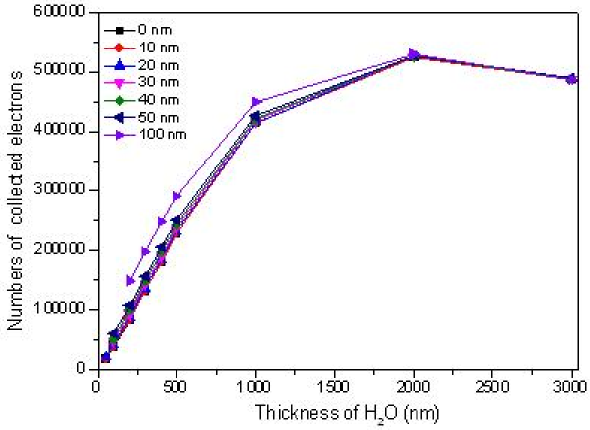

Fig. 1: Numbers of collected electrons for several Carbon particles with different thicknesses of water

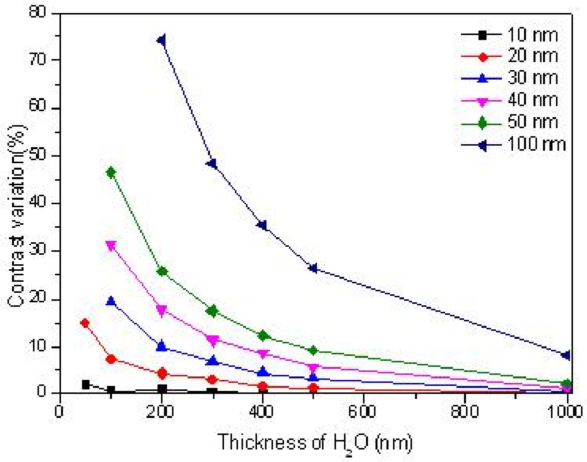

Fig. 2: Contrast variation for several Carbon particles with different thicknesses of water

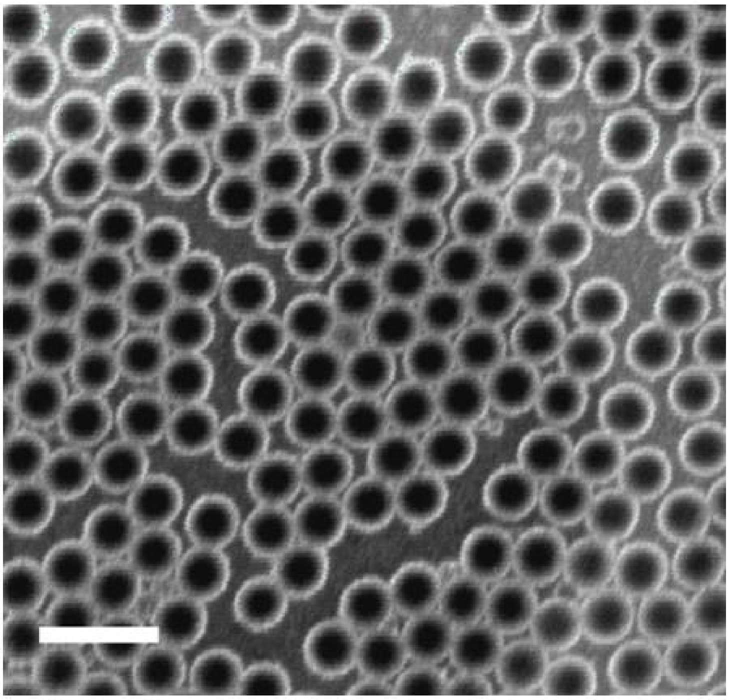

Fig. 3: Experimental Wet-STEM image of a SBA latex suspension – scale bar 500 nm