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MS-7-P-2024 Optimization of electron tomography for the three dimensional study of hybrid nanoparticle assemblies

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Recently, hybrid materials which contain both organic and inorganic components have gained interest due to a broad range of potential applications such as catalysis [1]. The nano-architecture of such self-assembled structures plays a crucial role in the development of tunable systems. In order to understand the structure-property relation, a thorough characterization of the 3D nanoparticle organization is crucial. Conventional transmission electron microscopy only provides 2D projections of a 3D structure which may prohibit an appropriate interpretation of the morphology. This limitation can be overcome by using electron tomography. However, the technique has been used in only a few analyses of hybrid systems [2], [3]. This is related to the fact that both compounds of the hybrid structure require completely different imaging conditions. Electron tomography for inorganic-organic hybrid systems can therefore be considered as challenging. Here, we discuss a dedicated route towards 3D characterization of hybrid structures consisting of Au nanoparticles suspended in a flexible polymeric matrix.

The preparation method of the TEM sample for electron tomography studies of nanoassemblies is of crucial importance when investigating the 3D arrangement of nanoparticles in a nano-assembly. The native structure of the nanoassembly, as present in the solution, should be maintained. The conventional approach of drying the sample on a carbon coated TEM grid will alter the morphology of the structures. Plunge-freezing results in instantaneously embedding the nanostructures in a thin layer of vitreous ice. The structure is maintained, but the sensitivity of the specimen to the electron beam presents the limiting factor in cryotomography, therefore the images are acquired at a low dose mode [4]. As a result, the reconstructions suffer from several artifacts caused by low-SNR of the projection images as well as the presence of diffraction contrast in the projection images. Therefore, we propose to freeze-dry the samples after vitrification, where low pressure ensures sublimation of the ice into the gaseous phase. The native 3D structure is preserved and by using HAADF-STEM tomography diffraction contrast is avoided. In this manner an accurate 3D reconstruction of the hybrid nanoassemblies is obtained.

[1] C. J. Newcomb, et al.,” Curr. Opin. Colloid Interface Sci., vol. 17, no. 6, pp. 350–359, 2012.

[2] T. Altantzis,et al., Part. Part. Syst. Charact., vol. 30, no. 1, pp. 84–88, 2013.

[3] M. Grzelczak, et al., Nano Lett., vol. 12, no. 8, pp. 4380–4384, 2012.

[4] A. Koster and M. Bárcena, Electron Tomography SE - 5, J. Frank, Ed. Springer New York, 2006, pp. 113–161.

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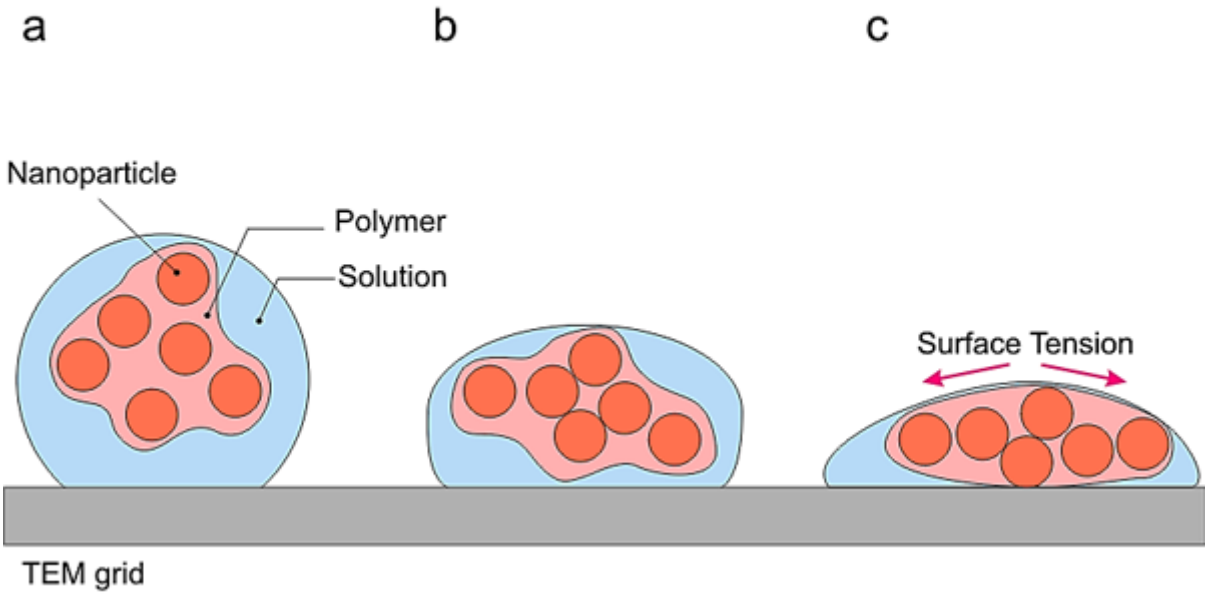

Fig. 1: (a) A droplet of suspension is deposted on a TEM support grid, (b) as a consequence of the behaviour on a hydrophilic surface; the solution tries to extend upon the surface, (c) the soft polymer is absorbed towards the grid upon surface tension effects.

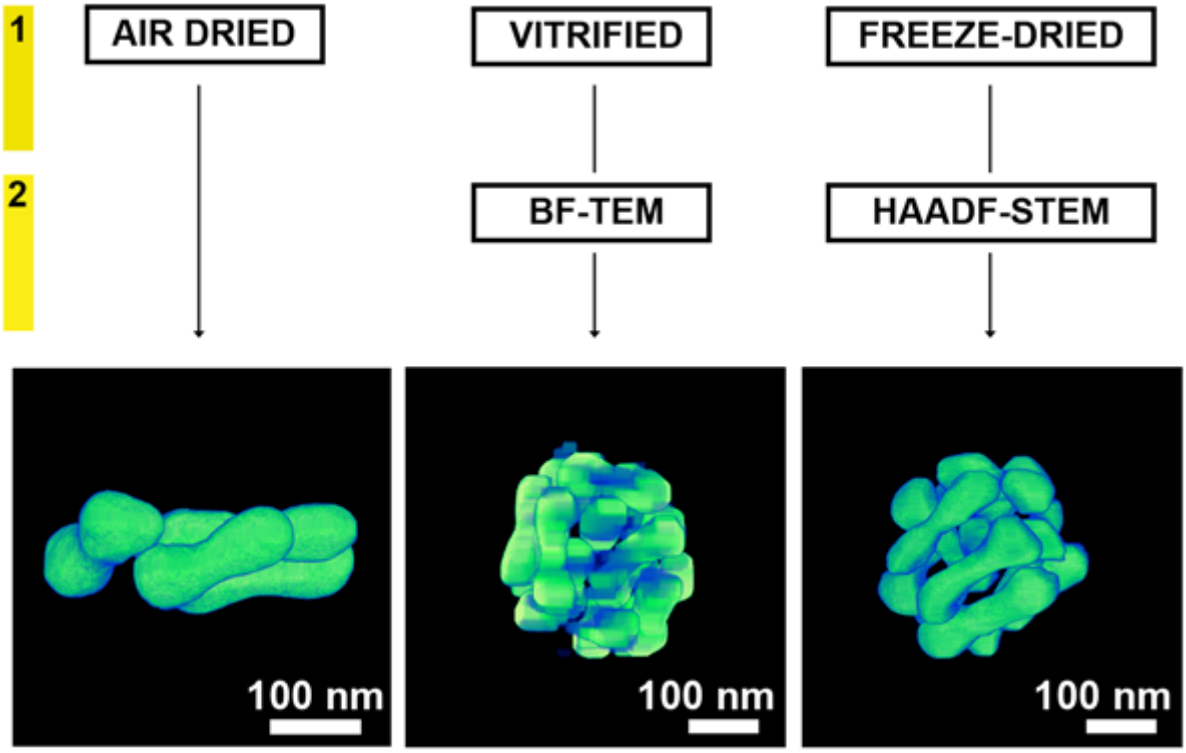

Fig. 2: A schematic overview of the optimized route for the 3D characterization of nanodumbbells in an assembly.