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In-situ Nucleation and Growth of Protein-Templated Magnetic Nanoparticles

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Transmission electron microscopy with the continuous flow Liquid cell TEM holder platform permits observation of dynamic nucleation and particle growth events in real time. Acidic recombinant proteins, Mms6 and Mms13, have been used for the biomimetic templated synthesis of the uniform magnetic nanoparticles, with the carboxyl- and hydroxyl- rich hydrophilic C-termini of these proteins enabling efficient iron binding. This type of synthetic approach provides a controlled nucleation and growth of the nanoparticles while permitting a better control over size, shape and orientation of the resultant magnetic nanocrystals. In this work we will report the effect of protein on the morphology and shape of resultant biomimetic magnetic nanoparticle. The *in-situ* experiments were carried out by utilizing the continuous flow liquid cell TEM holder platform and vapor delivery system. The *in-situ* results are compared to those obtained on the conventional TEM support grids *ex-situ*. Figure 1 shows the TEM micrographs obtained on protein-rich area of the specimen. Two different behaviors of as-formed iron oxide nanoparticles are discussed. The coalescence-induced crystallization under electron beam in observed in the areas corresponding to high concentration of nanoparticles. In a contrast, nanoparticles in diluted regions of the specimens remain in persistent amorphous sate, despite extensive exposure to the electron beam, as shown in Figure 2.

Reference

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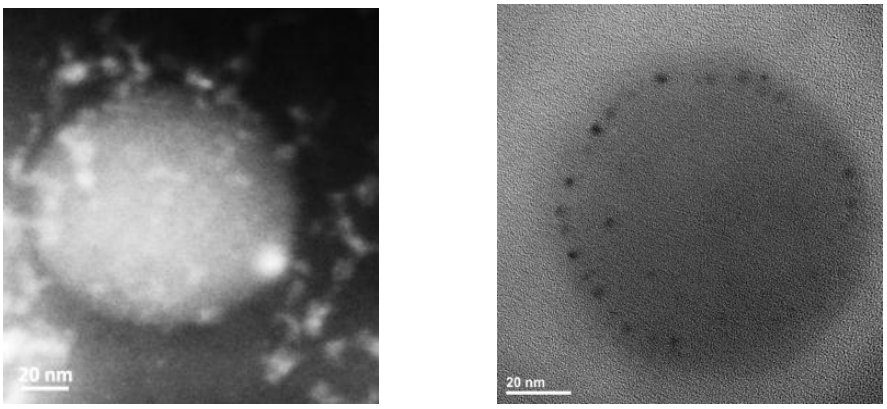
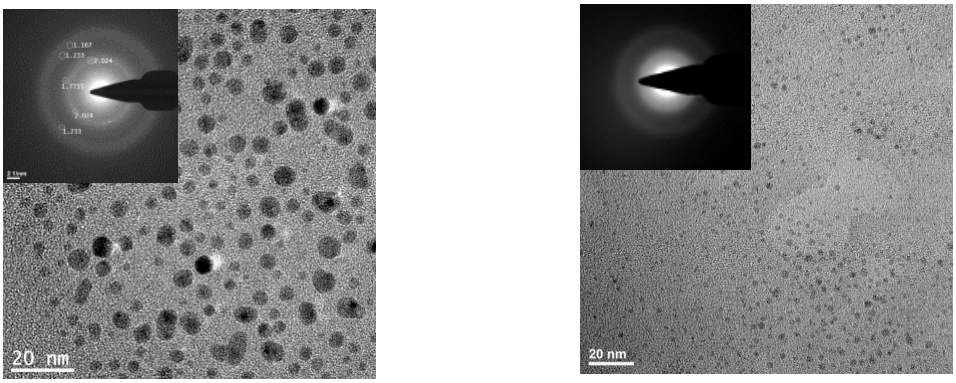


(a) (b)

Figure 1. (a) HAADF TEM image of iron-incubated Mms6 micelle; (b) Bright-field TEM image of maghemite nanoparticles (γ-Fe_2O_3) formed on the surface of protein micelle.



(a) (b)

Figure 2. (a) Coalescence-induced crystallization of iron oxide nanoparticles under the electron beam: Selected Area Electron Diffraction (SAED) pattern (inset) indicates formation of γ-Fe_2O_3; (b) iron nanoparticles in dilute area remain amorphous despite their prolonged exposure to the electron beam, as confirmed by the SAED pattern.

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