Lipid and Janus Nanoparticles for Active Delivery

The following synthesis is based on the paper „Production of large quantities of „Janus“ nanoparticles using wax-in-water emulsions“ published by Ravaine et al.[1]

Experimental

Synthesis of silica particles

45 mL ethanol (EtOH), 5 mL tetraethyl orthosilicate (TEOS) and 5 mL NH_4OH were added in a flask, stirred and heated at 40 °C for 6 h. Afterwards the product was centrifugated, decanted and the solid washed with EtOH several times and dried by 40 °C.

The particles were analysed by TEM (Transmission Electron Microscopy) and their hydrophilicity was tested by a dichloromethane (DCM)-water dual-phase-system.

Synthesis of Janus-Nanoparticles

In two beakers, 0.2 g of the synthesized silica particles were added to a solution of ethanol/water (6.7 % w/w, 100 mL), stirred and heated at 65 °C. To the suspensions were added 0.0220 g (Sample 1) or 0.0302 g (Sample 2) of cetyltrimethylammonium bromide (CTAB), respectively, and afterwards 6.682 g (for Sample 1) and 6.698 g (for Sample 2) of paraffin. After the paraffin was melted, the mixture was submitted to vigorous stirring by means of a homogenizer by 10000 rpm for 90 s. The emulsions were allowed to cool down to room temperature over night in order to get solid droplets of paraffin wax. For functionalization of the particles two solutions of 8 mL EtOH and NH_4OH (7 % v/v) with 2.1 mL aminopropyltriethoxysilane (APTES) were prepared and added to both emulsions. After 12 h the solid wax droplets were filtrated, washed 3 times with ethanol, dissolved in DCM and heated till the wax was melted. The mixture was filtrated to receive the Janus particles as a white-beige powder (Samples 1 and 2).

Functionalization with gold particles

To prove the correctness of the procedure and as a result the existence of Janus particles, the particles, in a solution of 0.2 mL of water and ethanol (8:2), were mixed with 0.2 mL of a gold nanoparticle[2] (stabilized by citrate) suspension.

The samples were analyzed by TEM.

Results

Silica particles

The synthesized silica particles exhibit a diameter of 100 nm, which can be seen in the following pictures (Fig. 1).

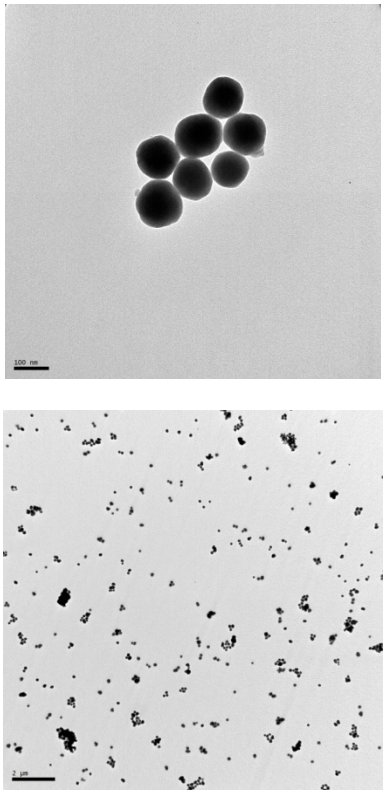

Fig. 1: TEM images of silica particles.

It could be shown that the silica particles stayed in the water-phase in the DCM-water dual-phase-system, which shows that the synthesized particles are hydrophilic and not hydrophobic.

Janus-Nanoparticles functionalized with gold particles

It can be seen that in both samples (Samples 1 and 2, Fig. 2) the gold particles were bound to the functionalized silica particles, whereas sample 2 looks like a Janus particle (Fig. 2, right side). Unfortunately, in both cases the distribution of the gold particles is not very homogeneous and dense like it could be shown in the literature.[1], [2]

Because the TEM samples were not completely dry, water can be seen in form of shadows around the particles.

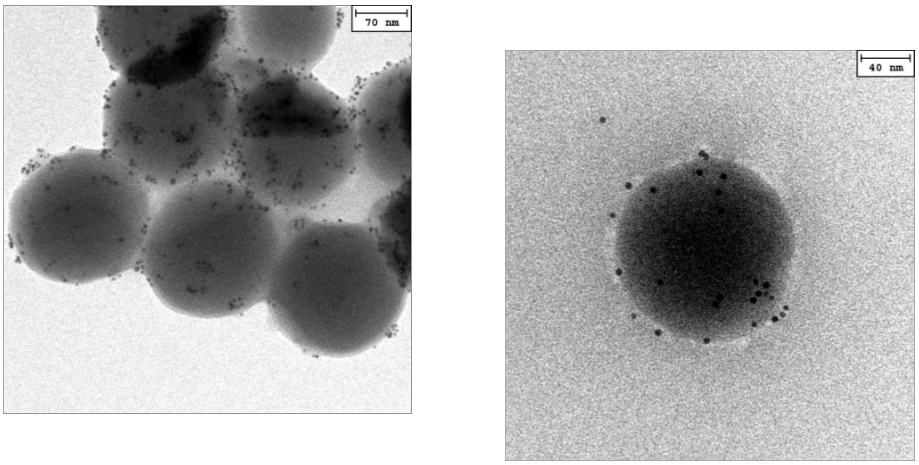

Fig. 2: TEM images of Janus particles functionalized with gold particles. On the left side: Sample 1. On the right side: Sample 2.

Literature

[1] A. Perro, F. Meunier, V. Schmitt, S. Ravaine, , Production of large quantities of „Janus“ nanoparticles using wax-in-water emulsions, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, **2009**, *332*, 57-62.

[2] S. L. Westcott, S. J. Oldenburg, T. R. Lee, N. J. Halas, Formation and Adsorption of Clusters of Gold Nanoparticles onto functionalized silica nanoparticle surfaces, *American Chemical Society*, **1998**, *14*, 5396-5401.

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