Type of presentation: Poster

**MS-1-P-1537 Characterization of silica-coated Au/Fe₂O₃ nanoaggregates**

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The plasmonic characteristics of metals like Au or Ag dramatically change with particle size. The increased light absorption of nanoparticles (NPs) moreover depends on the wavelength and is maximized when the electrons in the conduction band are in their resonance state. Relaxation processes turn this oscillation energy into phonons, with an efficiency that depends on various parameters such as the particle size, shape and aggregation [1]. The thereby generated heat can be utilized for various applications, including cancer treatment. If Au NPs are selectively taken up by cancer cells, they can be activated photothermally by laser irradiation and the resulting heat can destroy these cells [2]. Here we report on the electron microscopy characterization of hybrid agglomerates (50 - 100 nm in diameter) consisting of SiO₂-coated Fe₂O₃ and Au nanoparticles that show promising plasmonic and superparamagnetic properties [3]. This hybrid material was synthesized by enclosed flame spray pyrolysis, a very flexible and scalable technology [4].

TEM images (Figure 1) confirm that the Au/Fe₂O₃ NPs are indeed coated by an amorphous SiO₂ shell which is ca. 2.5 nm thick here. The dark disks correspond to Au NPs with diameters between 10 – 40 nm, while the Fe₂O₃ NPs appear gray similar to the silica layer which encloses both types of NPs. The crystalline Au and Fe₂O₃ NPs furthermore show some lattice planes. STEM is employed for detailed characterization of these aggregates (Figure 2). In the HAADF-STEM (Z contrast) image, bright disks correspond to the Au NPs whereas faint gray areas indicate the presence of the less heavy scatterers (i.e., Fe₂O₃ and SiO₂), as additionally confirmed by EDXS analysis of small areas (Figure 3a) and EDXS mapping (Figure 3b,c). Note that the crystalline Fe₂O₃ NPs are also detectable as areas showing lattice fringes in the PC-STEM image (Figure 2b) [5].

These results reveal that the Au and Fe₂O₃ NPs are predominantly located next to each other forming Janus- or dumbbell-like nanoaggregates and that they are encapsulates by SiO₂. The comprehensive characterization of the aggregates is important as the distance between the Au NPs determines the plasmonic interparticle coupling and this distance can be finely tuned by closely controlling the SiO₂ shell thickness [3].


Acknowledgement: Electron microscopy was performed at the electron microscopy center of ETH Zurich (ScopeM).
Fig. 1: TEM images of silica-coated Au-Fe$_2$O$_3$ aggregates revealing the coating of the Au and Fe$_2$O$_3$ NPs by an amorphous silica layer (microscope: Tecnai F30 (FEI), FEG, operated at 300 kV).

Fig. 2: HAADF-STEM (Z contrast) (a) and PC-STEM (phase-contrast) (b) images of the silica-coated Au-Fe$_2$O$_3$ aggregates (microscope: HD2700CS (Hitachi) with probe corrector (CEOS), cold FEG, operated at 200 kV).

Fig. 3: HAADF-STEM images (a,b) with the results of EDXS measurements of the indicated areas in (a) and EDXS elemental mapping (c) of (b). Au: green; Fe: blue; Si: red. (microscope: HD2700CS (Hitachi) with EDX spectrometer (EDAX Gemini system)).