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Impact of ethylenediaminetetraacetate ligands on CdS nanoparticle formation mechanism

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Organic ligands are commonly employed to stabilize nanoparticle sizes, shapes and long-term colloidal stability in dispersions. For Cadmium chalcogenides, ethylenediaminetetraacetate (EDTA) seems a good candidate due to its strong chelating action towards Cd2+. Further, EDTA-capped CdS nanoparticles were proven to be stable in aqueous dispersion at room temperature over months.[1,2]
Without ligands, the CdS nanoparticles nucleate via a two-step formation mechanism involving Cd13S4(SH)18 precursor particles and a diffusion-driven growth process to ca. 5 nm particles within 2.5 ms.[3] Yet, up to now no mechanistic insight into the CdS particle formation in presence of EDTA has been provided.
Here we evidence the formation of ca. 5 nm sized EDTA-capped CdS particles from CdCl2/EDTA and Na2S stock solutions with SANS and laboratory SAXS. The mixing speed and / or solvent (H2O / D2O) seem to impact the particle diameter. Contrast matching in SANS not only accesses the ligand shell, but also reveals an unexpected superstructure formation on a time scale of hours. pH-dependent studies and multinuclear and multidimensional solid-state NMR spectroscopy complement insight into the EDTA binding.[4]

[1] G. H. Reed, et al, Inorg. Chem. 1971, 10
[2] A. A. Rempel, et al, Russ. Chem. Bull. 2013, 62, 398
[3] A. Schiener, et al, Nanoscale 2015, 7, 11328
[4] S. W. Krauss, et al, in preparation

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