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Building up Crystals from Nanoparticles: Structure and Morphogenesis of Mesocrystals

ELENA STURM

Ludwig-Maximilians-Universität München

Presenting Author: sturm.elena@lmu.de

The self-assembly of monodisperse anisotropic nanocrystals (stabilized by organic molecules) allows to generate mesocrystalline materials which fulfil the criteria of crystalline material on two length scales: ordered superlattice (colloidal crystal) together with specific crystallographic orientation of the crystalline building blocks.[1] The mesocrystalline structure transposes nanoparticle properties to mesoscopic length scales and results in a complex structure-property relationship. Our recent examples include the synthesis and detailed structural characterization of such iron oxide and noble metal nanoparticles based self-assembled mesocrystals.[2, 3] The approach we are using in our study aims to determine the structure of mesocrystals incl. the translational and orientational order of nanocrystals within the superlattice (by means of different electron microscopy and X-ray diffraction techniques) as well as to examine the effect of synthesis conditions on the assembly process and especially on the formation of 3D faceted mesocrystals.[3, 4] Furthermore, we are also able to resolve the structural defects generated within the superlattice during the self-assembly process and growth of faceted mesocrystals.[3]

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[3] Carnis, Kirner, Lapkin, Sturm, Kim, Baburin, Khubbutdinov, Ignatenko, Iashina, Mistonov, Steegemans, Wieck, Gemming, Lubk, Lazarev, Sprung, Vartaniants & Sturm, (2021) Nanoscale 13 (23), 10425-10435.

[4] Chumakova, Steegemans, Baburin, Mistonov, Dubitskiy, Schlotheuber, Kirner, Sturm, Lubk, Müller-Caspary, Wimmer, Fonin, Sturm & Bosak, (2023) Advanced Materials 35, 2207130.