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Nonclassical Crystallization

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Nonclassical particle mediated crystallization has been found to be a relevant alternative crystallization pathway to classical atom/ion/molecule-based crystallization. Nonclassical crystallization can involve clusters, liquid or amorphous precursors or nanoparticle building units, which allow for the realization of different crystallization scenarios. Mesocrystals, built from iso-oriented nanocrystals are a relevant intermediate. Magnetite mesocrystals will be demonstrated as intermediate to single crystals, which can form by oriented attachment involving crystallographic fusion of the iso-oriented nanoparticles.

Nonclassical crystallization also seems to play a role in Biomineralization since mesocrystalline structures as well as amorphous precursor particles have been identified in several Biominerals and liquid precursors are discussed for their formation. For the example of the SM50 protein from a sea urchin, it will be shown how a protein can control the nonclassical crystallization process of $CaCO_3$. SM50 stabilizes amorphous $CaCO_3$ (ACC) in vesicles just like the ones found in sea urchins to transport ACC to the developing site of the spicule. Upon enzymatic cleavage of the protein, a protein domain is generated, which controls the crystallization of the ACC nanoparticles to mesocrystals. This is the structure found in spicules of the sea urchin. This close analogy to the $CaCO_3$ forms found in the living sea urchin demonstrates, how a nonclassical crystallization event can be controlled and triggered by proteins.