IMPRS on Multiscale Biosystems

Project description

Title: Polymer nanoparticle templates for calcium phosphate mineralization
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In collaboration with: Prof. Andreas Taubert, Institute of Chemistry, University of Potsdam

Project description: The project focuses on the synthesis of various block copolymer nanoparticles and the influence of their charge and morphology on crystallization of biologically relevant minerals. The main goal is to establish a polymer nanoparticle platform enabling the investigation of a number of physico-chemical parameters such as charge density in the polmyer particles (uncharged vs. highly charged) or type of charge (negative vs. neutral vs. positive) on calcium phosphate formation from aqueous solution. Calcium phosphate is one of the most important biominerals and has been studied, for example, for bone and dental repair. In spite of the many synthetic protocols available for the synthesis of biomimetic calcium phosphate hybrid materials, the nucleation and growth mechanisms, and (crystal) phase selection rules are largely unclear except for general concepts. We have previously shown that polymer surfaces drastically affect the outcome of calcium phosphate mineralization (Figure 1), but there are essentially no data on how polymer nanoparticles with a defined chemical composition and hence defined physical properties interact with the precursor ions, the growing calcium phosphate minerals and how nucleation and growth can be influenced. It has recently also been shown that block copolymer nanoparticles can withstand high ionic strength and that counter ions and co-ions of foreign salts are incorporated in the diffuse electrical double layer as prerequisite for subsequent mineralization under modified solubility conditions [Weber et al., Macromol. Chem. Phys. 2011, 212, 2071]. The current project therefore focuses on how calcium and phosphate ions interact with polymer nanoparticles with defined size, size distribution, charge, charge density, and charge position to elucidate the questions outlined above.

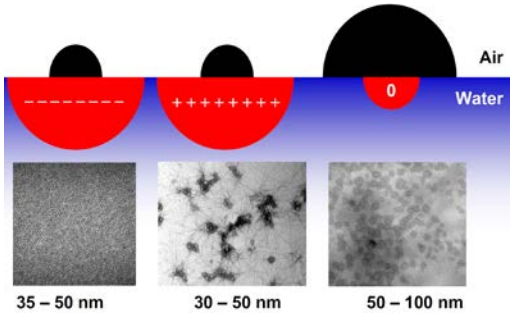

Figure 1. Effect of template charge on calcium phosphate formation beneath amphiphilic block copolymer films at the air-water interface. Data from:
(1) Casse et al., Faraday Discuss., 2008, 139, 179.
(2) Junginger et al. Nanoscale, 2010, 2, 2440.
(3) Junginger et al., Macromol. Biosci. 2010, 10 (9), 1084.

Required background: Degree in chemistry or materials science. Experience in synthetic and macromolecular chemistry, and interest in polymer synthesis, biomineralization, and crystallization are required. Experience in emulsion polymerization, electron microscopy, X-ray and scattering methods would be an asset, but is not mandatory.

Paper to read before the interview: The principle of block copolymer formation via heterophase polymerization: Macromolecules 2000, 33, 4986-4988. Further literature is available upon request.

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