Seminarankündigung

Dienstag, 03. Juli 2012
17:15 Uhr

ZNN, Seminarraum EG 0.001

“Biological processing and chemical nano-structure of biominerals”

Biomineralization, i.e. the formation of hard tissues such as bones and teeth, is a bottom-up synthetic process that results in the formation of inorganic/organic nano-composites with unrivalled control over hierarchical structure and mechanical properties. Biominerals frequently display adaptive response and the capability of self-repair, yet their design principles and processing remain poorly understood. Proteins and other macromolecules occluded in the mineral are part of the so-called organic matrix that mediates biological control over mineral polymorph, shape, and materials properties. Three-dimensional mineral-matrix interfaces with a roughness at the nanometer length scale are very challenging to investigate by conventional electron microscopy and scattering techniques. In biological samples, this is exacerbated by the presence of multiple chemical species, some of which occur at low abundance, and low atomic number (*Z*) molecules or ions that are notoriously hard to detect, visualize, and quantify. We will demonstrate that atom probe tomography (APT), an imaging mass spectrometry technique of unrivalled spatial resolution (<0.2 nm) and chemical sensitivity, allows us to dramatically improve our understanding of the complex chemistry and structure of nano-scale organic/inorganic interfaces in the ultrahard biomagnetite tooth cusp of the invertebrate chiton. In vertebrate tooth enamel, APT reveals segregation of magnesium and residual organics at hydroxylapatite grain boundaries and possibly the formation of interphases.

While APT imaging greatly improves our ability to design bio-inspired routes to hierarchical materials *de novo*, we believe that direct engineering of the biosynthetic machinery may offer an alternative route to adaptive/self-healing materials. We have demonstrated, for example, that micro-patterned cell culture surfaces allow us to control the cooperative growth of oriented, smooth, cylindrical calcite single crystals by sea urchin primary mesenchyme cells (PMC) many times larger than individual cells. We report here that the use of a growth factor endogenous to the sea urchin embryo, VEGF, greatly improves our ability to control the bottom-up synthesis of single crystals. In fact, VEGF induces not only a change in crystal shape, from linear rod to triradiate, but also switches the crystal growth direction from parallel to the *c*-axis to the *a*-axes.

How cells achieve this type of crystal growth control is an open question. In a reductionist approach, we are investigating how confinment in atto-to-femtoliter sized cellular compartments affects basic mechanisms of nucleation and growth. We report here on the synthesis and surprising stabilization of an important precursor material, amorphous calcium carbonate (ACC) nanoparticles, in liposomes. Finally, we will discuss fusing and/or patterning of ACC-contining liposomes as a model system for PMC-mediated crystal growth.

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