5. Workshop Projekthaus NanoBioMater

Sprecher: Prof. Dr. Sabine Laschat, Prof. Dr. Thomas Hirth, **Koordinatoren:** Prof. Dr. Christina Wege, Prof. Dr. Günter Tovar,
Leitungsgremium: Prof. Dr. Joachim Bill, Prof. Dr. Franz Brümmer, Prof. Dr. Holger Jeske, Prof. Dr. Sabine Ludwigs, Prof. Dr. Bernhard Hauer
Teamleiter: Dr. Alexander Southan, Dr. Sabine Eiben, Dr. Dirk Rothenstein

Datum: 8. Oktober 2015
Uhrzeit: 10:30 – 13:20 Uhr
Raum: Raum 6AB am Fraunhofer IGB, Nobelstr. 12, 70569 Stuttgart – B-Gebäude 6.OG

Programm

10:30 – 10:40 Uhr **Begrüßung**
Prof. Dr. Christina Wege und Prof. Dr. Günter Tovar
Koordinatoren des Projekthauses NanoBioMater

10:40 – 11:00 Uhr **Multilayered hierarchical arrangements of M13 bacteriophages and ZnO**
Stefan Kilper
Institut für Materialwissenschaft
Universität Stuttgart

11:00 – 11:20 Uhr **Synthesis and characterization of poly(ethylene glycol) diacrylate hydrogels for 3D printing**
Felix Markus
Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie
Universität Stuttgart

11:20 – 11:45 Uhr **Biomineralization of luminescent and zinc-containing inorganic materials by living microalgae**
Dr. Giulia Santomauro
Institut für Materialwissenschaft
Universität Stuttgart

11:45 – 13:00 Uhr **Poster session & Lunch**

13:00 – 13:20 Uhr **Progress in NanoBioMater**
Dr. Dirk Rothenstein, Dr. Sabine Eiben, Dr. Alexander Southan
Projekthaus NanoBioMater

Multilayered hierarchical arrangements of M13 bacteriophages and ZnO

Stefan Kilper[1]

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Inspired by the structure of natural nacre, we fabricate a multilayered material with alternating layers of M13 bacteriophages and zinc oxide. Uniform layers are produced by using convective assembly and subsequent chemical bath deposition. Nanoindentation experiments provide the mechanical properties, e.g. Young's modulus and hardness.

Synthesis and characterization of poly(ethylene glycol) diacrylate hydrogels for 3D printing

Felix Markus[1]

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For the preparation of hydrogels with defined properties by 3D dispensing, hydrogel inks have to be specifically engineered in order to fulfil the requirements defined by the processing technique. In this study, the physical properties after chemical cross-linking of hydrogels inks based on poly(ethylene glycol) diacrylate suitable for 3D dispensing were characterized. It was found that the hydrogel properties followed the same trends compared to similar hydrogels which did not contain the additives necessary for 3D dispensing. The results suggest that the hydrogels inks are suitable for 3D dispensed hydrogels with defined properties.

Biomineralization of luminescent and zinc-containing inorganic materials by living microalgae

G. Santomauro[1], J. Baier[1], W. Huang[1], S. Pezold[1], V. Srot[2], B. Bussmann[2], P. A. van Aken[2], F. Brümmer[3], H. Strunk[1] and J. Bill[1]

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Living microorganisms are able to generate inorganic materials of well-defined shapes through the process of biomineralization. Due to the genetic control of biomineralization, the organisms react to a certain environment always in the same way, resulting in homogenous shapes and structures. We have been using these mechanisms for the incorporation of non-biogenic elements in inorganic solids. In this contribution, we will give an overview of our recent research using two different algae species for the production of inorganic materials containing zinc or terbium.

First, the detoxification mechanism of the green unicellular alga Scenedesmus obliquus was used to generate zinc-phosphate-based nano needles. The algae were incubated in culture media with sublethal zinc concentrations. The obtained material has been investigated by scanning transmission electron microscopy (STEM) imaging combined with analytical X-ray energy-dispersive spectroscopy (XEDS) and fluorescence microscopy. Our findings indicate that the algae use polyphosphate bodies for the detoxification of the zinc ions, leading to the generation of intracellular zinc-phosphate-based nano needles. Furthermore, we could show that the zinc treated living cells are fluorescent. This is the first proof of a structured zinc-phosphate-based nano material produced by the process of biomineralization in living algae. This new experimental protocol can be applied also for the incorporation of other elements.

In the second experimental setup we could show that the presence of S. obliquus cells had a great influence on the extracellular precipitation of CaCO3 polymorphs. Without zinc and algae, calcite is formed. The cells promote by biologically induced mineralization the production of aragonite, which is enhanced by the presence of zinc ions in the media.

Furthermore, the intracellular biomineralization mechanism of another algal species, the unicellular marine alga Emiliania huxleyi was used to generate coccoliths containing terbium. This species produces elaborated calcite plates called coccoliths inside their cells. The algae were incubated in terbium containing media. The resulting coccoliths were analyzed chemically using ICP-OES. We could show that the Tb/Ca ratio in the coccoliths is positively correlated to the ratio in the media. The new, terbium containing coccoliths were also

analyzed via photoluminescence spectrometry and showed characteristic green luminescence belonging to the terbium spectrum. Thus the E. huxleyi cells incorporated terbium in their coccoliths producing luminescent material.

References: G. Santomauro, V. Srot, B. Bussmann, P. A. van Aken, F. Brümmer, H. Strunk and J. Bill. Biomineralization of zinc-phosphate-based nano needles by living microalgae. *Journal of Biomaterials and Nanobiotechnology, 3, 362 (2012)*.

G. Santomauro, J. Baier, W. Huang, S. Pezold and J. Bill, Formation of calcium carbonate polymorphs induced by living microalgae, *Journal of Biomaterials and Nanobiotechnology, 3 (4), 413-420 (2012*).