Bio-Inspired Organic-Inorganic Hybrid Materials

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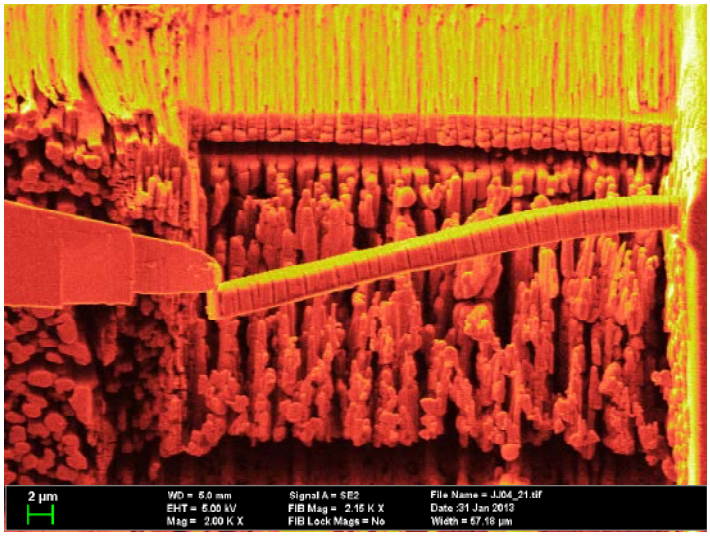
Biominerals teach excellent lessons about advanced materials design. Their structural design is optimized for the specific materials purpose and often, the beneficial properties are generated on several hierarchy levels. Consequently, Biominerals are an intense subject of research to reveal the design principles. This led to the discovery of amorphous or even liquid precursors to single crystals in Biomineralization and additive controlled crystallization events. Non classical particle mediated crystallization pathways were found to be important besides the classical crystallization path.

This presentation begins with self-assembled hierarchical layered materials from anisotropic nanoparticles aligned by modified self-assembling polyoxazoline polymers with mesogens forming liquid crystals as driving force towards crystallization. Furthermore, an attempt towards combination of several advantageous biomineral properties, namely the fracture resistance of Nacre, the wear resistance of chiton teeth and the magnetic properties of magnetotactic bacteria will be reported. The third example is bio-inspired elastic cement synthesized via a non-classical crystallization pathway. Calcium-silicate-hydrate (C-S-H) nanoparticles, the glue in concrete, are stabilized by copolymers with anionic groups and moieties able to form hydrogen bonds. These polymers bind to C-S-H nanoparticles at pH 12 and stabilize them. Further pH increase leads to destabilization and subsequent nanoparticle aggregation in crystallographic register forming a mesocrystal with a similar structure to a sea urchin spine. This mesocrystal is elastic and can be bent without breaking. This is a further demonstration that bio-inspired synthesis and structuration of organic-inorganic hybrid materials can lead to significant materials improvement – even for the most used synthetic material.



Bending by micromanipulation of bio-inspired mesocrystalline elastic cement.