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Organic-inorganic templates in biomineralization of shells, bone, teeth, and bacterial biofilms

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Recent experiments with the Spectromicroscope for PHotoelectron Imaging of Nanostructure with X-rays (SPHINX)[1] on the biofilm formed by Fe-oxidizing bacteria in fresh, ground water, demonstrated that microbially extruded polysaccharide filaments provide the precipitation site for amorphous FeOOH filaments [2]. Upon aging the mineralized filaments crystallize to ferrihydrite (2-line FeOOH), with one curved pseudo-single crystal of akaganeite β-FeOOH), at the core of each filament. The crystals are only 2 nm wide and up to 10 micron long (aspect ratio 1:1000:1), and their structure and morphology is unprecedented. Furthermore, akaganeite should not form in fresh water, therefore a templation mechanism was hypothesized, and supported by SPHINX analysis of carbon XANES. The results indicate that after formation of the crystal fiber, the polysaccharide structure is also altered, and C1s spectra suggest that the COO^- group is involved in the templation mechanism. This was the first successful attempt to understand the organic-inorganic chemical interface in a biomineralized system. Many more templated biomineral systems can and will now be analyzed with this new approach.

1. Ultramicroscopy **99**, 87-94 (2004).

2. Science **303**, 1656-1658 (2004).