

Lectures in Chemical and Biological Engineering

Imaging Buried Organic-Inorganic Interfaces in a Biological Composite Using Atom Probe Tomography



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Biological organisms have a remarkable ability to control the structure and properties of inorganic minerals across a wide range of length scales from single nanometers to the macroscale. In many cases, an organic matrix comprised of a variety of macromolecules interacting with the forming mineral is responsible for this control. For example, in the tooth of the chiton, the polysaccharide chitin, along with a number of proteins, has been shown to control and template the deposition of magnetite (Fe_3O_4) and their maturation to magnetite under very mild conditions. Furthermore, the same macromolecules are incorporated into the biomineral composite during growth. Incorporation can occur at different levels of hierarchy, e.g. intra- or inter-crystalline, and thus contribute to the outstanding fracture toughness and wear resistance. An in-depth understanding of nucleation, growth, and the advanced materials properties critically depends on the ability to characterize the interactions across the organic-inorganic interface. Atom-probe tomography is uniquely capable of providing structural insight at the atomic scale by directly probing the location and chemical identity of the atoms within a small sample of material.

We report here the application of atom-probe tomography (APT) to the tooth cusp of the chiton *C. apiculata*. We demonstrate that atom probe mass spectra allow the identification and localization of small atomic and molecular fragments within this mineral matrix. We identify fragments that are characteristic of the inorganic mineral and of organic (macro)-molecules, respectively. Three-dimensional reconstruction of the sample volume indicates the presence of characteristic fibrous organic structures that strikingly resemble chitin fibrils observed in unmineralized chiton teeth and fibrous structures visible in high angle annular darkfield (HAADF) STEM of mineralized teeth.

Thursday October 22nd at 4:00PM in Tech LR4

The Technological Institute

2145 Sheridan Road

Refreshments will be served at 3:45 PM