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Involving undergraduates in interdisciplinary research: The physics of biomineralization

PUPA GILBERT, University of Wisconsin-Madison

Biominerals include mollusk shells, the skeletons of sea urchins, corals, mammals, etc. Their formation mechanisms fascinate physicists, materials scientists, and chemists because they result in materials more robust than their components, with exquisitely intricate nano-structures, fill space more than synthetic nanoparticles, and directly control phase transitions. Because of the fundamental nature of research on the physical aspects of biominerals, their formation mechanisms, the potential for future bio-inspired materials synthesis, and the aesthetic beauty of biomineral structures, students of all ages are interested in biomineralization. While describing the involvement of undergraduates in this research, my talk will address two key questions: Q: How do biominerals achieve the beautiful morphologies we observe? A: By forming through amorphous precursor phases, with morphology and phase transitions directly under biological control [1, 2]. Q: How do organisms order their biominerals to be single-crystalline? A: By controlling crystal growth at the nanoscale, not atom by atom [3, 4].

[1] Y Politi et al PNAS 105, 17362 (2008).
[2] AV Radha et al PNAS 107, 16438 (2010).
[3] RA Metzler et al PRL 98, 268102 (2007).
[4] PUPA Gilbert et al JACS 130, 17519 (2008).