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Biosilica nanoscale pattern formation in diatoms

Over the last 200 million years, a number of aquatic unicellular eukaryotic organisms have evolved mechanisms to sequester and assemble biominerals into exogenous structures. The results seen today are high-fidelity, mineralized shells featuring patterned complex nanoscale ornamentations that defy synthesis in vitro. Among these organisms, diatoms are topical owing to their fundamental role in the carbon cycle, in food chains ascending to fish, and the potential uses of their biosilica shells in developing nanotechnologies. Their species-specific mineralized shells have diverse morphologies, with structures that span scales from 5 nm to 0.5 mm. At the finest scale are structures called pore occlusions, which in a matter of minutes assemble and solidify under ambient physiological conditions into roughly deterministic patterns that are conserved within species, but which vary between species. Very little is known about the physical processes governing this biosilica patterned assembly. In an attempt to identify the physical processes governing pore occlusion formation, we are investigating new pattern forming probabilistic (spin-like) lattice models in coordination with diatom culturing experiments, which have produced some promising results.