On the propagation of elastic waves in diatom frustule systems

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Résumé

Diatoms are single-celled microscopic algae ubiquitously present in water environments. The diatom cell is encapsulated inside an inorganic exoskeleton called frustule featuring a complex hierarchical architecture and an extraordinary species-specific diversity.
While the optical behavior of diatom frustules has already been investigated demonstrating enhanced light absorption and reflection properties due to local resonances and Bragg scattering mechanisms, the elastic dynamic response of these biological structures remains elusive so far.

In this preliminary work, we start investigating the effects of the complex and hierarchical architecture of diatom frustules on the propagation of elastic waves.

First, we show the structural arrangement at the nano- and micro- scales of different diatom species by using Scanning Electron Microscopy (SEM) and Focused Ion Beam Scanning Electron Microscopy (FIB-SEM). Second, we numerically demonstrate that the quasi regular arrangement of pores of certain diatom frustules can lead to the opening of elastic bandgaps. The work herein provides insight about the dynamic properties of these biological structures and offer new ideas for the design of advanced materials with tailored wave control functionalities.

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