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Formation of aragonite mesocrystals and implication for biomineralization

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Abstract

Highly oriented aragonite tablets have been found in the nacre layers of molluscan shell (or mother of pearl). In this article, we show that highly organized aragonite rods can be prepared over a broad range of pH values (1.5 to 6.9) and in the absence of any bio- or organic macromolecules. The organized rods were characterized by XRD, FTIR, FESEM, TEM, SAED, and EDX techniques. FESEM results reveal that the mesoscale aragonite rods are not only assembled with aragonite microrods end-to-end, and side-to-side, but are also partially fused to one another, forming flat, faceted surfaces, i.e., mesocrystal structure. TEM and SAED analyses confirm that the organized rods have the same crystallographic symmetry as single-crystal aragonite, and thus the self-assembly process is energetically favorable. Similar assembly processes also occur for the mineral strontianite of the aragonite group, revealing the occurrence of a general self-assembly process. The driving force controlling the self-assembly process may originate from the inherent anisotropic dipole-dipole interactions between the assembled units. Such dipole interaction may generally occur in biomineralization of nacre layers in molluscan shell, and orchestrate aragonite nanocrystals in an aragonite tablet to coherently orient and array. Furthermore, the dipole-dipole interactions may also contribute to the co-orientation of the aragonite tablets in the same nacreous column. Therefore, our experimental results may provide insight into biomineralization mechanisms. It appears that biological genetic and crystallochemical factors may synergistically operate in biomineralization.

Keywords: Aragonite, mesocrystal, biomineralization, oriented attachment, self-assembly