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Mesoscale twinning and crystallographic registers in biominerals

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Abstract

Mesocrystals attract increasing interest in the fields of physics, chemistry, materials, and Earth sciences. Yet, structural properties of this new class of solid materials are not fully described. Biominerals often display complex hierarchical mesocrystalline organizations. We report on the crystallography of sclerites, which are small (~80 μm), beautifully shaped calcitic biomineral structures found in the living tissues of octocorals. Despite a layered concentric structure, the submicrometer crystalline units constituting the sclerites display a remarkably simple crystallographic organization of similarly oriented units with only a low degree of misorientation between them. Some sclerites display crystallographic sectors, leading to the concept of "mesotwin." A mesotwin is to a twin what a "mesocrystal" is to a crystal: an analog with defects. On the basis of EBSD data, we propose a simple conceptual crystallographic model that accounts for the observed features. This model involves different rhombohedral unit blocks, with identical shapes and volumes, but different crystallographic faces. EBSD data show that quite unexpectedly slight misorientations of crystallites in the sclerites are not at random but organized around the three equivalent **a** axes of the hexagonal unit cell of calcite. In a subtle way, the overall organization and morphologies of the red coral sclerites are connected to the calcite crystallography.

Keywords: Biomineral, mesocrystal, calcite, twinning, sclerite, red coral