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Growth process and crystallographic properties of ammonia-induced vaterite

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Abstract

Metastable vaterite crystals were synthesized by increasing the pH and consequently the saturation states of Ca^{2+}- and CO_3^{2-}-containing solutions using an ammonia diffusion method. SEM and TEM analyses indicate that vaterite grains produced by this method are polycrystalline aggregates with a final morphology that has a sixfold-symmetry. The primary structure develops within an hour and is almost a spherical assemblage of nanoparticles (5–10 nm) with random orientation, followed by the formation of hexagonal platelets (1–2 μm), which are first composed of nanoparticles and that develop further into single crystals. As determined using transmission electron microscopy, these hexagonal crystallites are terminated by (001) surfaces and are bounded by {110} edges. The hexagonal crystals subsequently stack to form the "petals" (20 μm wide, 1 μm thick) of the final "flower-like" vaterite morphology. The large flakes gradually tilt toward the center as growth progresses so that their positions become more and more vertical, which eventually leads to a depression in the center. Since this sequence encompasses several morphologies observed in previous studies (spheres, hexagons, flowers etc.), they may actually represent different stages of growth rather than equilibrium morphologies for specific growth conditions.

Keywords: Vaterite, growth, crystallography, nanoparticle