Formation of hydroxylapatite with different morphologies and implication for biomineralization

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Living organisms are capable of inducing and controlling the crystallization and deposition of a wide variety of minerals, but the vertebrates mainly utilize the calcium phosphates in constructing their mineral phases in both normal circumstances in bone, dentin, and tooth enamel and in pathological ectopic mineral deposits. The predominant form of the mineral in all situations is hydroxyapatite. Morphological control during mineral crystallization is one of the prominent hallmarks of biomineralization. A general consensus is that organisms can employ some of biological or organic molecules to produce crystals with special morphologies. Herein, hydroxyapatite (HAP) was synthesized in the absence of any biological or organic molecules at room temperature. The results show that different phosphate concentrations leads to the hydroxyapatite with various morphologies. However, the porous flower-like spheres are always obtained at the different concentrations of Ca^{2+}. Moreover, the initial precipitate is always an unstable amorphous calcium phosphate (ACP) at all different PO_4^{3-} concentrations used, and the generation of the HAP with various morphologies may have experienced the dissolution of the initial ACP, and then the recrystallization and self-assembly of HAP. Contrary to the common believe that crystal morphology control of biominerals is generally achieved by biological or organic molecules, our results suggest that PO_4^{3-} concentration may also play an important role in the different morphogenesis of HAP. The dependence of HAP morphology on phosphate concentration suggests that in biomineralization biological genetic and physicochemical factors can cooperatively influence the formation of HAP with unusual morphologies and hierarchical structures. As such, this provides a deep insight into biomineralization mechanism.

Engineered crumpled graphene oxide nanocomposite for environmental application

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Graphene oxide (GO), with large specific surface area, strong hydrophilicity, and broad (chemical) functionalization possibilities, holds great promises for surface modification of engineered nanoparticles (ENPs). A one-step aerosol-based method, which utilizes evaporation-induced confinement force to crumple GO and thus effectively encapsulate ENPs, has been demonstrated to synthesize various GO-based binary and ternary nanocomposites, such as GO-magnetite (GOM), GO-TiO_2 (GOTI), and GO-TiO_2-Magnetite (GOTIM).

The as-synthesized quasi-spherical, core-shell nanostructured composites, with controllable size and functionality, have demonstrated outstanding water-stability. GOTI exhibited enhanced photocatalytic activity compared to bare TiO_2 due to increased lifetime of photo-induced holes and electrons; and reactive oxygen species, such O_2-·, H_2O_2, and OH·, have been identified by employing various radical scavenging experiments. GOM and GOTIM are ready to be magnetically recovered by one handheld magnet. Regarding nano-environment interfacial interactions, QCM-D is utilized to study deposition kinetics of GO-coated ENPs onto different model surfaces. The proposed facile aerosol-based method enables the encapsulation of nearly all pre-synthesized NPs by graphene oxide; and thus opens up many more possibilities in environmental applications, such as pollutant degradation and sensing, groundwater remediation. The potential impacts on the environment by examining the stability of the material will be examined. The compatibility with biological systems will also be discussed.

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