Chitosan-Mediated Formation of Silica and the Mechanism Investigation by CryoTEM

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Diatoms produce exquisite siliceous cell wall that is a perfect nanostructured artwork. Various macromolecules are involved in the formation of biosilica. From the molecular viewpoint, amphotericity and hydroxyl groups have been suggested to play key roles [1]. We used chitosan, a kind of modified natural cationic polysaccharide with abundant hydroxyl and amino groups, as a model molecule to mimic formation of biosilica and investigate the mechanism involved in biomineralization. Unique silica particles, e.g., spherical, sheet-like, or carambola-like, were produced, depending on the incubation time of chitosan solution with phosphate ion (Pi) before silicification [2]. We also found that the sheet of silica had granular surfaces fused with 20-40 nm spheres, which is similar to the diatom valve. By examining the chitosan/Pi incubation solutions with CryoTEM, we confirmed the growth of chitosan aggregates (from sphere to sheet to carambola-like) and the template effect of these aggregates on the formation of silica of unique architecture. The dynamic process and in-situ observation indicated the importance of the organic super-molecular structures in biosilicification.

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