A Mesoporous Pattern Created by Nature in Siliceous Spicules from Marine Sponges

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Marine sponges deposit hydrated silica in needle-like objects called spicules. These spicules also contain a protein axial filament which functions as template for silica deposition.

This presentation deals with the fiber diffraction structural study of the organization of the axial filaments in spicules from different sponges, carried out using a SAXS setup with synchrotron radiation. The collected images show diffraction spots sharper than what can be expected from a regular polymeric fiber, indicating that the protein units in the spicule axial filaments must form highly ordered patterns. The analysis of the position and distribution of the spots reveals a hexagonal arrangement with different possible bi- and tri-dimensional dispositions of the units along the main axis of the spicules. Analysis after thermal treatments reveals a structural ordering accompanying the thermal degradation of the organic material. This confirms our hypothesis that the protein units act as template in the formation of an inorganic mesoporous structure.

Our results suggest the following possible mechanism for the biosilification process in spicules. The initial step consists in the formation of a very ordered disposition of the protein units, forming a regular mesoporous arrangement in a silica matrix, similar to that found in synthetic materials. In a second step the biosilification process continues with a deposition of amorphous silica on the outer walls of the mesoporous core.

Keywords: biomineralization, SAXS, porous materials