Biominerals at the nanoscale: transmission electron microscopy methods for studying the special properties of biominerals

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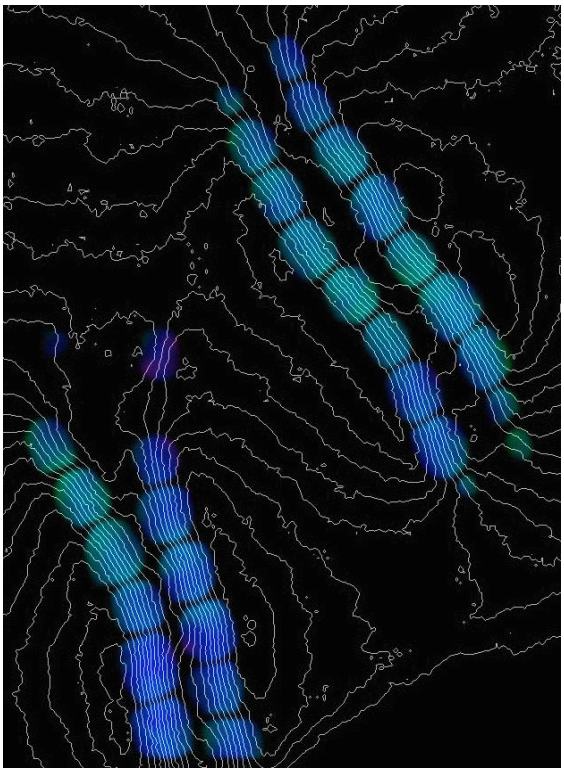
Biominerals have important functions in living organisms: apatite crystals provide the strength of our bones and hardness of our teeth, calcite and aragonite are used by many organisms for making shells, and magnetite helps bacteria and birds to navigate in magnetic fields. In order to fulfill their roles in organisms, biominerals have special, strictly controlled physical and chemical properties. Transmission electron microscopy is ideally suited for the study of the structures, compositions, morphologies, crystal orientations and textures, and magnetic properties of biominerals at the nanoscale. In this chapter we review the state of the art of TEM techniques as applied to the study of material properties at the inorganic-organic interface. Examples are mainly taken from studies of the magnetic nanocrystals that form in the cells of magnetotactic bacteria.



Magnetic induction map of two double chains of magnetite nanocrystals in the cell of an uncultured magnetotactic bacterium, obtained from electron holography. The parallel magnetic contours and uniform blue color indicate that each nanocrystal contains a single magnetic domain, with their magnetic moments parallel to the chain axis; in effect, the double chains behave as bar magnets.