Plenary Lecture

PL02

From the Crystal to the Rose: The Route to Biomimetic Self-assembled Nanostructured Materials

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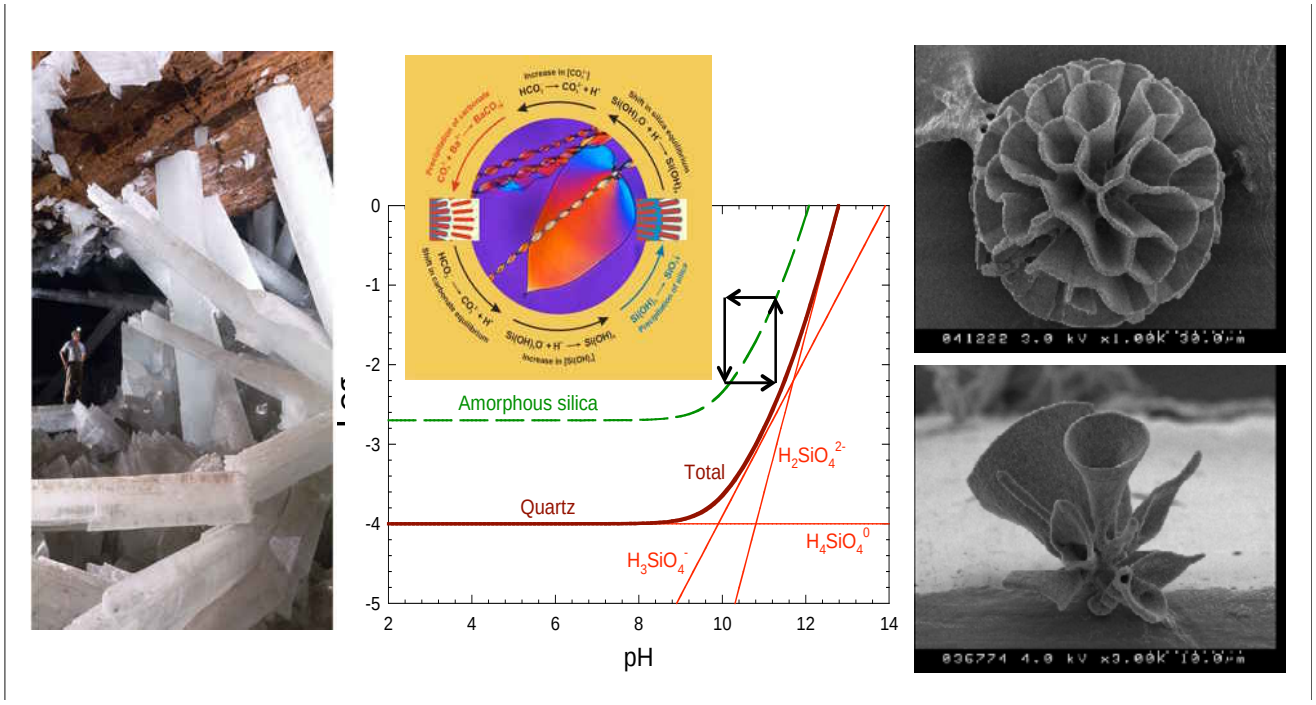
Life was able to create (bio)chemical pathways to mineral structures of great complexity, breaking the symmetry of single crystals into complex textures exhibiting morphologies with continuous curvature forbidden in crystal symmetry. Materials with non-crystalline morphologies can be made out of crystalline phases by filling volumes or coating surfaces with curved shapes. However, what wonders and challenges engineers and material scientists is the ability of life to create such a complexity by self-assembly. The formation of architectures such as shells and other exoskeletons of living organisms is governed by organic molecules or matrices, which modify crystallization in a deliberate manner. Their influence provokes the breaking of the single crystal character of the mineral precipitation and often leads to sinuous shapes, which have been thought to be a sign of life, and distinguish these minerals from their inanimate, mostly euhedral counterparts. In this lecture I will review a laboratory inorganic route to these biological structures. It has been discovered that silica -an ubiquitous mineral in the geological record, particularly in the early years of the planet- has a strong influence on the precipitation of carbonate and hydroxides. Under alkaline conditions, the chemical coupling of silica with CO3= and OH- creates abiotic, purely inorganic, self-assembled structures made of millions of nanocrystals building textures of high complexity and showing morphologies with continuous non-crystalographic curvature. The process of self-assembly, driven by a pH-based coupling of the chemistry of carbonate and silicate, is explored for applications in materials science. I will also discuss the geochemical plausibility of these self-organized mineral processes in terms of their implication in the origin of life and primitive life detection. Figure 1: Chemically induced cooperative phenomena break the restricted point symmetry of single crystals into self-assembled nanocrystalline structures with complex shapes of continuous curvature.

[1] *J.M. García-Ruiz, et. al., Science 2003, 302, 1194. DOI: 10.1126/science.1090163.,* ***[2]*** *J.M. Garcia-Ruiz, E. Melero, S. Hyde, Science 2009, 323, 362. DOI: 10.1126/science.1165349.,* ***[3]*** *M. Kellermeier, H Cölfen, and J.M. García-Ruiz. European Journal of Inorganic Chemistry (2012) 5123–5144. DOI: 10.1002/ejic.20121029.*



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