Calcium Carbonate Biomineralisation

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1. Introduction

Biogenic crystals attract large attention because of their superior properties in many aspects. The process of biomineralisation is realised by the use of organic macromolecules secreted by the organism. A deeper understanding of the mineralisation process and the mimicking of complex structures produced by nature in laboratory may have a significant impact on many fields. Many studies showed a correlation between the calcium carbonate growth modifications and the structure of the additive organic molecules as polyacrylic acid, EDTA, etc...[1-3]. The mechanisms of how these organic molecules control $CaCO_3$ crystal growth of the three polymorphs are still matter of conjectures [4].

2. Objectives

In this work, we study the crystallization of $CaCO_3$ particles in aqueous solutions in the presence of PAA. The PAA's effects on crystals' mean sizes and on the polymorphs volume contents at temperatures varying from 25° to 80° C are examined using X-ray and Rietveld method.

3. Materials and Methods

Two solutions of $CaCl_2$ and K_2CO_3 are mixed at different temperatures: 20°, 50°, and 80° C (with the presence or not of PAA). The solid precipitates were collected, rinsed and dried under vacuum. The samples were examined using TEM and X-ray diffraction (XRD). Rietveld method and Popa anisotropic model are used to study the mechanism of action of polyacrylic acid on the growth of different polymorphs of calcium carbonate.

4. Results

The Rietveld refinements on X-rays diffraction diagrams using anisotropic model for crystallites sizes shows a flattening effect on the crystallites in the case of both the vaterite and aragonite. This flattening is in the direction of the **c**-axis. This is due to the PAA-Ca^{+2} complexes which block the growth along the c-axis of the crystallites. The refinements show that no effect is observed on the calcite crystallite, which confirms the absence of a bonding activity for the PAA-Ca^{+2} groups(fig. 1).

5. Conclusion

The mechanism of action of the polyacrylic acid was clearly demonstrated when refining with anisotropic sizes model which shows a flattening effect on the crystallites in the case of vaterite and aragonite but not in the case of calcite (fig. 1). Then, there is a strong interaction with PAA and $CaCO_3$ that could help understand the growth of the natural bio-mineral.

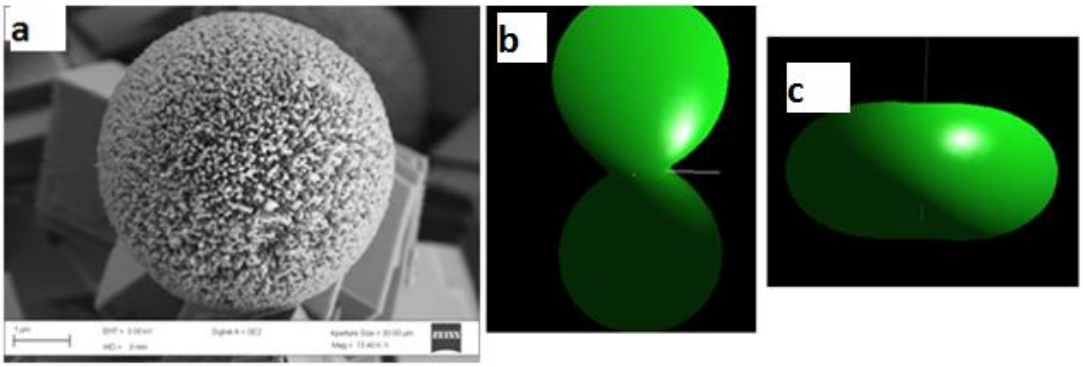

Fig 1: SEM image of vaterite particle (a) vaterite crystallite without PAA (b) vaterite crystallite with PAA.

References

[1] N. Hosoda, A. Sugawara, T. Kato, Macromolecules 36 (2003) 6449.
[2] S. Zhang, K.E. Gonsalves, Langmuir 14 (1998) 676.
[3] Q. Shen, Y. Chen, H. Wei, Y. Zhao, D. Wang, D. Xu, Cryst. Growth Des. 5 (2005) 1387.
[4] Ouhenia, S., Chateigner, D., Belkhir, M.A., Guilmeau, E., Krauss, C., 2008, Journal of Crystal Growth 310 (11) , (2008), 2832.