Influence of gelatin hydrogel porosity on the formation of calcite mesocrystals

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The formation of biological hard tissues occurs in confined environments within organic matrices and involves the oriented attachment of nanoparticles. Similarities between hydrogels and organic matrices make hydrogels an adequate support for studying biomineralization. In this work the crystallization of $CaCO_3$ in gelatin hydrogels with solid contents ranging between 2.5 and 10 wt% was investigated at 15ºC. Changes in the gelatin concentration correlated with changes in the characteristics of the $CaCO_3$ precipitates, with heavier hidrogels leading to smaller nucleation densities, diminishing proportions of vaterite with respect to calcite and calcite crystals showing smaller sizes, progressively rougher surfaces and more complex morphologies. Moreover, the calcite crystals grown in heavier hydrogels were identified as mesocrystals consisting in assembled nanometric basically equally-oriented rhombohedral subunits separated by small amounts of gelatine (Fig. 1a). Hydrogels with higher gelatin contents were characterized by more complex porosities, which correlated with lower ion difussivities through the hydrogel and higher supersaturations at nucleation (Fig. 1b). These results highlight the connection between medium porosity, supersaturation and mesocrystals formation.

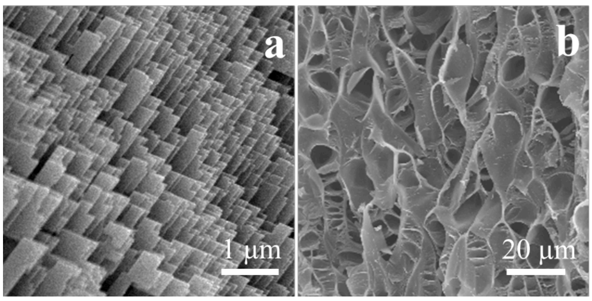

Fig 1. (a) Surface of calcite mesocrystal (10 wt% gelatine hydrogel) (b) Porous structure of a 10 wt% gelatine hydrogel

A Modeling Framework to Predict Changes in Soil Chemistry and Agricultural Return Flow in Seawater Farming of Halophytes

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Growing halophyte plants using Integrated Seawater Energy and Agriculture Systems (ISEAS) offers a sustainable solution for the generation of biomass feedstock for carbon neutral biofuels; halophytes neither enter the foodchain, nor do they compete with food-crops for natural resources. One such field demonstration of ISEAS for biomass production to generate aviation biofuels, is planned for the coastal regions of Abu Dhabi, UAE, where it will likely face a number of region-specific soil chemistry and hydogeology challenges not encountered in past demonstrations in Mexico and Eritrea. The unique soil chemistry (evaporite deposits, especially gypsum), and hypersaline coastal hydrogeology of Abu Dhabi will affect long-term halophyte agricultural productivity when Arabian Gulf seawater is applied to coastal soils as part of ISEAS. As an initial phase of the demonstration project, a salt deposition numerical modeling framework was developed to test different seawater loadings onto coastal soils. The aim of this exercise was to predict changes in irrigation return flow and soil chemistry over time in order to establish salt and water balances for sustained operation of the site. These modeling results will be further validated with laboratory lysimeter studies and with field monitoring data collected during one year of ISEAS operation. The results from this study could be used to (i) determine the optimal saline water loading correlating with peak soil salinities that selected halophytes can tolerate, (ii) potential for sodicity of the soil with saline water application, (iii) impacts of land application of saline water on underlying coastal groundwater, and (iv) develop strategies to control soil water activities in favor of halophyte agricultural productivity at ISEAS sites.

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