Micelle Templating of Calcium Precipitation: A Route to Artificial Bone

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Micelle-templating was investigated as a means to obtain macroporous calcium carbonate ($CaCO_3$) structures, with pores >50nm, suitable for applications such as bone grafting. Solutions of tetradecyltrimethylammonium bromide (TTAB) surfactant at 0, 2, 4, 6, 8, 10, 15 and 20 times the critical micelle concentration (CMC) of 3.5 mM were used to template $CaCO_3$ precipitation from calcium chloride and sodium carbonate stock solutions at pH 10. The solvent was evaporated and resulting morphology characterised using light microscopy, at 100 and 200x magnification, together with semi-quantitative structure scoring functions. pH stability was investigated by determining the pH at which the precipitate completely dissolved. TTAB concentration dramatically affected $CaCO_3$ morphology. In the absence of TTAB, calcite crystals and needles were observed, with porous structures and films seen with increasing TTAB concentrations. Particularly promising macroporous structures with average pore sizes of ~20μm were seen at 6x CMC. The presence of cationic surfactant stabilised the $CaCO_3$ precipitate. $CaCO_3$ precipitated from TTAB solution completely dissolved at mean pH of 2.22-2.28, compared to pH 5.68 for $CaCO_3$ precipitated from water. Micelle-templating is therefore a simple, cheap and viable means of obtaining macroporous $CaCO_3$ structures with enhanced pH stability.

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