Inhibition of calcite growth: New insight into the behaviour of Mg^{2+}, SO_4^{2-} and $MgSO_4$

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Controlling calcite nucleation and growth is of interest for understanding natural processes and for industry applications (e.g., scale prevention, pharmaceuticals etc). Mg^{2+} and SO_4^{2-} each affect calcite growth rate but little is known about their combined effect. We used the constant composition method to grow calcite and then quantified the effect of inhibition, the change in surface composition and the rates of growth in solutions containing Mg^{2+}, SO_4^{2-} and $MgSO_4$ at ambient conditions. Mg^{2+} was a more effective inhibitor when SO_4^{2-} was also present (Fig. 1). Solid surfaces were characterised with atomic force microscopy (AFM), scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). Mg^{2+} was incorporated into the calcite structure and affected crystal form to various degrees, depending on the ion(s) (Fig. 1, inset). We ascribe the enhanced effect of $MgSO_4$ to the process of Mg^{2+} forming ion pairs with SO_4^{2-}, which promotes Mg dehydration prior to its incorporation into calcite. The results suggest an environmentally friendly method to inhibit calcite scale formation.

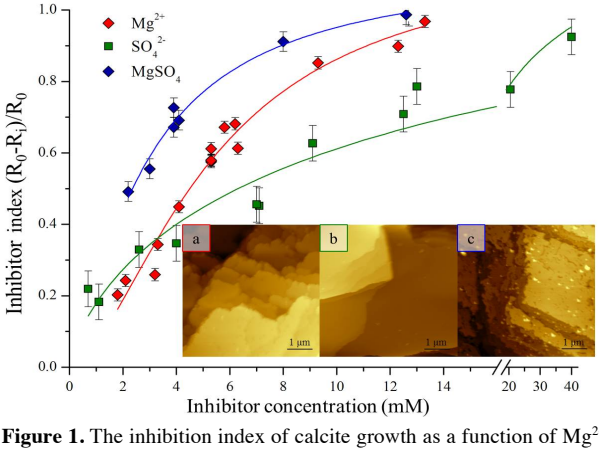

Figure 1. The inhibition index of calcite growth as a function of Mg^{2+}, SO_4^{2-} and $MgSO_4$ concentration. Inset: AFM images of calcite after growth in the presence of Mg^{2+} (a), SO_4^{2-} (b) and $MgSO_4$ (c).