Towards Establishing a Coupled Nucleation and Crystal Growth Rate Law

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Crystal nucleation and growth are the main processes which control the chemical precipitation of minerals. One of the main obstacles remaining for reaching a theoretical basis for the entire precipitation process is the absence of a theoretical coupling between both processes. While nucleation is defined by the formation of a new phase in the solution, crystal growth is mainly defined as the growth of existing nuclei, which is mainly a surface controlled mechanism. The unknown surface area of the growing nuclei limits the quantification of the growth process.

Most studies concentrate separately on nucleation and crystal growth processes. In order to link both processes, we conducted a series of batch experiments, in which gypsum nucleation was followed by crystal growth. A wide range of batch reactors made of different material, and various stirring devices and speeds were used.

The induction time of gypsum nucleation and the following rate of crystal growth were calculated for each experiment. The induction time was found to be a function of the reactor material, while the rates of crystal growth, which varied over 3 order of magnitude, were strongly affected by the stirring speed and its mode.

The observed changes in SO_4^{-2} with time, due to combined nucleation and crystal growth, were fitted using a forward model that uses simple rate laws for nucleation and crystal growth of gypsum.