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In situ characterisation of calcium carbonate prenucleation clusters around the solubility limit using Small Angle X-ray Scattering technique.

In the classical nucleation theory, a mineral will form in supersaturated solution by the random collision of dissolved ions to yield transient clusters through a dynamic and reversible process. Random addition of dissolved ions eventually causes a “critical cluster” size to be reached, at which point the process becomes essentially irreversible and the first mineral crystal is considered to have formed. Nevertheless, it has been proven that calcium carbonates don’t follow this theory. Instead, its abiotic precipitation proceeds by a novel mechanism involving formation of nanoparticle, between 1 and 250 nm in size and thermodynamically stable in under and supersaturated solution ($\Omega < 1$ and $\Omega > 1$). However, in situ studies aiming to characterise these nanoparticles have always been undertaken in highly oversaturated and simplistic conditions. Moreover, the exact role as well as their physical and chemical characteristics remains poorly understood. Here we’ve combined SAXS technics with an ultra fast mixing device in order to acquire high quality data at extremely short reaction times (estimated $< 1\text{ms}$) representing the very early stage of calcium carbonate nanoparticles formation. With these technics we’ve been able to characterise the size and shape of these nanoparticles around the solubility limit ($\Omega < 1$ and $\Omega > 1$), varying pH.

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