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An experimental study of periclase (MgO) hydration

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Hydration of periclase is an important industrial reaction, particularly in the field of cement and lime mortars. Dolomitic lime used for building contains significant amounts of periclase, which hydrates at a slower rate than lime (CaO), and commonly delays MgO hydration and swelling occurs in hardened mortar eventually resulting in fracture formation [1]. It also negatively impacts the durability of MgO-based refractory ceramics [2]. Periclase hydration involves a volume increase of ~110%, resulting in very high stresses if the process occurs in a confined space, which can lead to reaction-induced fracturing [3]. Hence, understanding the hydration mechanisms of periclase is crucial for technical applications, such as preventing dolomitic lime mortars fracturing due to swelling.

The hydration of periclase to brucite -$Mg(OH)_2$- was investigated experimentally, using mm-sized single crystals of synthetic periclase and periclase powders. Here we show, using *in situ* atomic force microscopy (AFM) and complementary analytical techniques (2D-XRD and TEM), that upon the reaction of periclase cleavage surfaces with deionized water, spherical nanoparticles form initially oriented along the periclase step edges, subsequently covering the whole periclase surface. With increasing reaction time, nanoparticles develop straight facets and acquire hexagonal features consistent with the crystal structure of brucite. Additionally, differences in adhesion between the outer part and the centre of the nanoparticles were observed, suggesting the initial formation of a precursor that subsequently transforms into crystalline brucite. These results reveal a nonclassical particle-mediated reaction mechanism for the hydration of periclase into brucite.

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