

Hydration of Periclase and the Influence of pH on Brucite Crystal Morphology

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The transformation of periclase [MgO] to brucite [Mg(OH)₂] via hydration is known as an important reaction due to the increase in solid volume by H₂O consumption, and energy transfer. Despite extensive research on the conversion of MgO to Mg(OH)₂, the key factors governing its kinetics, reaction mechanisms, and the size, shape, and orientation of individual brucite crystals remain only partially understood. The self-regulating pH during hydration is strongly influenced by impurities in the raw material, such as CaO or MgCl₂. Furthermore, pH plays an important role in controlling the hydration rate and the morphology of newly formed brucite crystals [1]. In this study, laboratory experiments were conducted using highly pure synthesized MgO (≈99.9%) to investigate its transformation into Mg(OH)₂ while eliminating the influence of foreign components. By maintaining pH levels between 11 and 13, it appears that the surface charge of both MgO and the newly formed Mg(OH)₂, along with their respective precipitation rates, governs the availability of dissolved Mg²⁺ and, consequently, the resulting brucite crystal morphology. Below the point of zero charge (pH_{PZC} ≈ 11.5 ± 0.5) of MgO and Mg(OH)₂, subhedral flaky hexagonal brucite crystals dominate at pH ≈ 10.0. At pH ≈ 11.5, brucite develops euhedral forms, exhibiting pyramidal to tabular morphologies with smooth crystal surfaces. At pH ≈ 13.0, brucite also exhibits tabular shapes but with a preferred growth along the c-axis. Additionally, the reactive solution was labeled with δ²H- and δ¹⁸O-depleted water to trace the dissolution pathways of MgO and the subsequent formation of Mg(OH)₂. By advancing our understanding of hydration kinetics and crystal growth mechanisms, brucite can be optimized for specialized applications and tailored product engineering.

[1] Pettauer, M., Baldermann, A., Eder, S., & Dietzel, M. (2024). Hydration of MgO: reaction kinetics and pH control on brucite crystal morphology. *Crystal Growth & Design*, 24(7), 3085-3092.