

MgO/SiO₂ and Portland cement formulations: mutual effects on reaction kinetics and hydration products

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Cement is the binder at the base of one of the most important building material: the concrete. Nowadays, formulations based on reactive periclase (MgO) [1,2] constitute a promising emerging technology toward eco-sustainable binders, with reduced CO₂ emissions as compared to the traditional CaO-based cements. [3,4] In the presence of water, MgO/silicate mixtures hydrate and form a binder phase, M-S-H (magnesium silicate hydrate), a colloidal gel analogue to calcium silicate hydrate, C-S-H, present in traditional Portland cements, but with inferior mechanical properties. The aim of the present study was the investigation of the hydration reaction and of the microstructure development of pastes prepared by mixing Portland cement and MgO/SiO₂ blend. Different percentages of CaO- and MgO-based binders were evaluated to explore the possibility of preparing pastes that could in principle combine the optimal mechanical properties of calcium based cement with the ecological features of MgO-based cement. The hydration kinetics of the mixtures were investigated by means of Differential Scanning Calorimetry. Concurrently, the pastes were characterized by means of a multi-scale approach and the formation of hydrated phases was studied by Thermogravimetric Analysis, Fourier Transform IR spectroscopy and X-ray Diffraction. The structural properties of all samples were investigated by solid state ²⁹Si-NMR. Finally, the morphology of the pastes has been studied by means of Scanning Electron Microscopy. The results showed that in the mixed pastes both C-S-H and M-S-H binder gel phases form, but, as evidenced in Figure 1, their domains remain segregate in different regions. The results evidenced that the kinetics of hydration in the mixed samples is dominated by MgO/SiO₂ hydration in the first period, while the diffusional stage is mostly dependent on the Portland cement presence. Moreover, mutual effects on the formation of the hydration products occur in the mixed pastes.

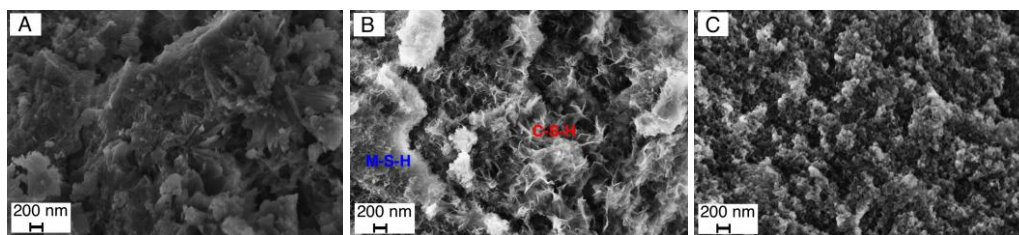


Figure 1 SEM images of CaO-based cement (A), mixed pastes with MgO- and CaO-based cements (B) and MgO-based cement (C).

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