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Long term correlation for the pozzolanic reactivity of alkali-modified calcium aluminosilicate glasses and their structure

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Abstract

The research and manufacture of novel supplementary cementitious materials (SCMs) for creating blended cements is the primary applied strategy in reducing the CO_2 emissions associated with the production of Portland cement. Therefore, it is essential to understand the impact of the SCM on the hydration of the blended cement in the design of performance-targeted chemical formulations. Synthetic glass-based supplementary cementitious materials may be tailored specifically to promote a certain level of glass reactivity, and the subsequent availability of ionic species in the pore solution. In this work, we correlate the pozzolanic reactivity of synthetic, peralkaline, alkali calcium aluminosilicate glasses to their chemical structure. We investigate the structural changes of glasses of four different $CaO–Al_2O_3–SiO_2$ ratios, by adding modifiers up to 20 mol% Na_2O and/or K_2O, and by subjecting the glasses to pozzolanic reactivity experiments in simulated cementitious environments. It is found that the local heterogeneity of the glasses, due to aluminum avoidance and the nature of non-bridging oxygens being associated primarily with silicon-tetrahedra, plays an important role in determining the degree of pozzolanic reactivity up to 28 days of hydration. During the hydration, the reactivity of the glasses possesses a steady state dissolution mechanism.

Keywords: Pozzolanicity, Reactivity, Glass, Cement, Sustainability

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