Structure and hydration of amorphous blast-furnace slag

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Abstract

Glass alteration is of large interest, from materials to Earth and environmental sciences. Ground Granulated Blast-furnace Slag (GGBS) is a glassy by-product of pig iron and steel manufacturing. This non-crystalline solid is a porous and textured calcium aluminate glass with an unusual silica-poor composition (about 35 wt.% SiO2). It acts as a hydraulic binder: the dissolution of the vitreous structure in water leads to the formation of various products including a calcium silicate hydrate (CSH) gel which is responsible for the setting of the material. When the GGBS is mixed with cement or another activator, this alteration takes place within a few days. GGBS has been used in cement for a hundred years as it improves its resistance to chloride and sulfate attacks and contributes to reduce the CO2 footprint by limiting the use of clinker.

Various studies have tried to better understand and predict GGBS reactivity in water. However, the structural control of glassy slag to binder transformation is poorly understood. In particular, the role of the cations in the starting glass and the hydration layer is still unknown. It has also been noticed that above 1 wt.% TiO2 in the pristine glass, the reactivity of the slag drops drastically but there is no understanding of the structural origin of this variation.

We present here the first results on the structure of the pristine glass and the reactivity of amorphous GGBS with a particular focus on the role of titanium during the hydration. Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) enabled the visualization of the first stages of this glass hydration, including the release and precipitation of elements of interest. The study also includes X-ray absorption spectroscopy (XAS) at Ca and Ti K-edges and Raman spectroscopy results.

Keywords: Inverted glass, Glass structure, Alteration, X ray absorption, Scanning Electron Microscopy (SEM)

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