The effect of Ti and other minor elements on the reactivity of granulated ground blast furnace slag (GGBS) in blended cements

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Ground granulated blast furnace slags (GGBS) - glassy by-products of pig iron production - are commonly used in concrete industry to replace cement and thereby lower the carbon footprint of the material. Their reactivity exhibits large variations, leading to differences of short-term compressive strength of resulting mortars of up to a factor of 4. These differences are mainly due to the content of major elements such as CaO, Al_2O_3 and SiO_2 in the slag glasses. Besides, some minor elements, like TiO_2 are known to have negative impact on slag reactivity.

In this study the effect of TiO_2 content on the strength development of blended cements containing 75 wt.% GGBS is investigated by artificially modifying the TiO_2 content of the liquid slag. Results show that the 2d compressive strength of the material is reduced by > 50% if only 2.5 wt. % of TiO_2 are added to the liquid slag. After 28 days of curing, compressive strength is still more than 40 % lower than without TiO_2 addition. To investigate the mechanism controlling the impact of Ti on the slag reactivity, mixed-flow dissolution runs of GGBS with various TiO_2 contents were performed at 25°C and a pH of 11. In addition the binding environment of Ti in the unreacted slag was investigated through Ti K-edge XANES measurements.

The GGBS TiO_2 content has only a minor impact on glass network dissolution rate. However, TiO_2 addition affects the incongruence of the slag dissolution reaction. XANES measurements show that TiO_2 occupies network-forming positions in the slag glass and that its configuration does not change with its content. Finally, calorimetric experiments show that other minor elements such as V, Cr, Sn, Zr, Mn, also decrease the GGBS reactivity.