

Synthesis of sodium iron silicate hydrate(N-F-S-H)

M. Zhang ¹, E. Bernard², M.H.N. Yio¹, C.R Cheeseman¹, and R.J. Myers^{1,*}

¹ *Department of Civil and Environmental Engineering, Imperial college London, London, UK*
Email: m.zhang22@imperial.ac.uk, marcus.yio@imperial.ac.uk, c.cheeseman@imperial.ac.uk,
*r.myers@imperial.ac.uk.

² *Empa, Laboratory for Concrete and Asphalt, 8600 Dübendorf, Switzerland*
Email: ellina.bernard@empa.ch

ABSTRACT

Alumina production generates a bauxite residue by-product that can be processed into a Fe-rich cementitious material, for example, as a precursor for alkali-activated materials (AAMs). Typically, AAMs use Ca-poor precursors to produce a binder composed of a nano crystalline zeolite-like alkali aluminosilicate (hydrate) phase, often described as N-A-S-(H) gel. However, the chemistry of AAMs based on Fe-rich precursors like bauxite residue are poorly understood. For example, it is unclear whether Fe can play an analogous role to Al in the binding gel phase.

In this study, results are reported for samples with Fe to Si mol ratios from 0.1-1, synthesised at 50°C, targeting the precipitation of a sodium iron silicate hydrate (N-F-S-(H)) phase. NaOH is added to maintain a high pH to increase Fe solubility. At pH values of ~12, thermogravimetric analysis (TGA) and scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS) results reveal that initially FeO(OH) and N-F-S-H are formed. At higher Fe/Si mol ratios, more of these hydrates are formed. Fourier-transform infrared (FTIR) spectroscopy results show that the band related to Si-O internal stretching vibrations in N-F-S-H shifts to lower frequencies, indicating silica network rearrangement and Fe participation in the silica network. We report complementary X-ray diffraction (XRD), TGA, FTIR, and SEM-EDS results for these samples, and discuss them together to improve understanding of the formation and stabilisation of N-F-S-H.