

Immobilization of metals in low pH M-S-H cement

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Incorporation of metal ions in cement hydrates is of great interest for the storage and immobilization of toxic, hazardous, and radioactive wastes using cementitious matrix. Magnesium silicate hydrate (M-S-H) is a low pH alternative cementitious binder to commonly used Portland cement. Low pH cements have been considered as promising matrix for municipal and nuclear waste immobilization in the last decades. It is however crucial to assure that the incorporation of secondary ions is not detrimental for the formation of the hydration products. Herein, we investigate the early stages of formation of M-S-H from electrolyte solutions in presence of a wide range of metal cations (Li^{I} , Ba^{II} , Cs^{I} , Cr^{III} , Fe^{III} , Co^{II} , Ni^{II} , Cu^{I} , Zn^{II} , Pb^{II} , Al^{III}). The final solid products obtained after 24 h have been characterized via powder X-ray diffraction (PXRD), attenuated total reflectance-Fourier transformed infrared spectroscopy (FTIR-ATR), elemental analysis via energy-dispersive X-ray spectroscopy (EDX), scanning electron microscopy (SEM), and high-resolution transmission electron microscopy (HR-TEM). In all the experiments, the main precipitated phase after 24 h was confirmed to be M-S-H with a ratio (total metal/Si) close to 1. The obtained M-S-H products showed strong immobilization capacity for the secondary metal cations and can incorporate up to 30 % of the total metal content at the early stages of M-S-H formation without significantly delaying the nucleation of the M-S-H. It has been observed that presence of Cr, Co and Fe in the solution is extending the growth period of M-S-H. This is related with a higher secondary metal/total metal average ratio in the precipitated material. Secondary phases that co-precipitate in some of the experiments (Fe, Pb, Ni and Zn) were also effectively trapped within in the M-S-H matrix.