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Advanced Hydrated Cement Composite Materials for Gamma and Neutron Shielding Applications

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Many different types of hydrated cement composite materials and concretes, which contain light and heavy elements, have been used in building construction and radiation shielding for years.
One of the main points about popularity of hydrated cements and concretes is its hydrogen content for neutron shielding. Cements containing barium and especially strontium may be considered for shielding against gamma or X-ray radiation.
This work summarizes the hydration behaviour of state-of-the-art cements belonging to the CaO-Al2O3-ZrO2 system doped with metal cations with different valence states. The effects of Sr-, Ba- or Fe-doping of the Ca7ZrAl6O18 were investigated with the objectives to assess the effects of structure modifications on hydraulic behaviour of this phase. Strategies for the incorporation of Sr, Ba or Fe into the structure of calcium aluminates are necessary for the potential application of these hydraulic binder materials as ingredients of high temperature resistant heavy concretes.
The hydration products formed in the Sr, Ba or Fe-doped CaO-Al2O3-ZrO2-H2O and SrO-Al2O3-H2O cement pastes were subjected to morphological, chemical and structural characterization using X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS) techniques. The thermal stability and dehydration mechanism of hydrates were assessed by simultaneous thermal analysis i.e. Thermogravimetry (TG) and Differential Scanning Calorimetry (DSC) at different hydration times. The detailed thermal decomposition mechanism of the hydrated cement materials has been clarified based on Evolved-Gas-Analysis data with a Quadrupole Mass Spectrometer (QMS).

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