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Synthesis and Characterization of Iron and Aluminum-Containing AFm Phases

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Abstract : The cement industry accounts for 8% of the global CO_2 emissions, and approximately 60% of these emissions are associated with the Portland cement clinker production from the decarbonization of limestone (CaCO3). Their impact on the greenhouse effect results in growing social awareness. Therefore, CO2 footprint becomes a product selection choice, and substituting Portland cement with a lower CO2-footprint alternative binder is sought. In this context, new hydraulic binders have been studied as a potential Ordinary Portland Cement substitute. Many of them are composed of iron oxides and aluminum oxides, present in the Ca_4Al_2-$xFe_{2+x}O_{10}$-like phase and forming Ca-LDH (i.e. AFM) as a hydration product. It has become essential to study the possible existence of Fe/Al AFM solid solutions to characterize the hydration process properly. Ca_2Al_2-$xFex(OH)_6$.X.nH_2O layered AFM samples intercalated with either nitrate or chloride X anions were synthesized based on the co-precipitation method under a nitrogen atmosphere to avoid the carbonation effect.AFM samples intercalated with carbonate anions were synthesized based on the anionic exchange process, using AFM-NO_3 as the source material. These three AFM samples were synthesized with varying Fe/Al molar ratios. The experimental conditions were optimized to make possible the formation of Al-AFM and Fe-AFM using the same parameters (namely pH value and salt concentration). Rietveld refinements were performed to demonstrate the existence of a solid solution between the two trivalent metallic end members. Spectroscopic analyses were used to confirm the intercalation of the targeted anion; secondary electron images were taken to analyze the AFM samples' morphology, and energy dispersive X-ray spectroscopy (EDX) was carried out to determine the elemental composition of the AFM samples. Results of this study make it possible to quantify the Al/Fe ratio of the AFM phases precipitated in our hydraulic binder, thanks to the determined Vegard's law characteristic to the corresponding solid solutions

Keywords : AFm phase, iron-rich binder, low-carbon cement, solid solution
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