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ANALYSIS OF BUILDING MATERIALS BY SYNCHROTRON X-RAY IMAGING

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Abstract: Building materials have complex hierarchical microstructures. The largest components are coarse aggregates with dimensions larger than a few centimetres and the smallest ones are the calcium silicate hydrate (C-S-H) gel nanoparticles with sizes smaller than 5 nm. To fully understand the main properties of cement binders and optimize their performances, a sound description of their spatially-resolved contents is compulsory. Furthermore, cement manufacturing is responsible for about 7% of the anthropogenic CO_2 emissions and hence, to decrease the CO_2 footprint, in a sustainable and cost-effective way, is a top priority. To gain a deeper insight into the microstructures of building materials, synchrotron X-ray ptychographic nanotomography and absorption-based microtomography have been employed.
Here we will present three examples of our approach blending quantitative powder diffraction with synchrotron X-ray imaging. Firstly, we will show our comparative work on belite and Portland cement pastes cured at varying temperatures [1]. Synchrotron tomographic data taken at TOMCAT allowed understanding the different hydrating behaviour of both cements. Secondly, ptychographic nanotomographic data taken at cSAXS showed the hydration of $CaAl_2O_4$ with curing temperature [2]. Ptychographic data have permitted to characterise the conversion of the aluminate hydrates which is key for durability. The very good contrast in the electron density tomograms will be discussed as well as the porosity induced after the conversion reactions. Finally, we will report our work on Portland cements [3]. The densities and spatial distribution of calcium silicate hydrate (C-S-H) gel and amorphous iron-siliceous hydrogarnet components will be described.

Key words: synchrotron tomography, Rietveld analysis, ptychography

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