Nanomolecular structure and phase constituent quantification of multiscale UHPC using 29Si and 27Al MAS NMR, Nanoindentation and XRD techniques

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Abstract: ^{29}Si and ^{27}Al magic angle spinning nuclear magnetic resonance (^{29}Si and ^{27}Al MAS NMR) investigations (quantifications) of the C-(A-)S-H nanomolecular structure combined with grid nanoindentation and quantitative X-ray diffraction (QXRD) of multiscale ultra high performance concrete (UHPC) have provided invaluable insights that correlate very well with the macroscopic behavior and properties of this innovative material. The UHPC samples were cured with and without microwave energy. The microwave-cured samples contain in total more hydration products that the one not cured with microwave energy. A nanocomposite (C-S-H/CHnm) that consists of high density (HD) C-(A-)S-H and nanoscale portlandite (CH) is contained, and its amount is more than double for the pressure compacted and microwave-cured sample. There is a higher degree of hydration and of polymerization for samples treated under elevated curing conditions (microwave curing) and especially for the ones that were additionally load-pressed. The incorporation of aluminum (AlIV) in the structure of C-(A-)S-H by substituting silicon leads to an increase in the degree of polymerization of the structure.

Keywords: Nanomolecular structure, phase constituent, multiscale UHPC, 29Si and 27Al MAS NMR, Nanoindentation, quantitative XRD