LABORATORY OF CONSTRUCTION MATERIALS

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

XRD applied to cementitious materials

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Anhydrous materials

- **Solid reaction kinetics investigation, C_3S synthesis[1]**
- **Mineral composition:**

✓ cement, SCMs (fly ash, slag, calcined clay)

✓ blended cement (amorphous content) can be obtained by applying Rietveld analysis based XRD experiments. Examples were shown in the table on the right.

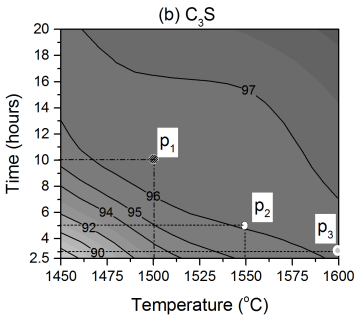


Fig. 1 Contour plot of C_3S content (%) against the sintering time and temperature. P1-P3 are the possible parameters for C_3S synthesis depend on the furnace

Phases (%)	CEM1	SFA
C3S	61.7±0.4	--
C2S	13.4±0.3	--
C3A cubic	3.1±0.2	--
C4AF	10.4±0.3	--
Periclase	0.3±0.1	--
Lime	0.3±0.1	--
Anhydrite	0.4±0.2	--
Gypsum	4.5±0.2	--
Bassanite	1.3±0.2	--
Calcite	4.6±0.3	
Quartz	--	10.6±0.3
Mullite	--	18.3±0.5
Amorphous	0	71.1±1.0
Sum	100	100

Table 1 Minerological composition of the CEM1 and fly ash (SFA)

Hydrated cement

- **Degree of hydration for clinker**
- **Crystalline hydrates: Portlandite, Ettringite, etc.**
- **Total amorphous content**
- **Degree of hydration for SCMs (PONKCS method)**

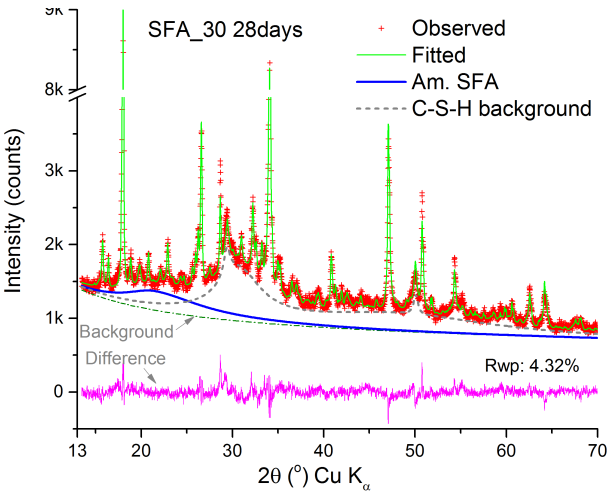


Fig. 3 The decomposition of the Rietveld analysis of the 30% fly ash replacement sample (SFA_30) hydrated for 28 days[2]

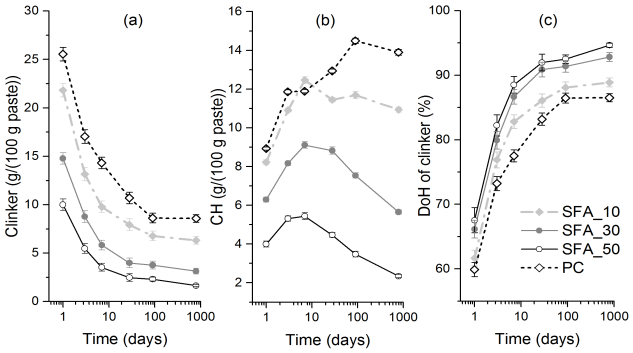


Fig. 4 Clinker content (a), Portlandite content detected (b) and the corresponding degree of hydration of the clinker (c)

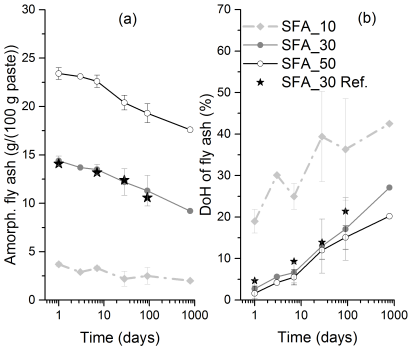
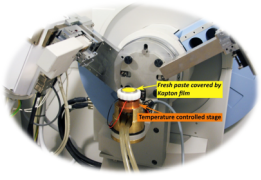


Fig. 5 Amount of amorphous fly ash (a) detected and the corresponding degree of hydration for the fly ash, SFA_10, SFA_30 and SFA_50 referred to 10, 30 and 50 wt.% replacement of blended cement

Other applications

- **In-situ XRD for hydration**
- **Hydration at early ages (~1 day), The sample is sealed with Kapton© film and measured continusly using the customed sample staged.**



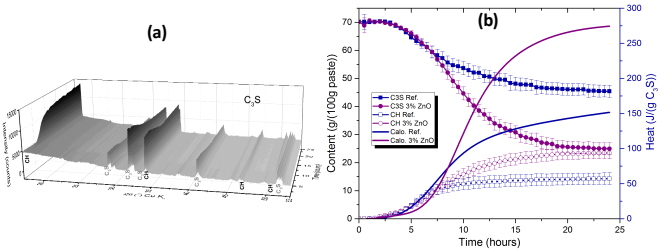


Fig. 6 (a) XRD pattern of the in-situ hydration of C_3S; (c) Quantitative results for in-situ XRD of C_3S hydration[3]

Notes * Room MXG234, xuerun.li@epfl.ch
a: See more fundamentals in Ch.4 of "*A Practical Guide to Microstructural Analysis of Cementitious Materials*",
b

References
[1] X. Li, A. Ouzia, K.L. Scrivener, Laboratory synthesis of C3S on the kilogram scale. Cem. Concr. Res. 2018
[2] X. Li, R. Snellings, K.L. Scrivener, Quantification of amorphous siliceous fly ash in hydrating blended cements by X-ray powder diffraction, manuscript in preparation
[3] X. Li, K.L. Scrivener, Impact of ZnO on the C3S hydration, manuscript in preparation