

# Technological and crystal-chemical aspects of nano-dispersions of hydrous silicates as cement additives.

## Part 2: Kinetics and crystal-chemical aspects

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*Maria Chiara Dalconi*

*Luca Valentini*



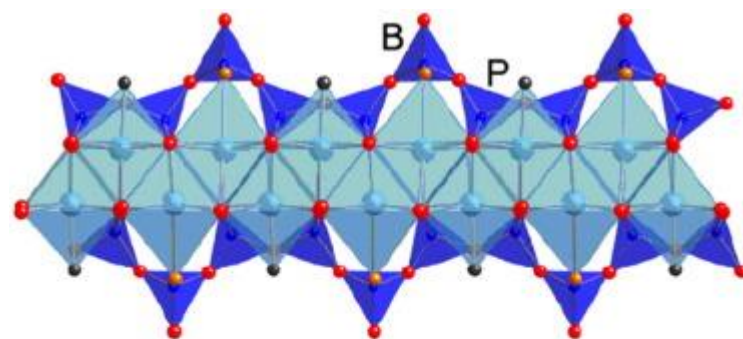
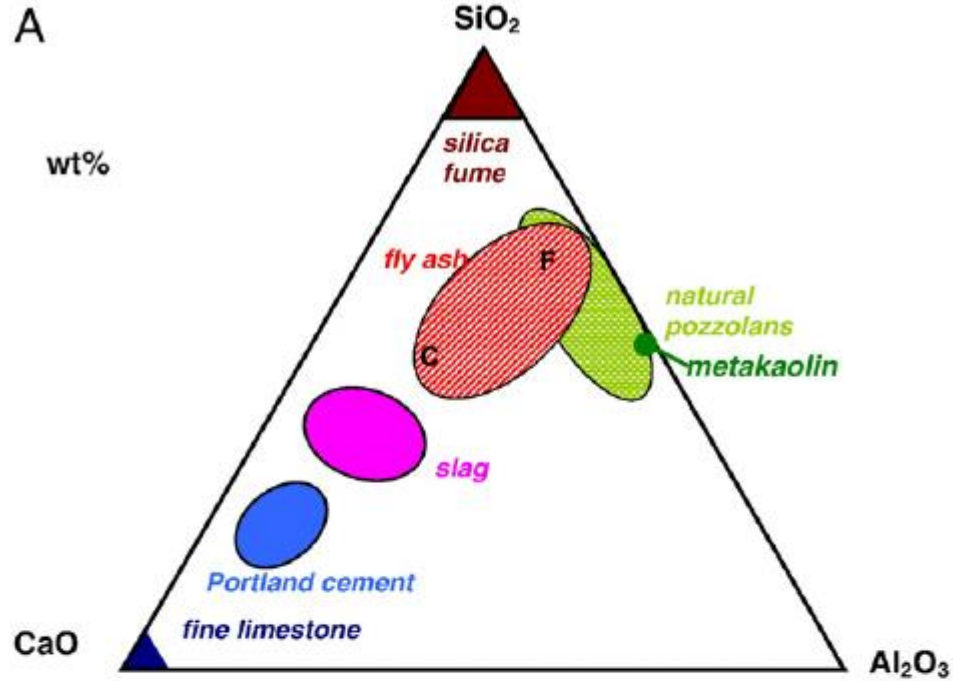
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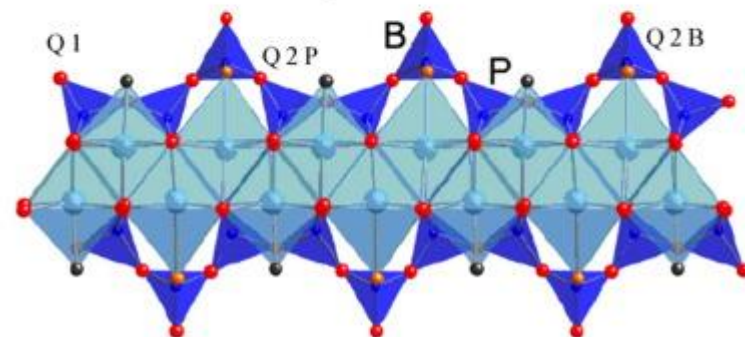
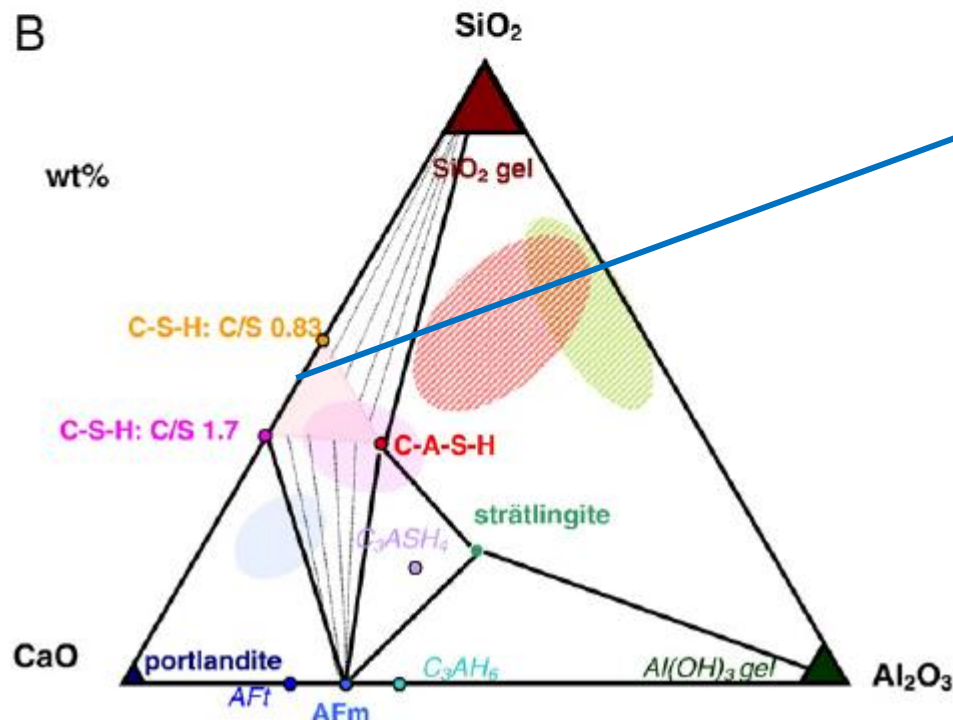
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A



B



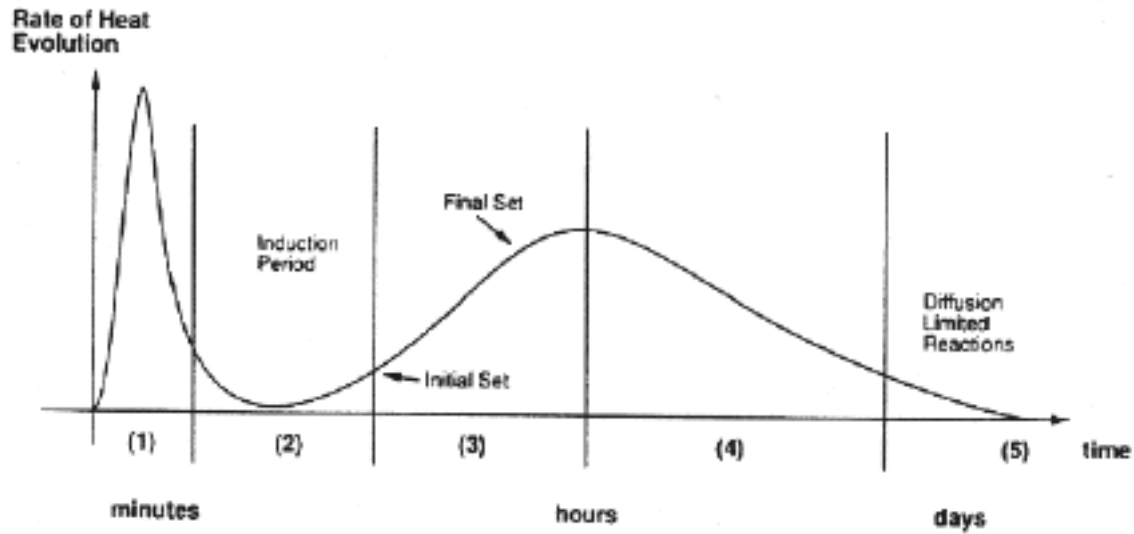
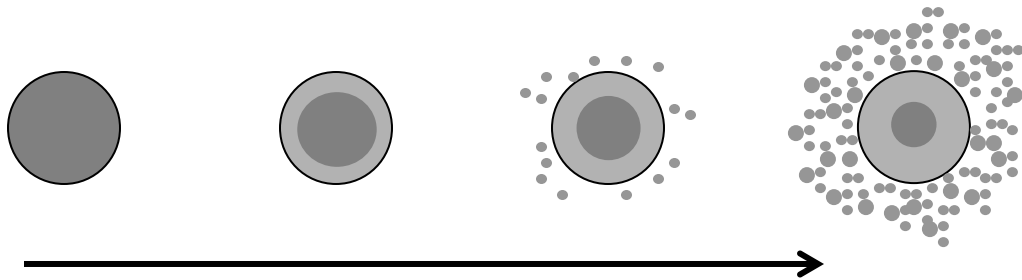
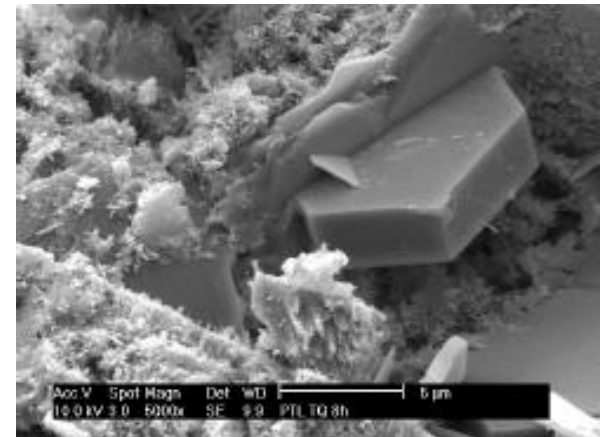
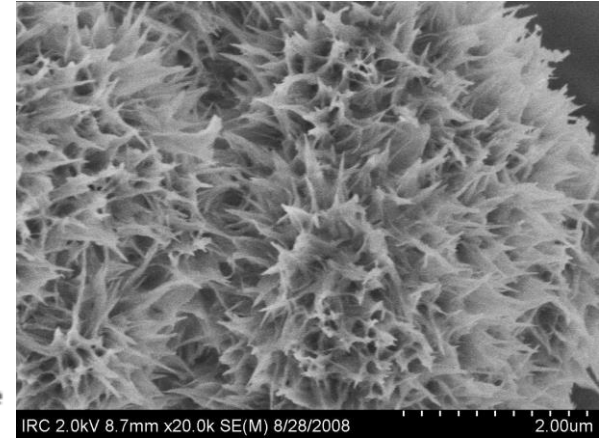


Figure 2. Stages in the hydration of cement.



Hydration process

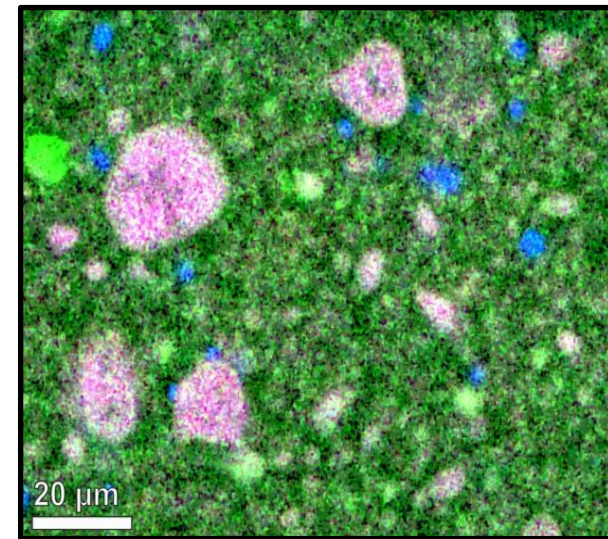
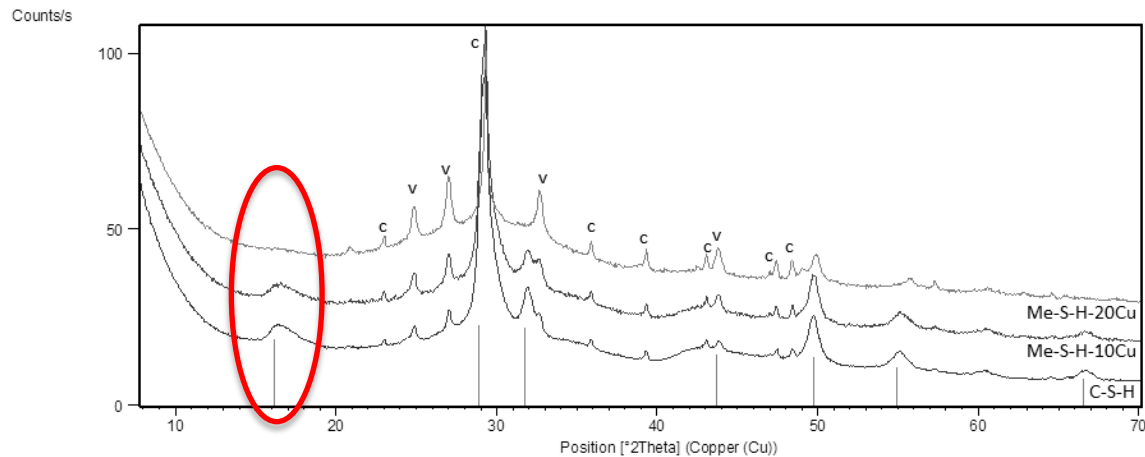


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Dispersion	Theoretical Cu/Ca (mole %)	(Cu+Ca)/Si (molar)	Total solids content (%)	BET (m <sup>2</sup> /g)	Color
Me-S-H 20Cu	20	1.1	21.6	420	Dark Blue
Me-S-H 10Cu	10	1.1	21.7	388	Blue
C-S-H	0	1.1	21.5	320	white

**Pink:** Si-rich “tobermorite-like” phase  
**Blue:** CaCO<sub>3</sub> phases (calcite and vaterite)  
**Green:** Cu-rich amorphous phase



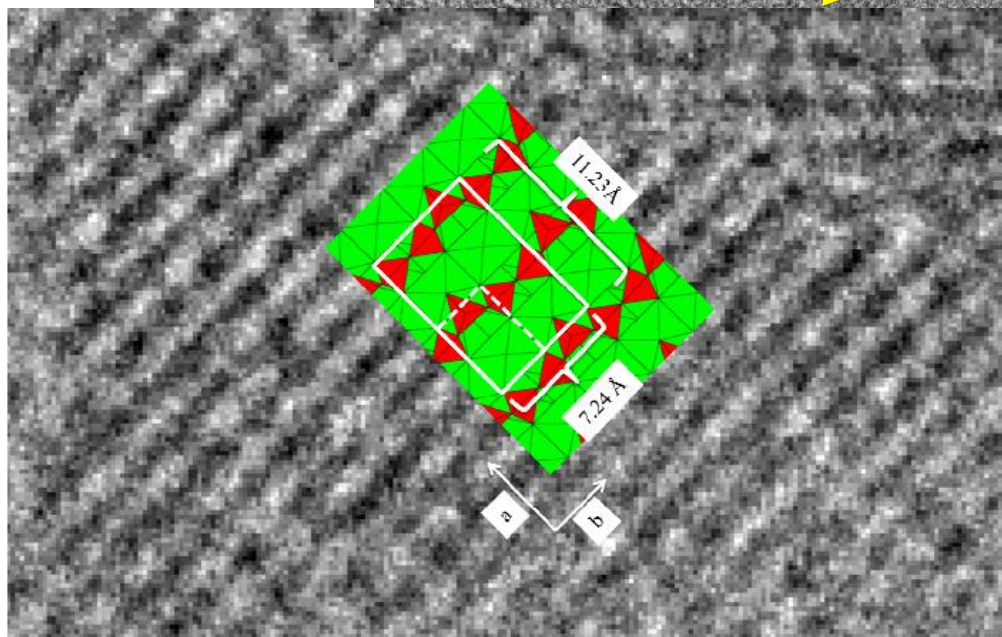
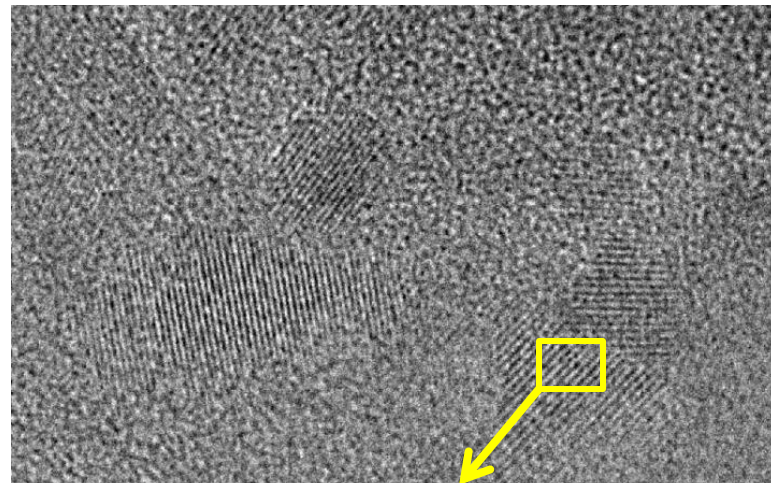
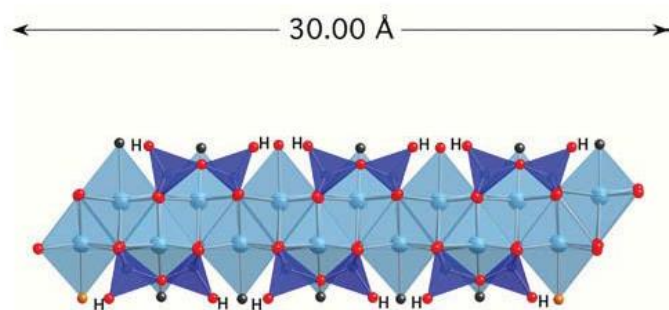
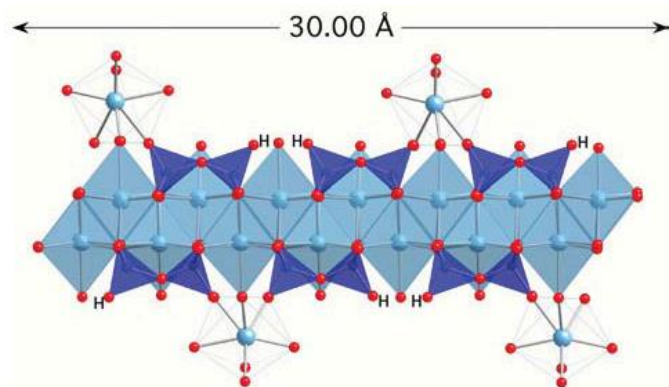
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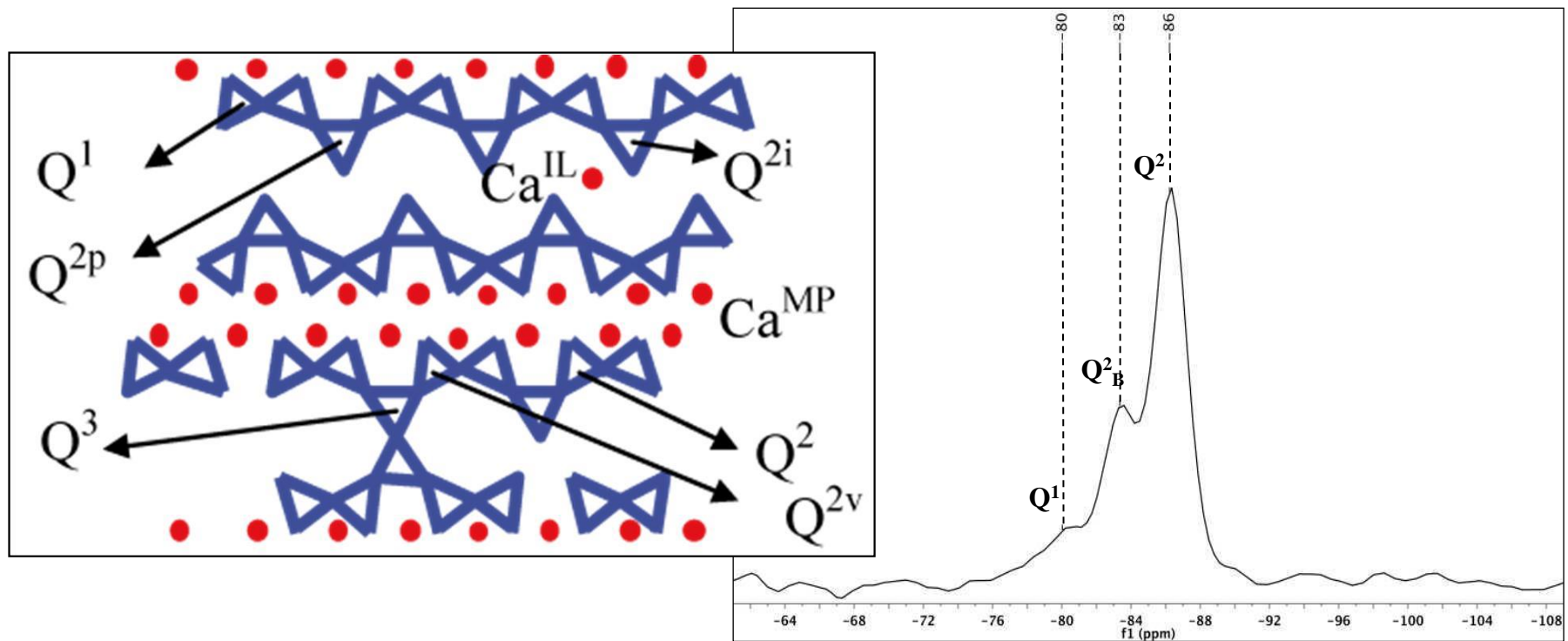


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The deconvolution of the peaks affords the following distribution

18.5%	Q1
21.5%	Q2B
60.0%	Q2

$$MCL = 2 \cdot \frac{(Q^1 + Q^2 + Q_B^2)}{Q^1} = 10.8$$

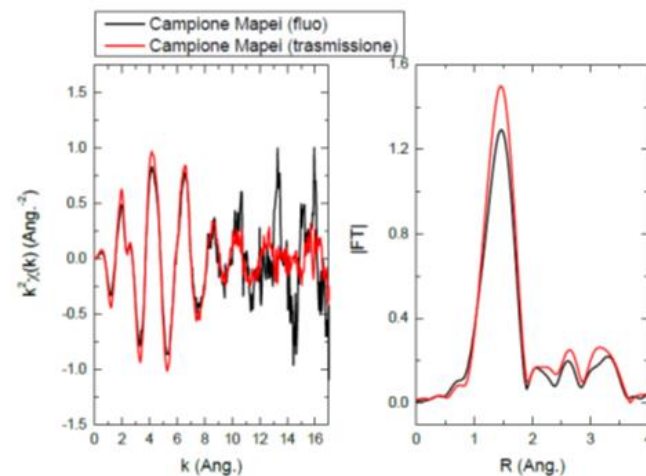
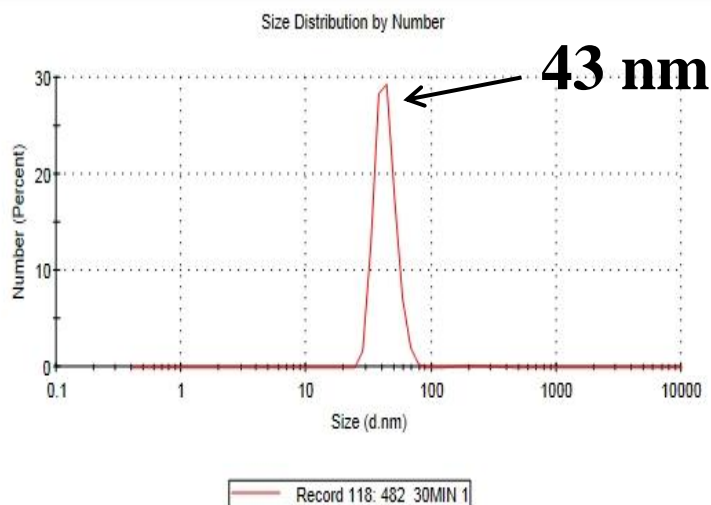
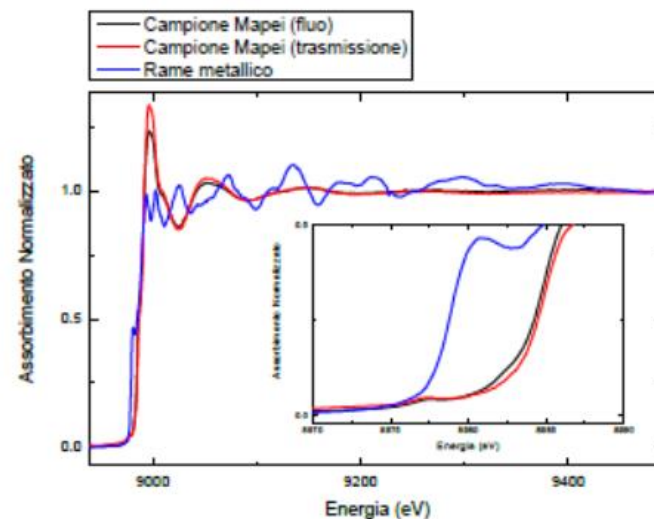
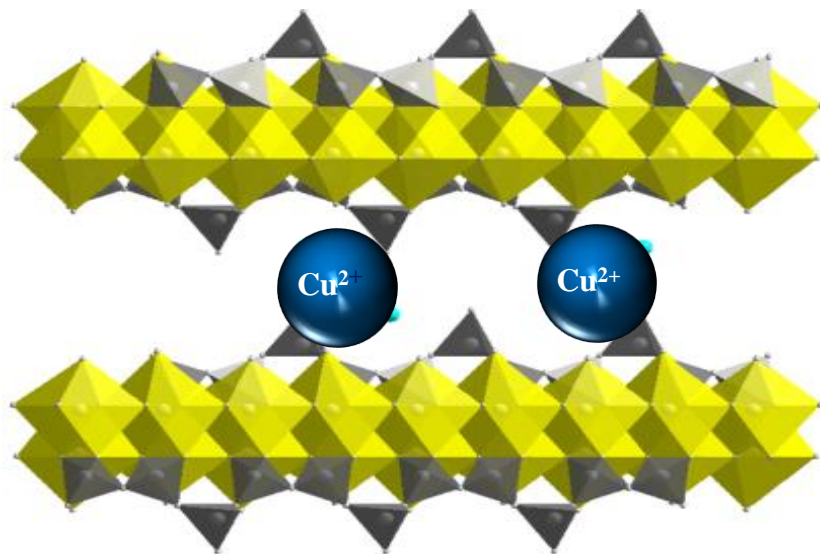


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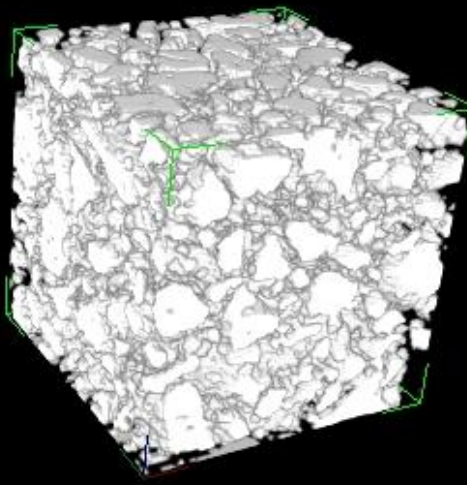
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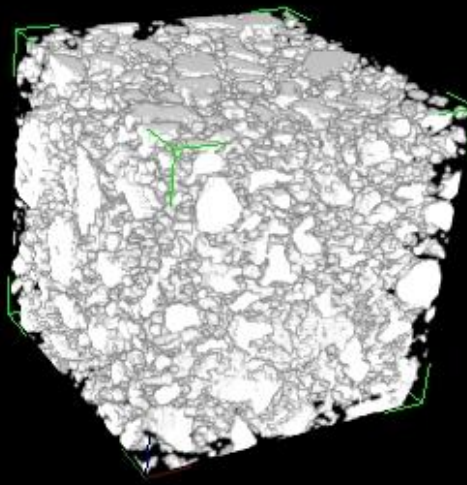
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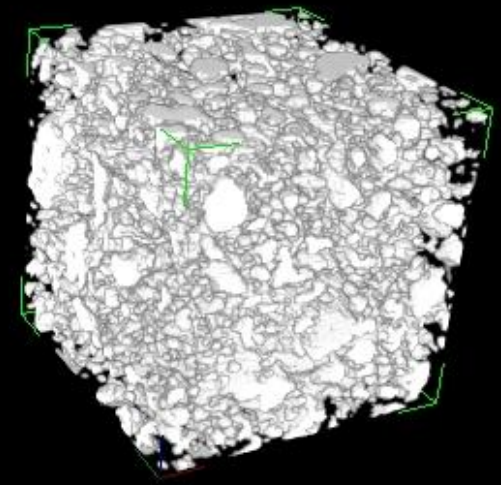




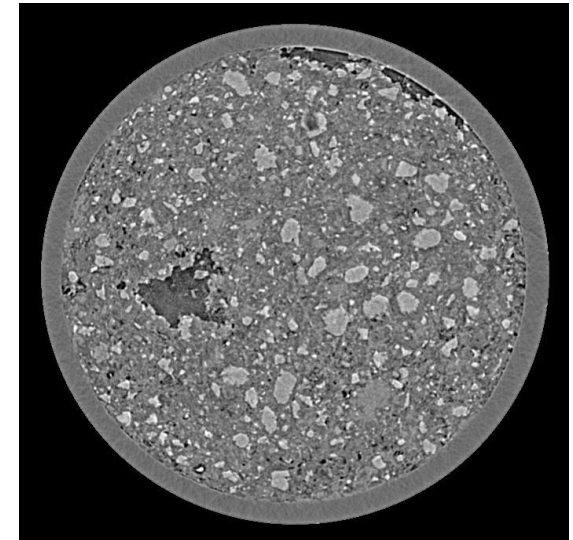
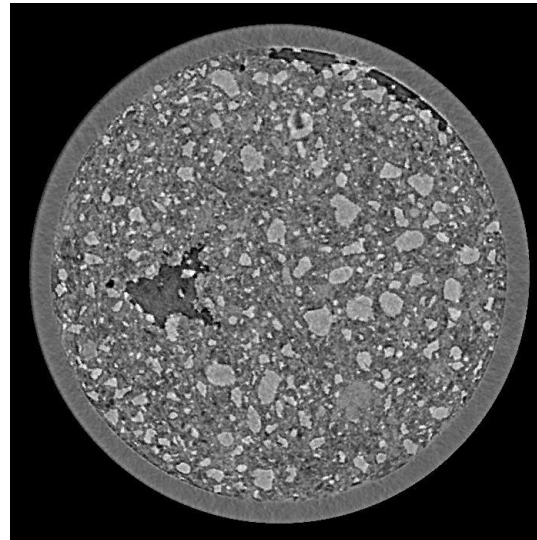
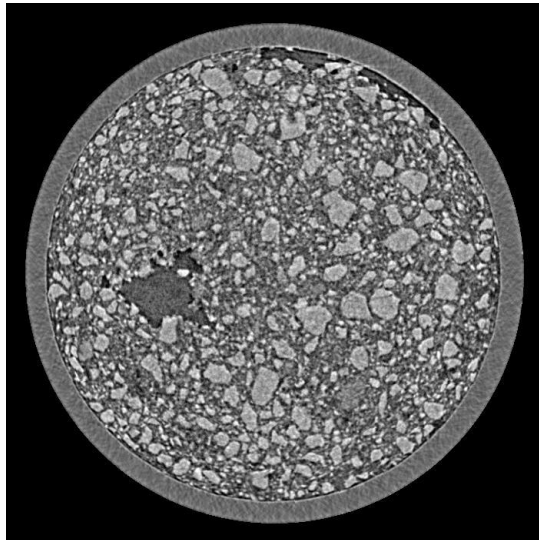
OPC 8 h



OPC 24 h



OPC 72 h



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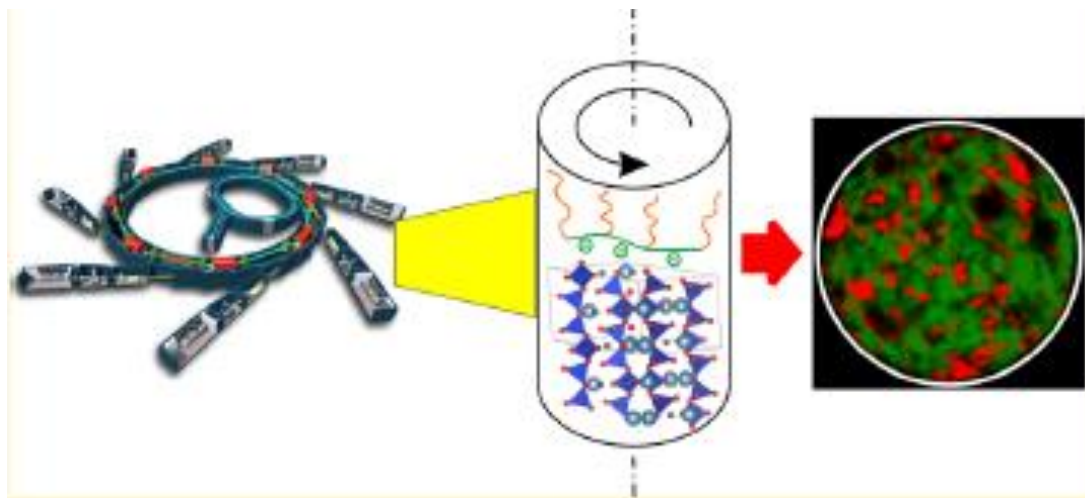
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# Direct Imaging of Nucleation Mechanisms by Synchrotron Diffraction Micro-Tomography: Superplasticizer-Induced Change of C–S–H Nucleation in Cement

Gilberto Artioli,<sup>§</sup> Luca Valentini,<sup>\*,§</sup> Marco Voltolini,<sup>†</sup> Maria C. Dalconi,<sup>§</sup> Giorgio Ferrari,<sup>‡</sup> and Vincenzo Russo<sup>‡</sup>

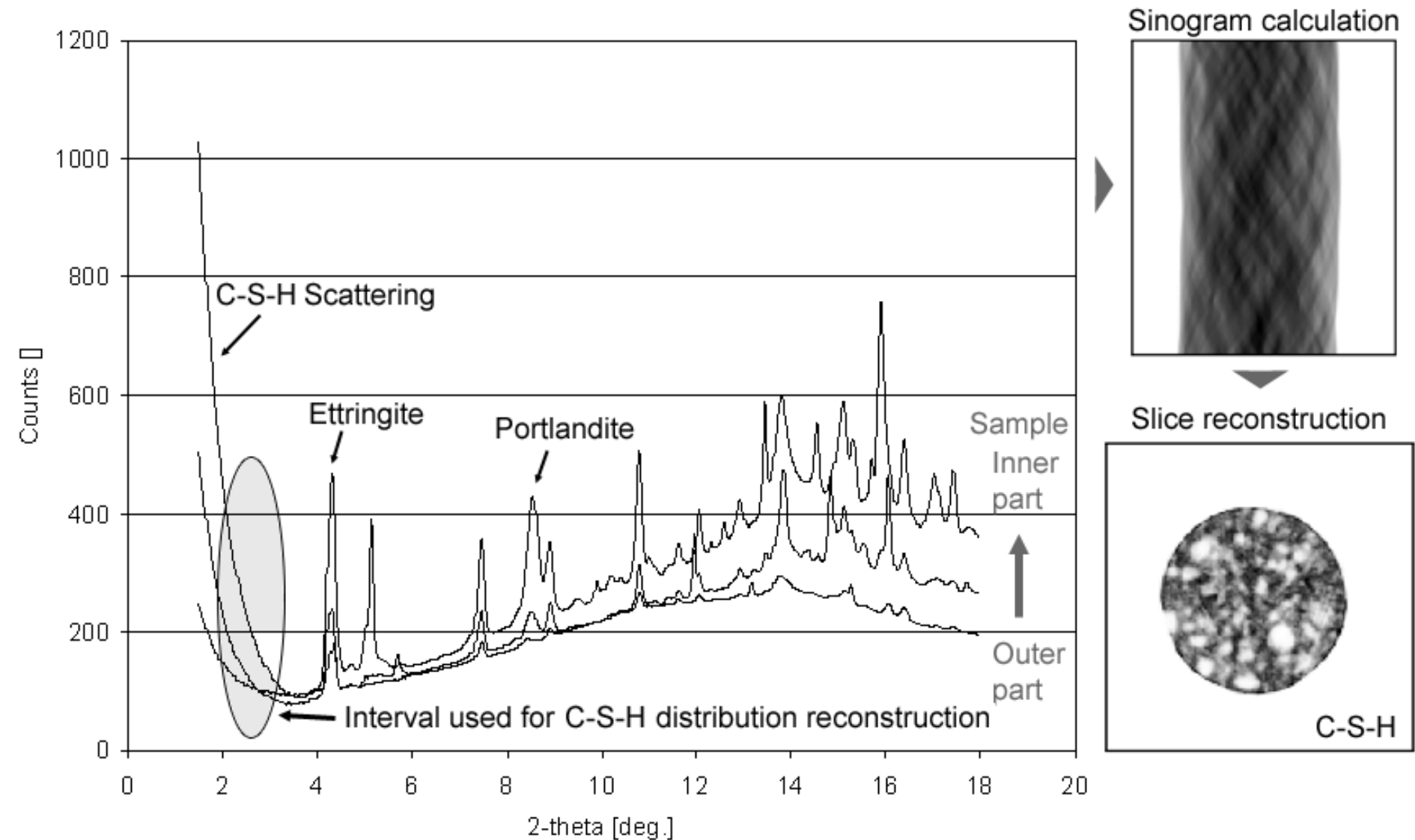


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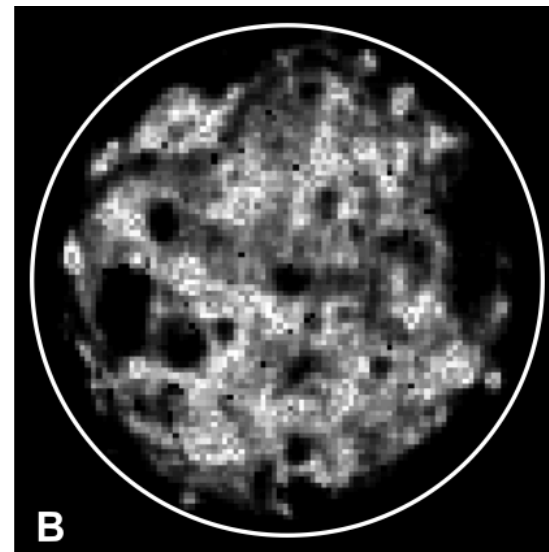
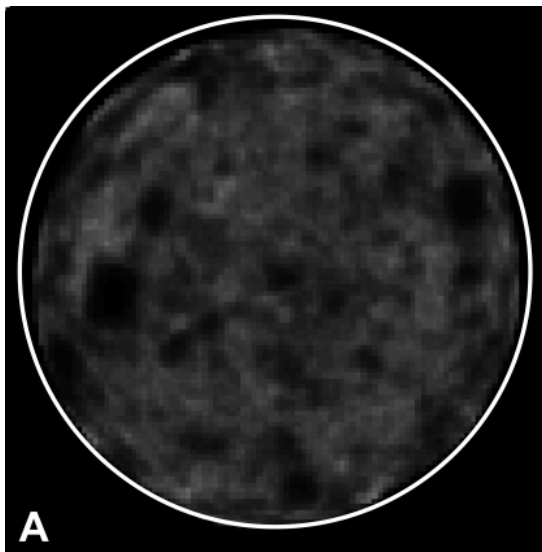
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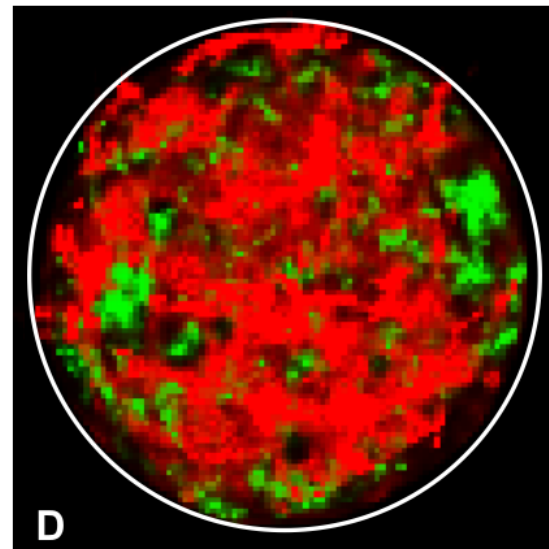
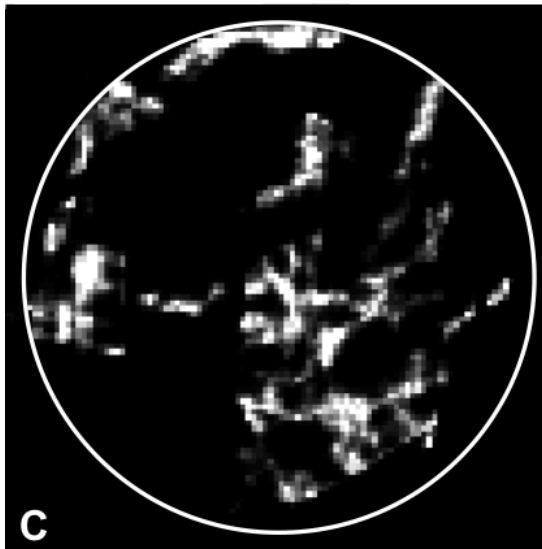
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ettringite



C-S-H

portlandite



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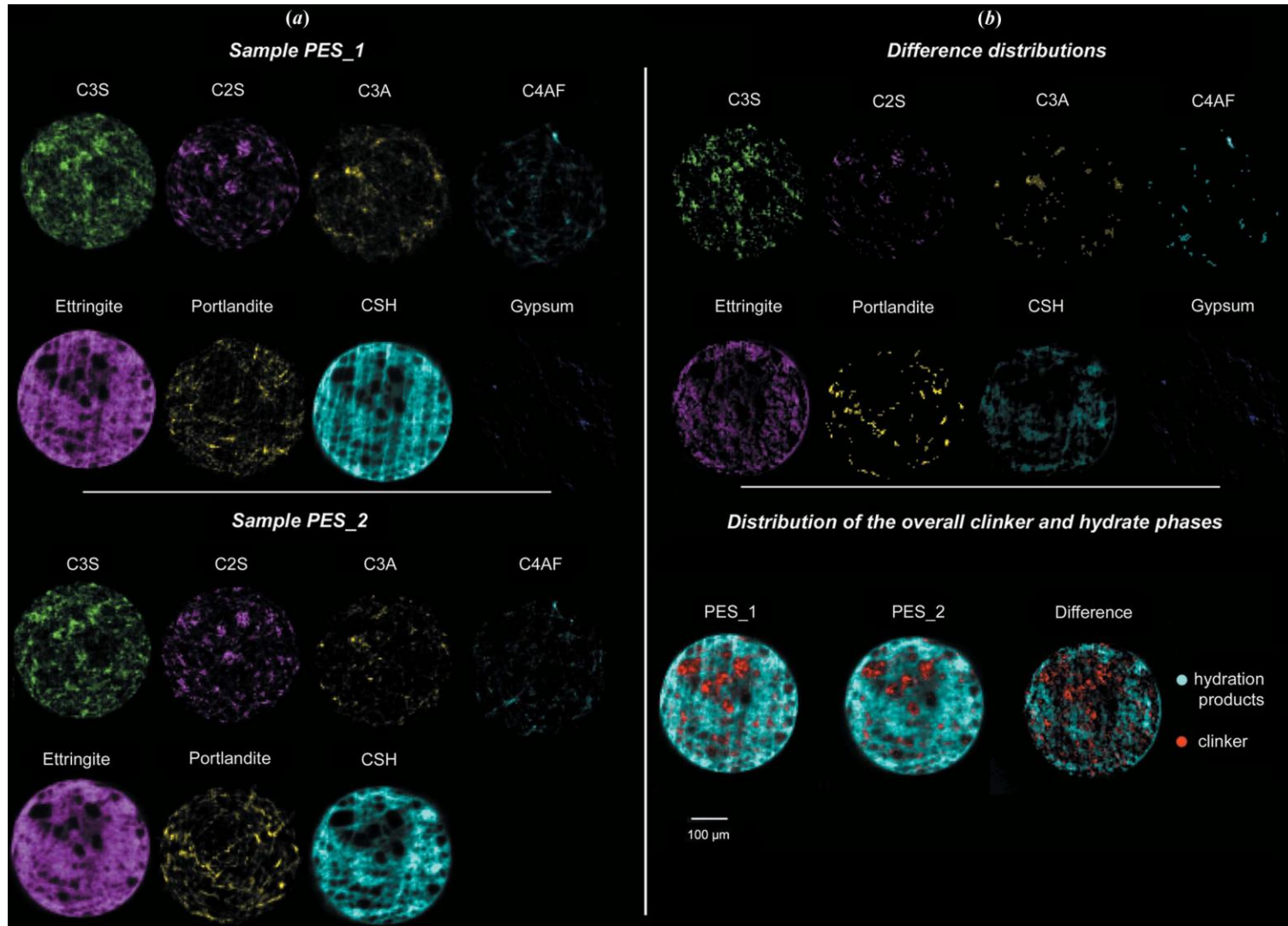
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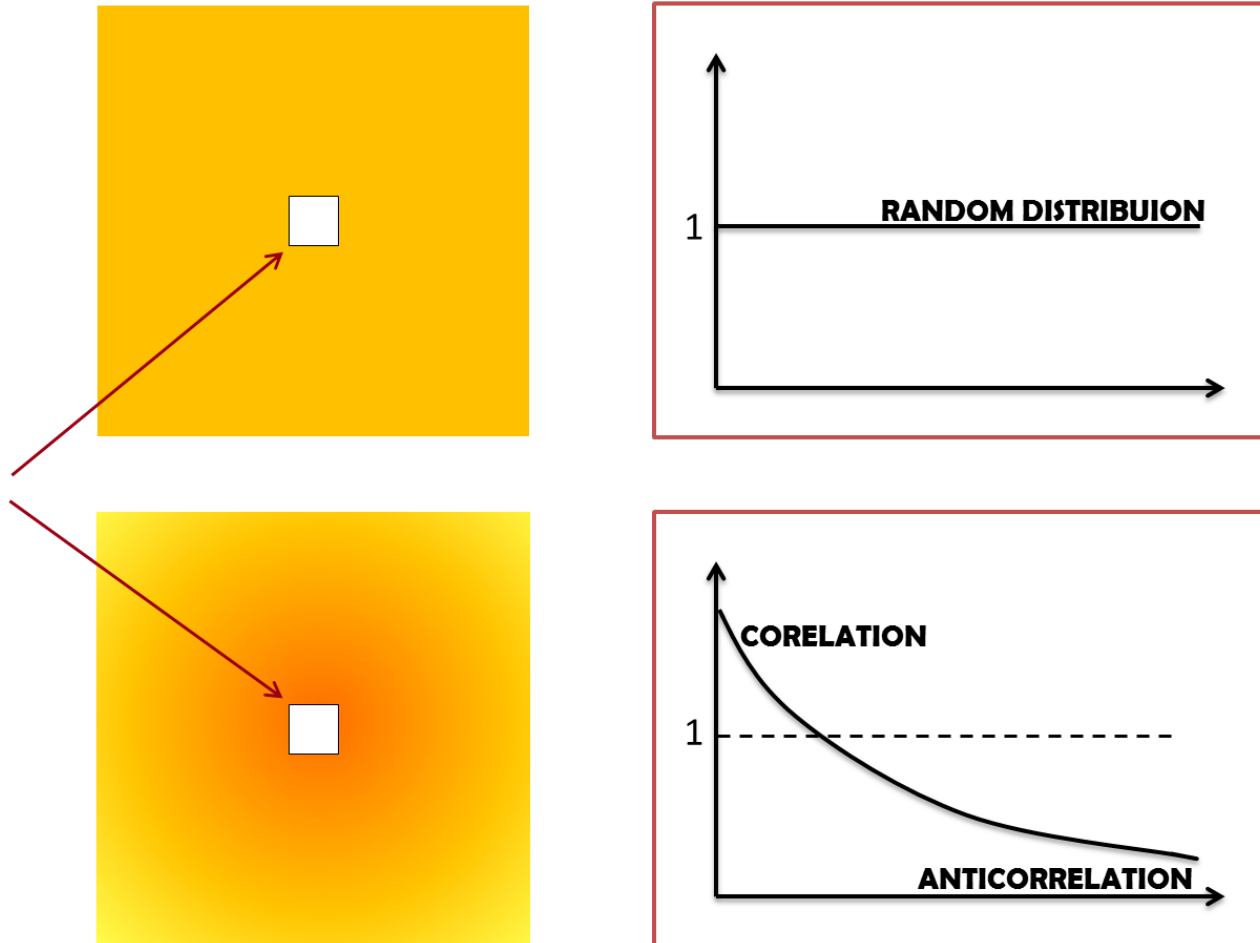


# Time-resolved diffraction tomography $\rightarrow$ $\Delta$ -maps

$$G_i^\Delta(t_\Delta, x, y) = |G_i(t_2, x, y) - G_i(t_1, x, y)|$$



# Radial distribution functions

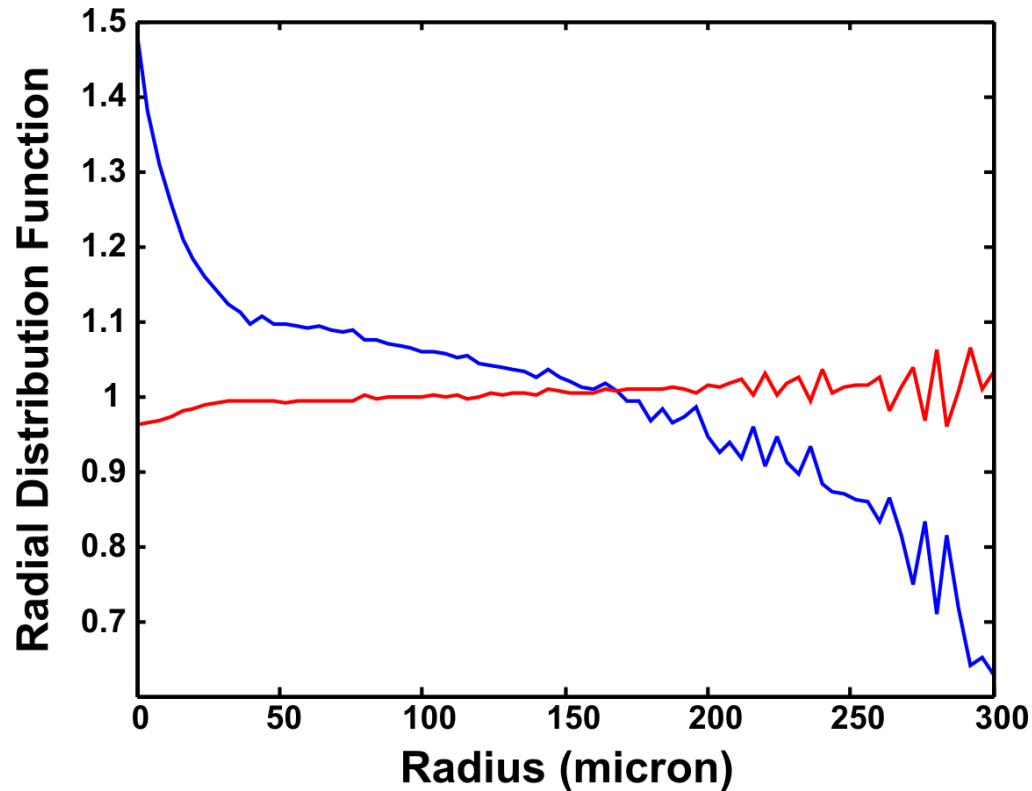


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Radial functions pertaining to different nucleation mechanisms.

The **blue curve** indicates heterogeneous CSH nucleation from the surface of the dissolving C3S particles, whereas the **red curve** indicates homogeneous growth from the CSH seeds dispersed in the cement pores.



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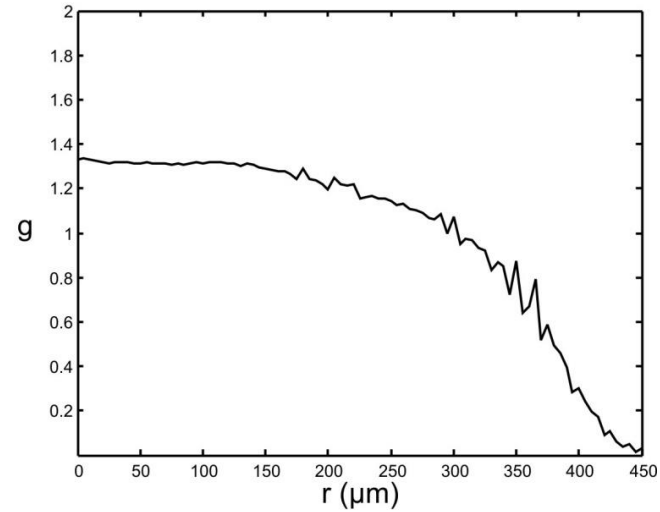
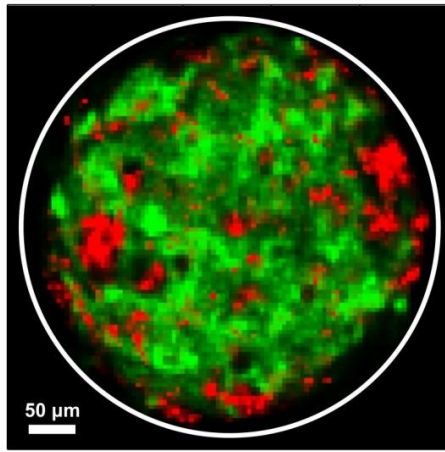
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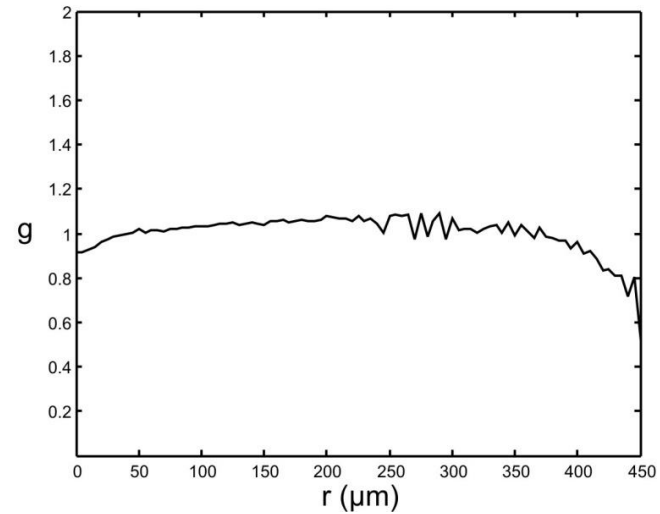
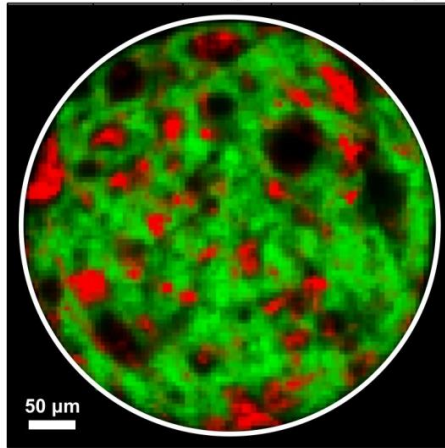
**SAMPLE S3 (OPC)**

time = 1 week



**SAMPLE S4 (OPC + Sp1)**

time = 1 week



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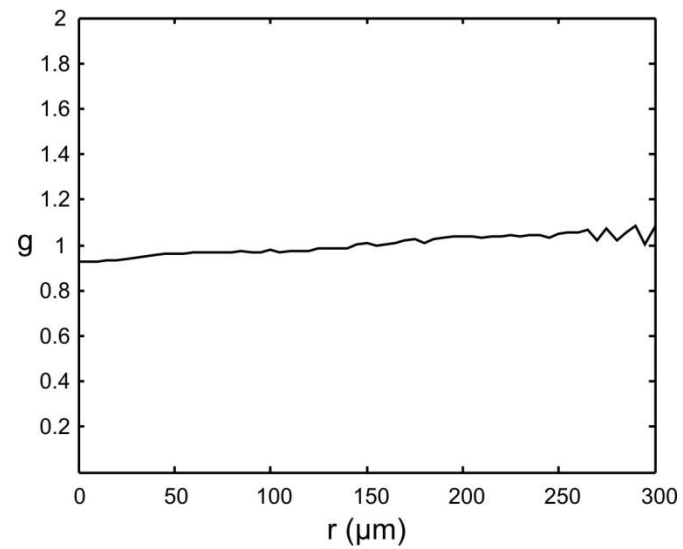
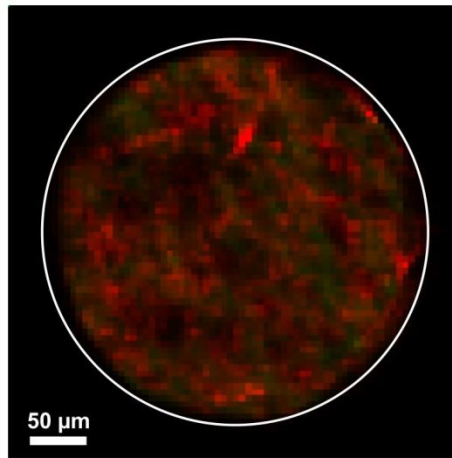
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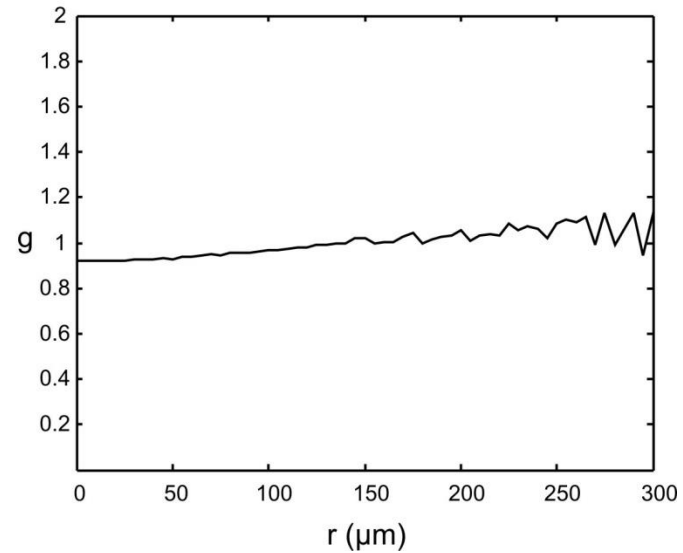
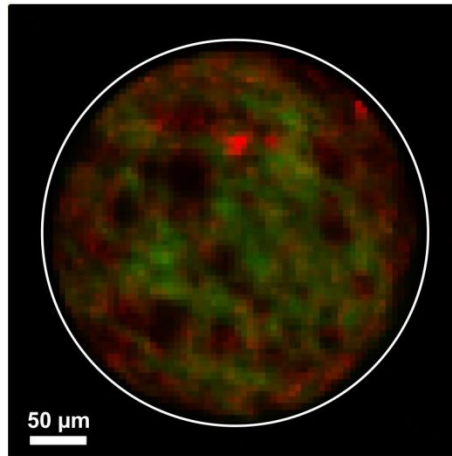
### ***SAMPLE CSH seeded***

t = 2 hours



### ***SAMPLE CSH seeded***

t = 13 hours



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# Kinetic Model of Calcium-Silicate Hydrate Nucleation and Growth in the Presence of PCE Superplasticizers

Luca Valentini,<sup>\*,†</sup> Marco Favero,<sup>†</sup> Maria C. Dalconi,<sup>†</sup> Vincenzo Russo,<sup>‡</sup> Giorgio Ferrari,<sup>‡</sup> and Gilberto Artioli<sup>†</sup>

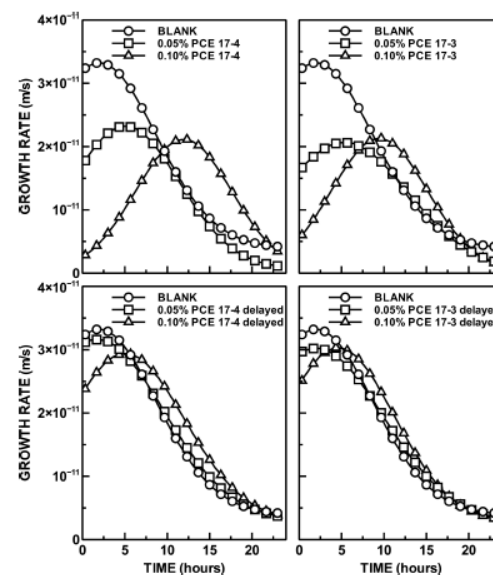
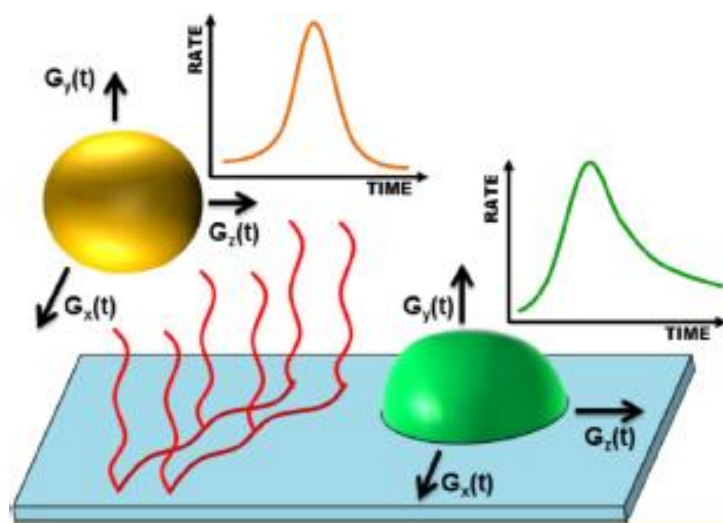


Figure 7. Time-dependent rate of C–S–H growth in pure water and in the presence of PCE (added in the mix water or in delayed mode) resulting from the kinetic model.



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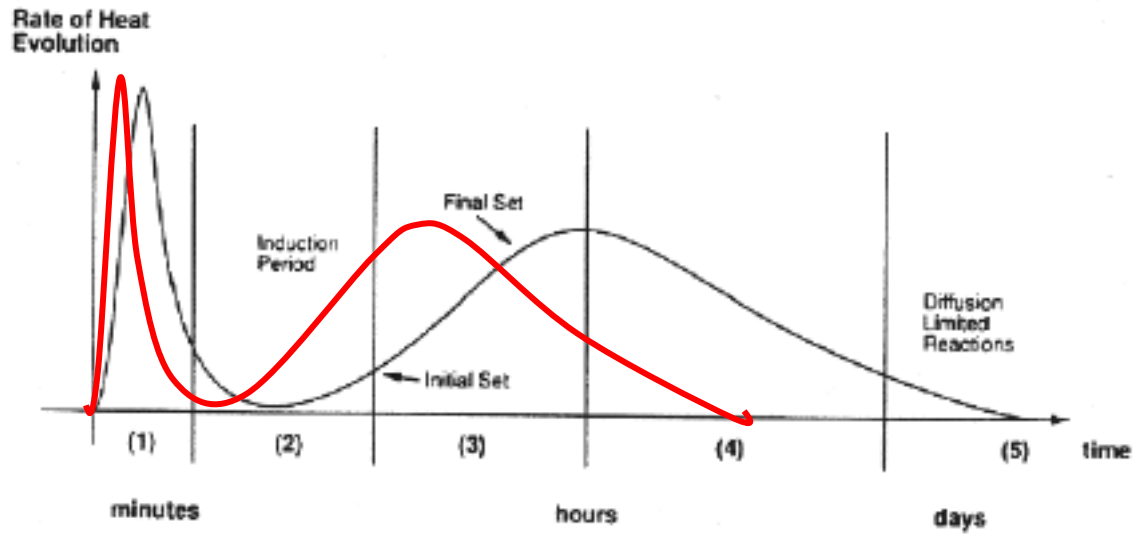
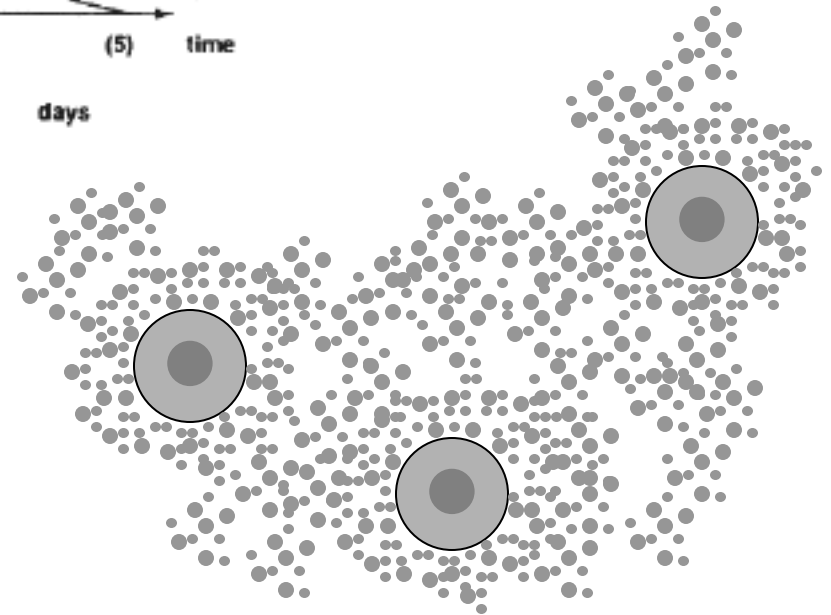
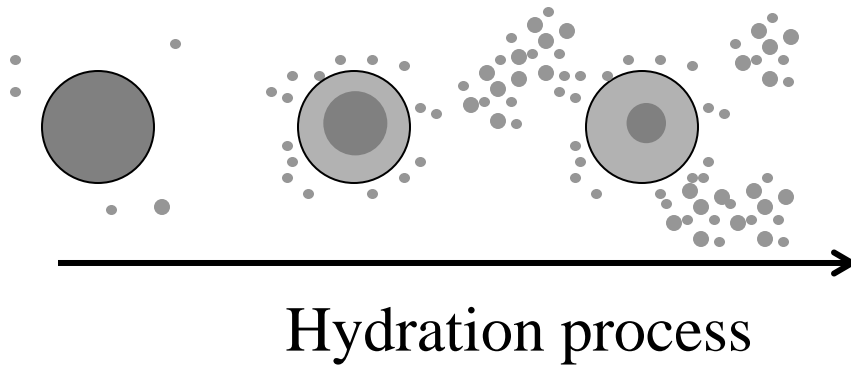


Figure 2. Stages in the hydration of cement.



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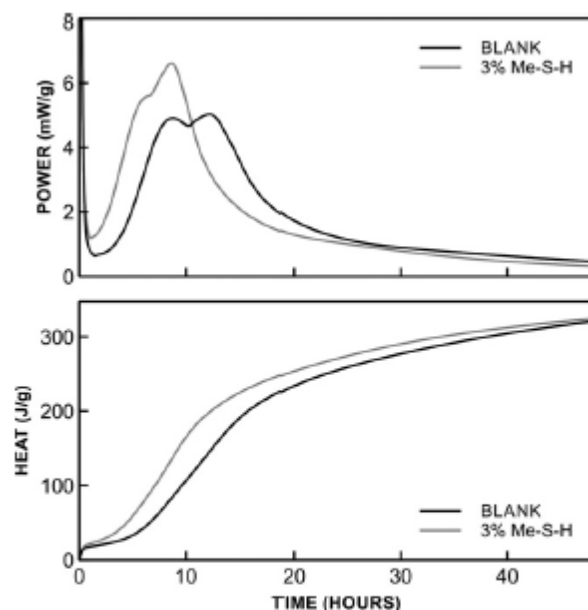
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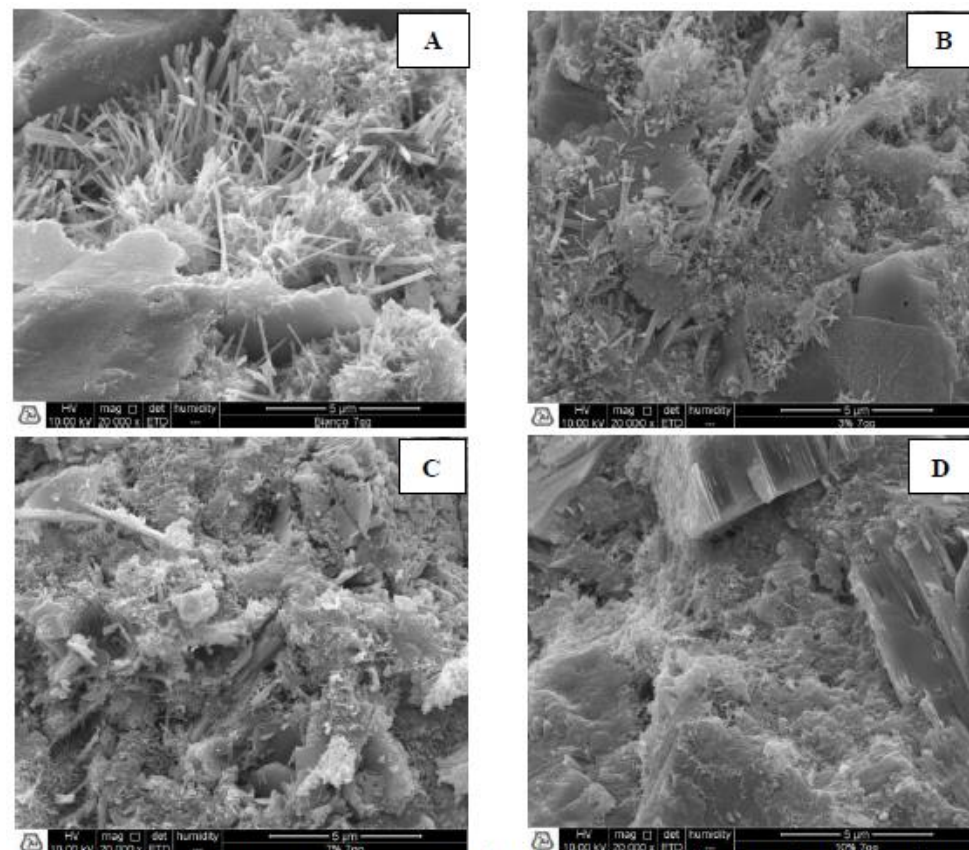
## ORIGINAL ARTICLE

## Use of nanocomposites as permeability reducing admixtures

Luca Valentini<sup>1</sup>  | Giorgio Ferrari<sup>2</sup> | Vincenzo Russo<sup>2</sup> | Mateja Štefančič<sup>3</sup> |  
Vesna Zalar Serjun<sup>3</sup> | Gilberto Artioli<sup>1,4</sup>



**FIGURE 1** Results of isothermal calorimetry measurements performed on cement pastes in the absence and in the presence of Me-S-H nanoparticles



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**Thank you  
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