**Introduction**

- Superplasticizers are now frequently used in cement industry to improve the workability in order to achieve high strength and durability in specific demanding applications. But these polycarboxylate ether (PCE) based superplasticizers are often associated with undesired retardation of cement hydration.
- With the help of modeling and standard characterization techniques, this project tries to study the interaction of PCE on alite hydration specifically the induction (stage 2) and acceleration (stage 3) period of the hydration curve shown. The retardation effect of PCE is due to the interaction in this regime.

**Grid model**

- Cylindrical disks nucleate on inert spherical substrate
- T - transversal growth rate
- R - radial growth rate
- Number of plates (NP) - number of disks that can grow in different directions from one disk
- Nucleation density (ND) – initial number of disks
- Nucleation rate (NR) – number of discs formed at each step

**Hypothesis**

A non classical nucleation and growth mechanism tested shown in the schematic on top right

\[ \text{Nucleation} \to \text{Nucleation} & \& \text{growth} \to \text{Only growth} \]

Retardation effect simulated by stopping
- conversion of cluster to a nucleus
- and/or growth of one of the branches of a growing nucleus

**Calorimetry: Alite + PCE**

- NS 28 – fast adsorbing
- NS 31 – slow adsorbing

Similar trend observed in OPC
- PCE acts mainly on alite hydration

**SEM**

1. Alite
2. Alite + 1% Gypsum
3. Alite + 1% Gypsum + 0.2% NS 31
4. Alite + 1% Gypsum + 0.1% NS 28

**Conclusion**

- Grid model is able to produce the initial morphology of C-S-H growth
- Delayed formation of C-S-H does not affect its morphology
- PCEs mainly act on alite hydration in OPC
- Adsorbed PCE could be interacting with the dissolution and/or the nucleation and growth of C-S-H
- Integrating dissolution and diffusion mechanisms in the model could give insights into which one of the above mechanisms is rate limiting

**Comparison of results**

- Slow adsorbing
- Fast adsorbing

**Simulation**

- No retardation
- With retardation (dark blue)