# Polymers for green cements: a new chemistry to reduce the environmental impact of cements

Cement production is responsible for about 7% of worldwide $CO_2$ emission. There is thus an urgent need to reduce the carbon imprint of cement. This leads to the conception of totally new mineral binders based on industrial by-products. However, these new cements have usually a low calcium content and thus need to be chemically activated by an alkali solution.

As it turns out, the polymers used by the cement industry to fluidify cement pastes are inefficient in alkali-activated cements. A recent PhD thesis conducted in our laboratory on this topic has shown that this is largely because the conformation and solubility of polymers change in alkali solutions. This impacts their adsorption on the cement grain and changes the rheology of the paste.

We are looking for an intern whose goal would be to provide a better understanding of what are the physical phenomena influencing polymer adsorption on low calcium cements and how it can be related to the rheology of the cement paste.

This interdisciplinary project involves a good comprehension of polymer and colloids physics but the work will be mainly experimental. The principal methods to be used are: NMR, Size exclusion chromatography (SEC), light scattering, rheology, TOC (Total Organic Carbon).

Besides working daily with the academic team at SIMM, the student will have to interact and report to the industrial partner CHRYSO SAINT GOBAIN. Good communication skills are thus required.

Necessary qualities:

- General knowledge of polymer and of characterization methods;
- General knowledge of the physical chemistry of colloids;
- Experimental skills;
- Reporting and communication skills.

The SIMM laboratory is located at ESPCI Paris, a world-renown research institution and a member of the PSL Research University, in the heart of the Parisian Latin Quarter.

CHRYSO SAINT-GOBAIN is one a main supplier of organic admixtures to the cement industry. It has an active and successful R&D department.

We have several PhD openings on this or related topics next year, funded by the industry and in collaboration with a consortium of European universities.

The position is open and will be filled as soon as the candidate is identified. Interested applicants should send a CV and contact information to: jean-baptiste.despinose@espci.fr and nicolas.sanson@espci.fr, Soft Matter Science and Engineering Laboratory, ESPCI Paris PSL.

Papers typical of research conducted in the SIMM lab on this topic are:

C. Paillard et al., “The Role of Solvent Quality and of Competitive Adsorption on the Efficiency of Superplasticizers in Alkali-Activated Slag Pastes,” *Cement and Concrete Research* 163 (2023): 107020, https://doi.org/10.1016/j.cemconres.2022.107020.

Claire Giraudeau et al., “Surface and Intercalation Chemistry of Polycarboxylate Copolymers in Cementitious Systems,” *Journal of the American Ceramic Society* 92, no. 11 (2009): 2471–88, https://doi.org/10.1111/j.1551-2916.2009.03413.x.

M. Palacios et al., “Early Reactivity of Sodium Silicate-Activated Slag Pastes and Its Impact on Rheological Properties,” *Cement and Concrete Research* 140 (2021): 106302, https://doi.org/10.1016/j.cemconres.2020.106302.

Elizaveta Pustovgar et al., “Understanding Silicate Hydration from Quantitative Analyses of Hydrating Tricalcium Silicates,” *Nature Communications* 7 (2016): 10952, https://doi.org/10.1038/ncomms10952.