

# Geopolymerization: a new route to reduce the environmental impact of cements

The reduction of the carbon imprint of cement production leads to the conception of totally new mineral binders. These binders can be totally devoid of ordinary cement, replacing it with reactive silica sources that are industrial by-products.

The hardening of these materials follows a completely different scheme than traditional cements. It does not involve the precipitation of calcium silicates but the polycondensation of silicate and aluminate moieties. This is why they can be viewed as geo-“polymers”.

To adopt such a solution, the industry needs a better fundamental comprehension of the chemical mechanisms at stakes in order to identify leverages to control the polycondensation reaction and its consequences in terms of fluidity, time of operation and ultimate mechanical resistance.

We are looking for a PhD candidate to study the geopolymerization reaction and ways to control its kinetics as well as characterize the rheological and mechanical properties of the paste. This is thus a highly multidisciplinary PhD topic that will be carried on as a CIFRE thesis in collaboration with an industrial group active in the field of construction materials.

Although the study will target specific applications, we will focus on basic understandings of the relevant bulk and interfacial chemistry by mobilizing state-of-the-art techniques such as multidimensional and DNP enhanced NMR, synchrotron x-rays and proton relaxometry. Macroscopic properties such as the rheological behavior and water sorption will be equally mobilized.

Applicants must hold a European master degree, a French engineering degree or a US bachelor degree in chemistry or physics, and have good reporting skills to interact efficiently with the industrial partner. A good command of either French or English is necessary.

The position is open and will be filled as soon as the candidate is identified.

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.

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

J. Aupoil, J.-B. Champenois, **J.-B. d’Espinoze de Lacaillerie**, A. Poulesquen, Interplay between silicate and hydroxide ions during geopolymerization, **Cement and Concrete Research**. 115 (2019) 426–432. doi:[10.1016/j.cemconres.2018.09.012](https://doi.org/10.1016/j.cemconres.2018.09.012).

E. Pustovgar, R.P. Sangodkar, A.S. Andreev, M. Palacios, B.F. Chmelka, R.J. Flatt, **J.-B. d’Espinoze de Lacaillerie**, Understanding silicate hydration from quantitative analyses of hydrating tricalcium silicates, **Nature Communications**. 7 (2016) 10952. doi:[10.1038/ncomms10952](https://doi.org/10.1038/ncomms10952).

A. Favier, J. Hot, G. Habert, N. Roussel, **J.-B. d'Espinose de Lacaillerie**, Flow properties of MK-based geopolymer pastes. A comparative study with standard Portland cement pastes, **Soft Matter**. 10 (2014) 1134. doi:[10.1039/c3sm51889b](https://doi.org/10.1039/c3sm51889b).

Interested applicants should send a CV and contact information for two references to : [Prof. Jean-Baptiste d'Espinose](#)  
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