The ISTerre (CNRS & University of Grenoble Alpes), in collaboration with the IACT (CSIC, Granada, Spain) and TITAN Cement Group, invites applications for a three-year PhD programme focusing on

Nucleation and growth rates of calcium carbonate in cement pores and surfaces

Cement is the single most used material in the world, and its fabrication accounts for about 8% of the total anthropogenic CO_2 emissions to the atmosphere. **Carbonation of cement materials** and of recycled concrete are foreseen as viable technologies for the decrease of the carbon footprint of the cement production and usage. However, several fundamental questions still need to be solved for these technologies to be implemented at a large scale. The formation mechanisms, the polymorph selection and the texture of the final carbonated materials are important fundamental points that need to be addressed for a sucessful implementation of carbonated cementitious materials.

In this project, the nucleation and growth pathways of $CaCO_3$ at solid-liquid-water interfaces will be studied. In situ experiments will be performed using a set of **lab-based characterization** instruments (FTIR, Raman, AFM, Quartz-Crystal microbalance, UV-vis). These will be complemented with surface-sensitive **synchrotron X-ray scattering** investigations to determine $CaCO_3$ nucleation pathways and rates. These studies will result in a comprehensive description of the properties of oxide surfaces that are most adequate to promote $CaCO_3$ formation, of the nucleation and growth rates, and of the polymorph of the final $CaCO_3$ phase formed. This information is pivotal for the effective implementation of carbonation solutions for the cement industry.

The PhD project is part of the CONTRABASS doctorate network (Marie Skłodowska Curie Actions), focused on the fundamental physico-chemical processes governing the carbonation of the clinker phases and the cement paste, as well as the subsequent formation of calcium carbonate cements (CCCs).

The PhD project will be located at the ISTerre laboratory in Grenoble (France). Research stays at IACT (Granada, Spain) and at TITAN (Athens, Greece) will be planned. The successful candidate will be employed for a period of up to three years, with a competitive UE salary, together with other benefits. A team of experts, including the teams at ISTerre and IACT, and interactions with our industrial partner TITAN, will supervise the work of the PhD student.

Applicants should have a degree in a relevant **chemistry, physical-chemistry or materials science** discipline. Academic knowledge of cementitious materials will be a plus. The application file should contain a detailed CV, copies of the university marks (Master level), a motivation letter and the names and contact information of at least two referees. Deadline for application is November 30th 2023.

Supervisors: Alejandro Fernandez-Martinez, ISTerre (CNRS & Univ. of Grenoble Alpes), Alexander Van Driessche (IACT-CSIC, Granada, Spain). Industrial supervisor: Vasileios Michalis (TITAN).

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