Chemistry of near zero or negative emissions concrete produced from waste CO_2, end-of-life concrete, and electricity

Supervisor (primary) Imperial College London: Dr. Rupert J. Myers

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Applications are invited for a PhD scholarship funded by the European Research Council Starting Grant project titled “Decarbonising cementitious materials through carbon capture and utilisation ($CO_2$4Cem)”.

In the future, concrete will have a near zero or negative CO_2 emissions footprint. It will be produced by mixing a novel cement made in electric furnaces and blended with carbonated end-of-life cement paste (produced by carbonating end-of-life concrete using waste CO_2), with water, sand, gravel, and waste CO_2 in manufacturing facilities (precast slabs, blocks) and/or in concrete trucks (ready-mix). The chemistry of this future concrete will be significantly different to the chemistry of the concrete that we use today.

The PhD student will experimentally investigate the chemistry of these low carbon concretes of the future. They will synthesise solid phases that are likely to be formed in these concretes (via hydration of the novel cement, and fresh concrete carbonation), and develop thermodynamic data and models for them. It is expected that these solid phases will include Fe(II), Fe(III), and Ca carbonates and (hydr)oxides, and that the work will advance the leading and widely used thermodynamic database for cements (CEMDATA: Lothenbach, B.; Kulik, D.A.; Matschei, T.; Balonis, M.; Baquerizo, L.; Dilnesa, B.; Miron, G.D.; Myers, R.J. *Cement and Concrete Research*, 115, 472-506, 2019). The PhD student will apply these data in thermodynamic modelling software, and use the results of this modelling to experimentally optimise the key processes involved in the production of future low carbon concrete such as the electric furnace, carbonation reactor, and batching of fresh concrete, as well as during concrete hydration/setting.

The PhD student will be based in the Materials Section of the Department of Civil and Environmental Engineering. This is a heavily experimental PhD project in materials chemistry that will utilise the suite of state-of-the-art materials characterisation equipment available in our Advanced Infrastructure Materials, Structures, and Environmental Laboratories, which is a world-class facility that is essentially unparalleled in terms of quality within the UK. This PhD project will be conducted alongside one other PhD student and two postdocs working on complementary topics within the $CO_2$4Cem project. This position offers a world-class range of training and development opportunities in a highly stimulating environment, as well as access to internationally leading academics and industrial partners, research facilities, and networks, which will likely include international research visits.

Academic requirements and experience

Required

- A first class degree (or international equivalent) in a STEM subject, e.g., Chemistry, Metallurgy, Physics, Materials Science, Chemical Engineering, Environmental Science, Geology), or a course with strong emphasis on chemistry.

- A masters level degree qualification in any course with a strong emphasis on chemistry or materials, as indicated above, alone or in addition to an undergraduate level degree.
- Laboratory experience.
- Strong interest in sustainability and research.
- Excellent English communication skills.

How to apply

Applicants wishing to be considered for this opportunity should send their CV including details of their degrees and ideally class ranking to Dr. Rupert J. Myers (r.myers@imperial.ac.uk):

Application via the Imperial College Registry is not necessary at this stage.

Applications will be regularly reviewed until the position is filled.

The start date of this PhD project is flexible within year 2024.

Funding notes

The studentship will provide funding for 4 years including tuition fees and a tax-free stipend at the standard UKRI London rate, £19,668 for the 2023/24 academic year.

Full funding is available to Home students. The funding can also be used to partly support an international student, and can be combined with other scholarship schemes (e.g. Skempton Scholarship).