

Reducing energy demand and CO₂ emissions from industrial ceramic manufacture through the use of novel raw materials and additives

How to apply

Applicants must email a [postgraduate application form](#) (including a 1500 word proposal) to meri@shu.ac.uk by 12 noon on Friday 24 February 2017.

Your application form should clearly indicate the project you are applying for and outline:

- a) why you are interested in doing PhD research on this topic
- b) how your skills and experience to date (including your undergraduate and/or masters dissertation, if relevant) prepare you to embark on the project
- c) any challenges that you foresee in conducting the research and how you might approach or solve them

Where English is not your first language, you must show evidence of English language ability to the following minimum level of proficiency: an overall IELTS score of 7.0 or above, with at least 6.5 in each component or an [accepted equivalent](#). Please note that your test score must be current, i.e. within the last two years.

Please view our [eligibility criteria](#) before submitting an application.

Selection process

Successful applicants will be required to attend an interview where you will be asked to talk through your research proposal.

Project details

Director of Studies: Dr Paul Bingham; Second Supervisor: Dr Hywel Jones

[Materials and Engineering Research Institute](#)

External partner: Wienerberger Ltd.

Project description:

This PhD project will research new methods for reducing energy demand and CO₂ emissions associated with brick and roof tile manufacture, presenting an opportunity to apply scientific excellence to real-world industrial problems [1].

You will explore the mineralogy, vitrification and high-temperature behaviour of raw materials, including novel fluxing agents and sintering aids. The vitrification period for brick and tile clays commences at ~900°C and extends to the highest temperature that the material can withstand without distortion, usually ~1200°C. During this vitrification period strength and other key

properties, including durability, develop. As temperature increases within the vitrification range, the clay increasingly melts. Remaining crystalline particles become coated with liquid which, when the brick is cooled, forms a glass that binds the crystalline particles together, providing high-strength, durable products. The extent to which clay melts during firing depends on temperature and time, which both carry significant energy demand and CO₂ emissions. It also depends on the raw material mixture and levels of fluxing agents therein. These improve properties or reduce the peak firing temperature / time, enabling reductions in energy and CO₂ emissions. Whilst limited studies of such additives have taken place [2, 3], successful adoption by industry has not yet occurred.

This project will significantly expand on current knowledge in this field, drawing on the supervisory team's expertise in ceramics and also in glasses, minerals and waste materials. Candidate fluxing agents will be identified and tested in formulations, focussing on the most promising candidates for detailed study of low-melting liquid formation, sintering behaviour, densification, vitrification, crystallisation, phase development and the physical properties of the resulting materials.

The research will involve multiple spectroscopic techniques including X-ray diffraction, X-ray fluorescence, thermal analysis (TGA, TG-MS), electron microscopy, Mössbauer and Raman spectroscopies, and optical, density and mechanical property analysis, to develop a fundamental understanding of these materials.

This work is in collaboration with our industrial partner, Wienerberger Ltd., the world's largest manufacturer of bricks and Europe's largest manufacturer of roof tiles. Wienerberger Ltd. is committed to responsible, sustainable manufacturing and reducing specific energy consumption and CO₂ emissions. You will gain vital industrial experience and professional development through visiting Wienerberger's UK sites and working with their staff throughout the project.

Successful applicants could receive the additional benefits of involvement in the University Alliance [Doctoral Training Alliance in Energy](#)

For further information, please contact Dr. Paul Bingham p.a.bingham@shu.ac.uk

References:

- [1] [U. K. Government, Department of Energy and Climate Change and the Department of Business, Innovation and Skills, Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050, Ceramics Sector \(2015\).](#)
- [2] S.N. Monteiro, L.A. Pecanha, C.M.F. Vieira, Reformulation of roofing tiles body with addition of granite waste from sawing operations, Journal of the European Ceramic Society 24 (2004) 2349 – 2356.
- [3] T. Manfredini and M. Hanuskova, Natural raw materials in traditional ceramic manufacturing, Journal of the University of Chemical Technology and Metallurgy, 47 (2012) 465-470.