Open PhD Position in European Industrial Doctoral Network (DN-ID)

www.reffracteur.eu

Digital REFractory FRAmework for a Carbon-neutral and Resilient indusTry in EURope (REFFRACTEUR)

What is REFFRACTEUR and what is the focus of this network?

REFFRACTEUR will train researchers at the interface of **materials science, process engineering and digitalisation,** exposing them to **both academic and non-academic sectors** through **international** and **inter-sectoral mobility** combined with an **innovation-driven mind-set**. They will acquire a balanced set of research-related and transferable competences covering the full life cycle of refractory materials, from design and production to operation, monitoring, reuse and end-of-life management, in the **context of Europe's high-temperature industries facing decarbonisation, circularity and energy-efficiency challenges**. A core part of the project is dedicated to the development of digital frameworks for refractories, including digital twins, data-driven decision-support tools, material traceability and circularity assessment. The 15 doctoral candidates will benefit from state-of-the-art numerical tools, data infrastructures and advanced experimental facilities to model, monitor and optimise refractory systems under demanding industrial conditions. **Trained in scientific, technical and soft skills, these PhDs will become highly employable engineers and scientists for the refractory sector and related industries**. Novel experimental methods, modelling strategies and digital approaches will be developed to address key scientific and technological challenges and to support the design of resilient, high-performance and sustainable refractory solutions. The **research training is implemented through a strong European network** bringing together academic institutions and industrial partners across the refractory value chain, in close connection with the **FIRE federation (**fire-refractory.org**)**.

Specific subject of PhD7 (one of 15 PhD's of the REFFRACTEUR DN-ID project)

PhD7 Topic: Virtual laboratory for microcracks prediction in refractory materials

Objectives: To develop digital modelling tools supporting refractory digital twins in order to investigate the relationships between microstructure, processing routes and thermomechanical performance. The work will combine physics-based approaches and numerical simulations, including thermo-mechanical coupling, damage evolution and anisotropic behaviours. These developments will lead to a virtual digital framework able to provide predictive indicators, virtual testing and decision-support for lifetime and performance assessment, in connection with REFFRACTEUR data architectures. These developments will be integrated to the free DEM software GranOO.

Expected Results: Validation of the digital twin approach against experiments through (i) thermo-mechanical quantities such as CTE, Young's modulus, Poisson's ratio, stress-strain law, fracture energy) and (ii) microcrack initiation, closure and coalescence under thermo-mechanical loading dynamically observed by SEM/microtomography. A validated virtual lab will provide predictive indicators and virtual tests.

Keywords: Discrete Element Method (DEM), microstructure, refractory, thermo-mechanics

Applicant Profile: **Master's level in *Materials Science and/or Computational Methods in Mechanical Engineering***. Excellent skills for numerical method applied to mechanics. A good knowledge in material science and their associated experimental characterisation technics is also expected. Oral and written communication skills (English) are also required. Some experiences in Python and/or C++ programming will be appreciated.

PhD main locations:

Period 1 - IRCER (www.ircer.fr), Limoges, France (18 months)

Period 2 - IMERYS (www.imerys.com), Vaulx-Milieu, Lyon area, France (18 months)

Due to the Mobility Rule by the funding agency, residents of France cannot apply for this PhD07 position

Apply until June 8th following indications at www.reffracteur.eu

If you have any questions, feel free to contact the supervisors:

Dr. Damien ANDRÉ, damien.andre@unilim.fr **Prof. Marc HUGER,** marc.huger@unilim.fr

Dr. Ratana SOTH, ratana.soth@imerys.com **Dr. Christoph WÖHRMEYER,** christoph.wohrmeyer@imerys.com

This project has received funding from the European Union's Horizon Europe research and innovation program under grant agreement no. 101312113