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OPEN PhD POSITION
in European Training Network (ETN)

We are looking for a dedicated and highly motivated Early Stage Researcher (ESR), who will join our team to craft the future of ceramic materials and large structures for high temperature industrial applications.

ATHOR description (4 years ETN project started in October 2017)

Refractories are heat-resistant materials used as inner linings of high temperature furnaces, reactors and processing units. ATHOR (Advanced THermomechanical multiscale mOdeling of Refractory linings) is an innovative, collaborative and interdisciplinary project that brings together 6 academic beneficiaries and 8 private partners. The main objective is to develop high-end engineering technologies in material engineering and numerical simulations thanks to an intensive cooperation between academia, raw materials suppliers, refractory producers and end-users. Starting from material characterization, all significant properties will be investigated, including fracture behaviour, tension and compression creep behaviour, corrosion and thermal shock resistance. The interdisciplinary aspects will be addressed thanks to a multiscale approach looking at the influences of micro-, meso- and macro-characteristics on each other. To conduct their research and interlink the different topics, the 15 recruited researchers will take advantage of the most sophisticated numerical tools to model, design and predict the life of different lining configurations in critical operation conditions. The ATHOR network is deeply committed to provide a combination of research and training activities which will support and enlarge the initiative of the Federation for International Refractory Research and Education (**FIRE**).

Specific subject of ESR10 (one of 15 ESRs of the ATHOR ETN project)

Nonlinear thermomechanical modelling of refractory masonry lining

Objectives: In the steel industry, some vessels are protected from the hot products they contain by a refractory lining made of bricks. The objective of this study is to perform a finite element simulation of a steel ladle that contains masonries with joints with or without mortar. This simulation must consider the nonlinear behaviour of the refractory materials (bricks, mortar and interfaces) at high temperature.

Expected Results: Determination of tensile strength of brick/mortar interface. Modelling of the nonlinear behaviour (elastic-visco-plastic-damageable) of bricks and joints at high temperature. Development of a numerical tool for the definition of a homogeneous material with a behaviour equivalent to a masonry using previous models of constituent behaviours and nonlinear homogenization methods (analytical and/or numerical). This homogeneous equivalent material will be used to model industrial vessels, to determine their evolution versus time (creep, damage), and evaluate their lifespan. Validation of the masonry model using the results of thermomechanical tests performed on masonries by University of Minho (thermal loads), RHI (biaxial compression tests) and Tata Steel (large ring test). Validation of the developed numerical model applied to a steel ladle containing refractory masonry linings by comparison with in situ measurements performed on a real vessel in operation conditions.

Keywords: Refractory masonries, thermomechanical behaviour, finite element simulation, nonlinear homogenisation

Applicant Profile: Master level in Mechanics with a good level of knowledge in continuum mechanics and in finite element simulation. Excellent communication skills (both written and oral) in English.

PhD main locations: The recruited ESR will be offered the possibility to conduct a 3 years PhD studies at Laboratory **LaMé** from the **University of Orléans**, France, but also to visit other network partners for secondments (University of Minho, Portugal; RHI, Austria; Tata Steel, The Netherlands), and to attend the training events of the network.

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More details about ATHOR project:
http://www.etn-athor.eu/

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