



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



[www.cesaref.eu](http://www.cesaref.eu)

## Concerted European action on Sustainable Applications of REfractories (CESAREF)

### What is CESAREF and what is the focus of this network?

CESAREF will train researchers in multi-engineering areas and expose them to the academic and non-academic sectors through international and inter-sectoral mobility combined with an innovation-oriented mind-set. They will get the right combination of research-related and transferable competences in the **full production-to-the-end-of-life cycle of refractory materials applied to Iron & Steelmaking processes** with regards to the new operation conditions requested by the drastic reduction of greenhouse gas emissions, improved energy efficiency, and by life cycle assessment requirements. An important part of the project will be dedicated to the sustainability of refractories, including recycling issues, using the **Life Cycle Assessment** methodology. **15 doctoral candidates** will take advantage of the most sophisticated numerical tools and laboratory equipment to model, design and predict the life of refractory materials in critical operational conditions. Being trained in scientific, technical, and soft skills, these PhDs are the next generation of highly employable scientists and engineers in the refractory sector and related areas. New testing methods and models will be developed to address the Scientific/Technological challenges for these applications and help to design better performing and sustainable refractory materials and linings. The research training is implemented through strong relationships between 10 academia and 16 industrial partners across the EU. The CESAREF network ([www.cesaref.eu](http://www.cesaref.eu)) is structured to take full advantage of intensive cooperation between **academia, raw material suppliers, refractory suppliers and high-tech metal component producers** with a direct link to the **FIRE federation** ([fire-refractory.org](http://fire-refractory.org)).

### Specific subject of PhD8 (one of 15 PhD's of the CESAREF DN-ID project)

#### PhD8 Topic: Discrete Element Method to support microstructure design of refractories

**Objectives:** To conduct developments of numerical tools based on the discrete element method (DEM) for investigation of the relationships between microstructure and thermomechanical properties of model materials. These developments include debonding, thermomechanical coupling, crack-closure and anisotropic behaviours. These developments will lead to a “virtual numerical lab” able to provide tensile, dilatometry, fracture mechanics or thermal shock virtual tests for virtual characterizations. The related developments will be integrated to the free DEM software GranOO.

**Expected Results:** Validation of the method in regard to experimental observations in terms of (i) mesoscopic thermomechanical quantities such as CTE, Young's modulus, Poisson's ratio, stress-strain law and fracture energy and (ii) microscopic observations such as fracture coalescence under thermal and mechanical loadings dynamically observed in SEM.

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

**Applicant Profile:** **Master's level in Materials Science and/or Computational Methods in Mechanical Engineering.** Candidates should be excellent in their skills for numerical method applied to mechanics, with some experiences. 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 - IMERYS ([www.imerys.com](http://www.imerys.com)), Lyon, France (18 months)

Period 2 - IRCER ([www.ircer.fr](http://www.ircer.fr)), Limoges, France (18 months)

Due to the Mobility Rule by the funding agency, residents of France cannot apply for this PhD8 position

Apply until June 27<sup>th</sup> following indications at [www.cesaref.eu/recruitment-procedure](http://www.cesaref.eu/recruitment-procedure)

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

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