Multiphysics and multiscale modelling at the LIGHTCOCE – OITB project

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LIGHTCOCE project
(No 814632)

Introduction

LIGHTCOCE project aims in offering an open access Ecosystem for upscaling and testing multifunctional lightweight concrete and ceramic materials through five upgraded Pilot Lines (PLs) targeting to **Concrete**, **Conventional and Advanced Ceramics**.

The Open Innovation Ecosystem provides **characterisation** facilities, process **modelling**, quality assurance and monitoring, **standardisation**, safety and innovation management **services** that will be accessible to interested customers at fair conditions and cost.

The LIGHTCOCE Ecosystem will ultimately strengthen the cooperation between stakeholders (technology providers, service providers and the industry), building business model based on Open access cooperative Innovation.

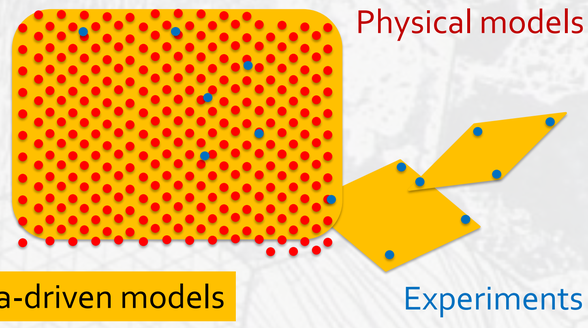
Methodology

Multiphysics and multiscale materials modelling has been conducted in order to estimate mechanical, acoustic, thermal, hygrothermal, self-sensing properties of concrete and ceramic materials. The final goal can be concluded as the optimum conditions under which the multifunctional lightweight structures can be formed to have an enhanced performance, according to final applications.

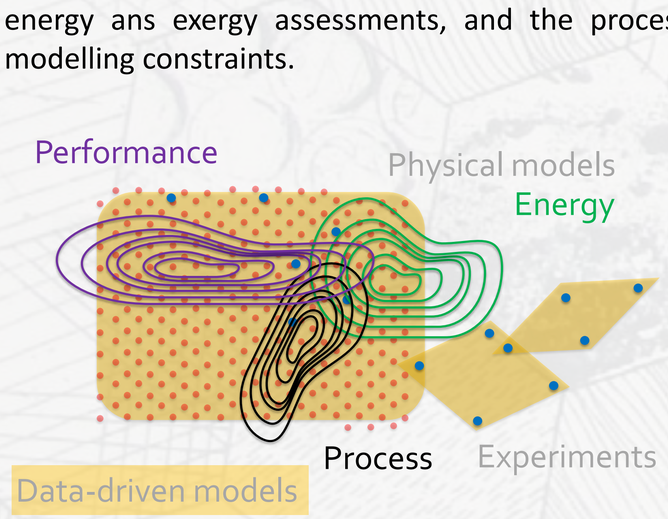
Optimization modelling workflow keys:

- Proper scale selection
- Micro numerical versus micro analytical
- Inverse modelling for scale bridging

Develop **surrogate models** combining experiments, Multiphysics and multiscale materials modelling and NNs linking the material composition and component properties with the performance

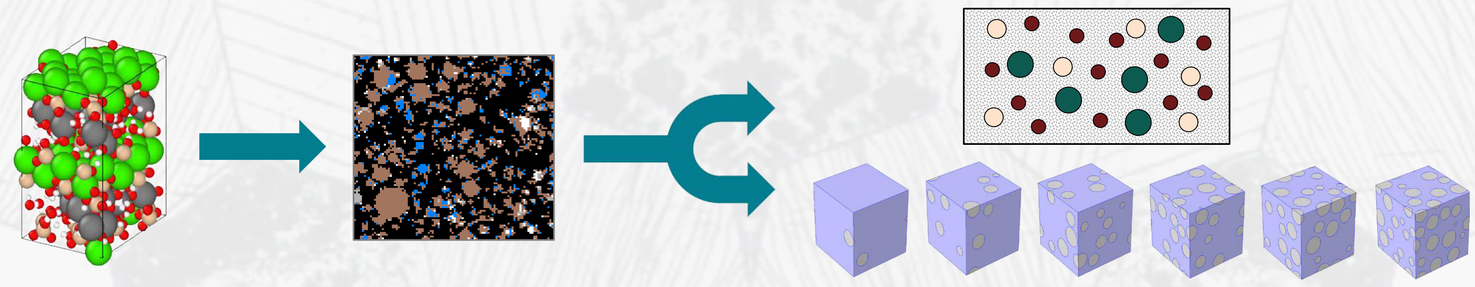


Multi-objective optimization considering the performance of materials and component, the energy ans exergy assessments, and the process modelling constraints.

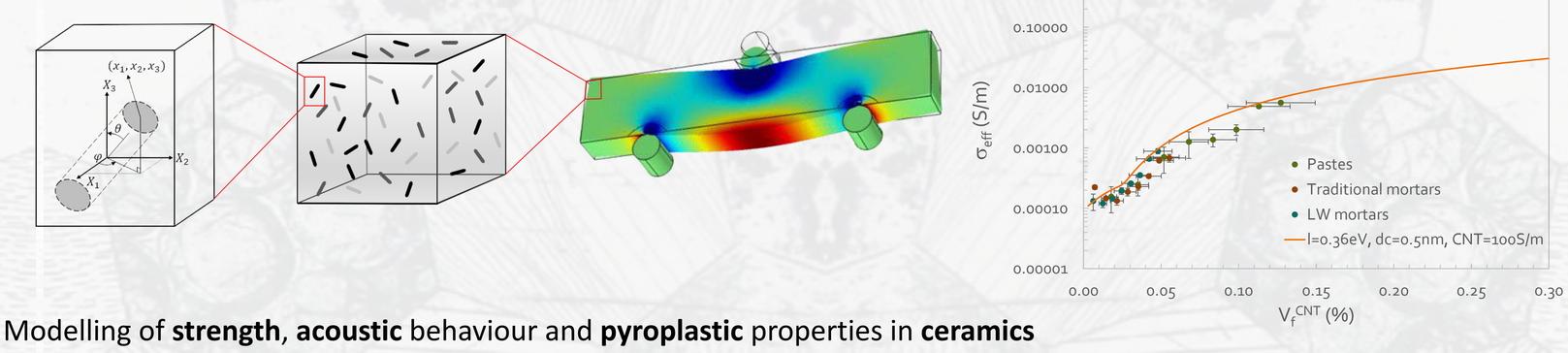


MULTISCALE MODELLING

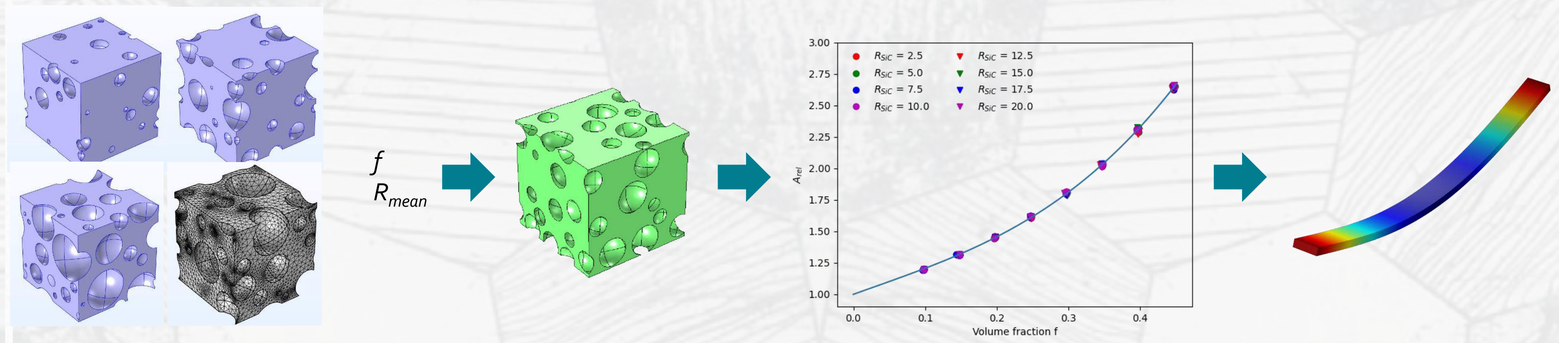
Multiscale modelling of **thermal conductivity** in **concrete** and **ceramics** following different workflows strategies



Modelling of **self sensing** behaviour of **concrete** with **CNTs**



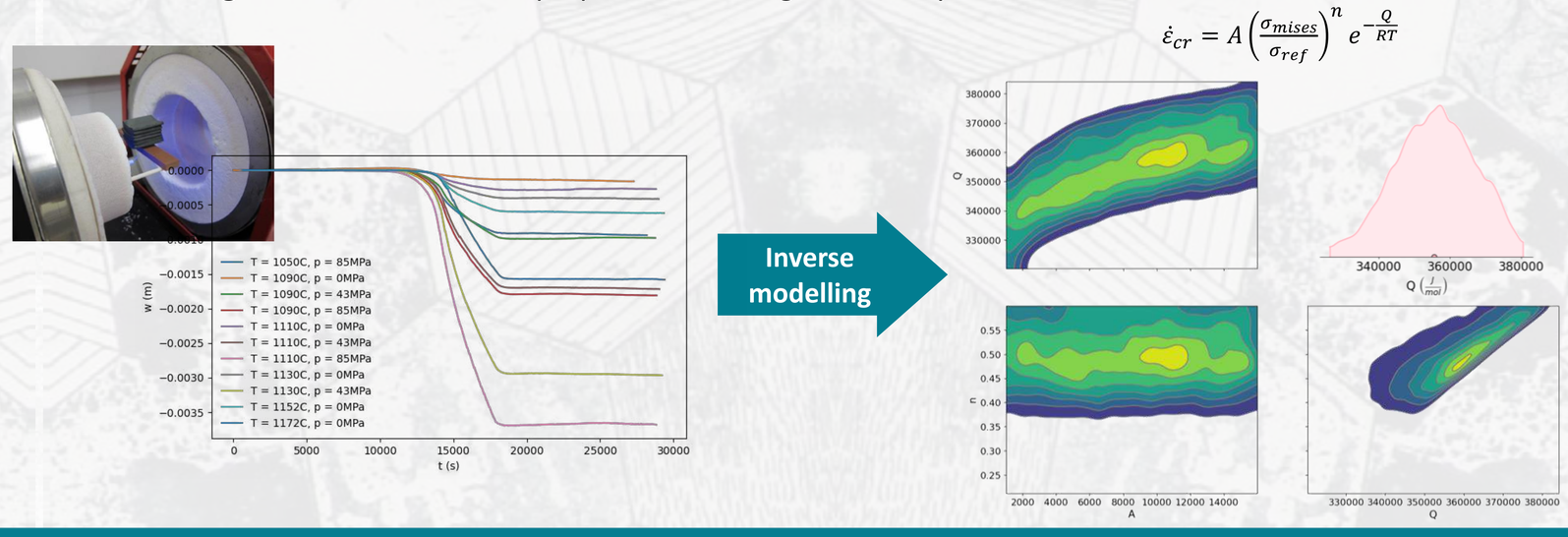
Modelling of **strength**, **acoustic** behaviour and **pyroplastic** properties in **ceramics**



Modelling to simplify experimental programme

Inverse modelling to determine material properties including uncertainty assessment

$$\dot{\varepsilon}_{cr} = A\left(\frac{\sigma_{mises}}{\sigma_{ref}}\right)^n e^{-\frac{Q}{RT}}$$



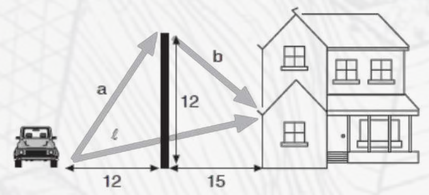
MULTIPHYSICS MODELLING

Physics involved in modelling:

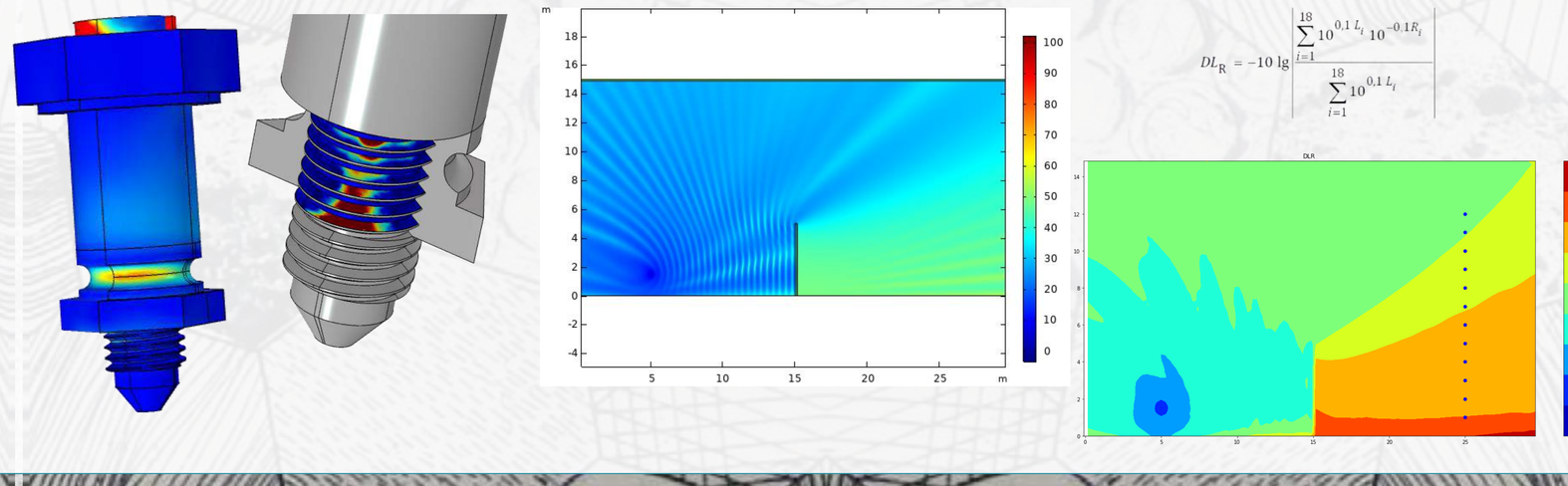
Mechanical, acoustic, tribological, thermal, hygrothermal, reaction-diffusion…

Examples:

Bolt nut wear simulation and acoustic model of an isolation panel



$$DL_R = -10\lg\left(\frac{\sum_{i=1}^{18} 10^{0.1\,L_i}\,10^{-0.1R_i}}{\sum_{i=1}^{18} 10^{0.1\,L_i}}\right)$$



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