# Description for the general public

During the last fifty years, many technological advances have completely revolutionized the way we live our lives - just think about the impact of mobile electronics - and a similar trend is expected in the future. However, at the basis of a new technology, there is often the invention of new materials with unprecedent physical and chemical properties.

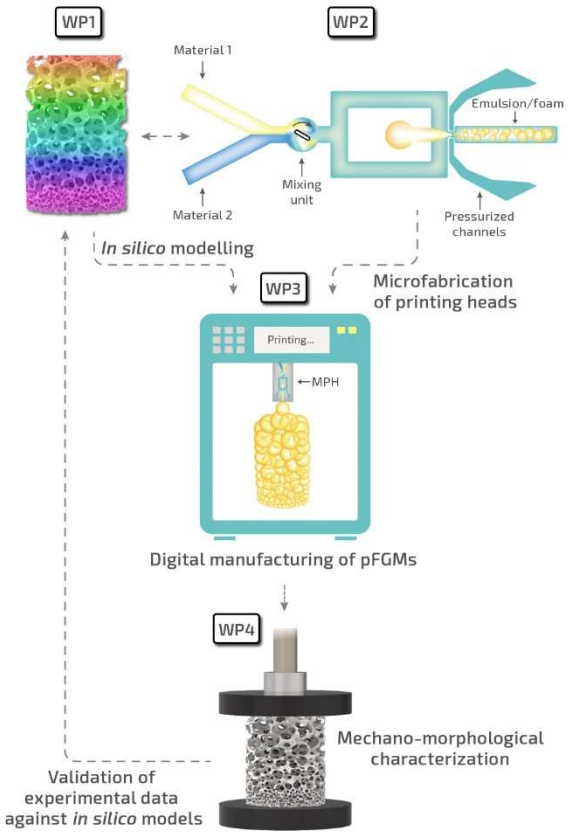
The process of designing and manufacturing an object with tailored properties may wrongly appear as a simple and routine work for materials engineers. Instead, in many cases, this represents an actual challenge requiring great creativity and deep knowledge in many fields of science.

Nowadays, the development of materials characterized by advanced and unprecedent physical properties is becoming increasingly important for a vast range of added value research and industrial applications. Tuning the physical properties of an object is a complex task, being influenced not only by the nature of the material is made of, but also by its 3D micro- and macro-structures. Therefore, it should not be surprising that researchers have spent a great deal of work to develop several technologies to process the largest amount of raw materials – including glass, ceramics, metals and natural/synthetic polymers – and to refine the control over their 3D architectures.

Among the known types of materials, **porous materials** – i.e. materials that contains a network of voids – have greatly attracted researchers' attention as they generally **offer unique structural and functional properties compared to their fully-dense counterpart.** For instance, they possess many attractive properties such as low weight, high permeability, high specific surface area and have wide applications in sound and energy absorption, heat dissipation, filtration, separation and catalysis. One way to control the physical properties of a porous material consists of introducing **compositional or micro-architectural gradients along at least one material direction** so as to fabricate what is generally called a functionally graded material (FGM). As one can probably guess, fabricating such materials is extremely arduous not only from a mere manufacturing but also from a designing standpoint.

In this context, we propose to develop a new approach for the design and manufacturing of **porous FGMs that exhibit enhanced mechanical performance**. Our method will comprise three steps:

- ***IN-SILICO* MODELLING** aimed at identifying the most suitable 3D architectures and materials using finite element method (FEM) coupled with search algorithms based on artificial intelligence (AI).
- **DIGITAL MANUFACTURING** employing innovative 3D printing technologies equipped with reconfigurable microfluidic printing heads;
- **ADVANCED MATERIAL CHARACTERIZATION** using state-of-the-art technologies including mechanical testing coupled to high-resolution micro computed tomography.




We believe that the outcome of the proposed project, if successful, may truly boost the development of advanced pFGMs with completely new and tailorable mechanical properties with potential applications in several research and industrial fields ranging from aerospace and electronics to transportation, environmental protection and bioengineering.