



ICCF - Materials For Health team

Thesis supervisor: Jean-Marie NEDELEC (Professeur) jean-marie.nedelec@sigma-clermont.fr Co-supervisor : Stéphane DESCAMPS (PU-PH) stephane.descamps@uca.fr

Title of PhD subject : 3D printing of ceramic implants for bone reconstruction and their mechanical characterization

Summary :

Personalized medicine is one of the major areas of development in the field of health. The extracellular matrix of bone tissue is a complex multi-scale material whose architecture is damaged by traumatic or osteolytic pathologies. Often, these situations require the use of bone substitutes to replace and stabilize the bone parts in order to achieve healing/consolidation. Stabilization is essential to this process, hence the use of various immobilization and/or osteosynthesis solutions without which no consolidation can be achieved. In situ stabilization by a three-dimensionally personalized substitute for substance loss allows, through its precise and specific adaptation, to increase the intrinsic stabilization of the bone piece compared to current solutions.

The thesis will explore the new possibilities offered by additive manufacturing to produce Calcium phosphate based synthetic bone substitutes suitable for the filling of bone loss encountered clinically both in terms of three-dimensional geometry and clinical indication.

Based on clinical imaging of the defect (CT scan), a digital model will have to be reconstructed integrating clinical constraints (fixation for example) and will serve as input data for ceramic additive manufacturing, whose customized dimensions must integrate specific issues in their manufacture (shrinkage).

The resources available at the laboratory include two ceramic 3D printers working either using stereolithography (SLA) or by Dynamic Light Processing (DLP), and access to real-time medical imaging.

Adapted formulations will be prepared and will allow to obtain parts with complex geometry adapted to clinical cases. The presence of the 4 senior orthopaedic surgeons from the Clermont-Ferrand University Hospital within the team will make it possible to obtain a variety of model cases.

The implants obtained will be finely characterized from a morphological, chemical and structural point of view.

Particular attention will be paid to the characterization of mechanical properties and the influence of process parameters on them. Ultimately, the evaluation of the biological properties will make it possible to validate the proposed solutions.

The requested profile is highly multidisciplinary, including expertise or an interest for:

-materials

- imaging and image reconstruction

-3D printing technologies

- Characterization of mechanical properties

Candidates will hold a Master's degree in Materials or Processes or an engineering degree in one of the above mentioned specialties.



