M2 Internship Proposal

ERRMECe Laboratory, Biomaterials for Health Group, CY Cergy Paris Université, France

Collaboration with Photonic Glasses Group, Tampere University, Finland

The regeneration of critical losses of bone substance, particularly in maxillofacial reconstruction and repair surgery, frequently must contend with cellular infiltration of the surrounding soft tissue, a problem that compromises the osseointegration of the filling material and ultimately the preservation of the bone defect. To address this issue, researchers at ERRMECe laboratory and Tampere University have initiated some promising work by developing a **bipartite material** combining a **3D bioactive glass (BAG) scaffold** promoting bone regeneration and a porous **honeycomb 'barrier' membrane** preventing the fibrous tissue ingrowth [1,2]. First results showed the potential of this device for bone regeneration while preventing the invasion of harmful fibrous tissue. However, this strategy needs to be developed further, considering also the post-implantation risk, as for example, the infection post-implantation. Here, the project is to **maximize the potential of the porous barrier membrane** by making it dynamic and **capable of releasing biocidal active ingredients** by adding two types of particles: **up-converters and persistent luminescent particles**. When excited, they will emit light that can be used to induce the **release of photosensitive molecules with a therapeutic response**. This innovative strategy opens the path of 4D biomaterials for personalized medicine.

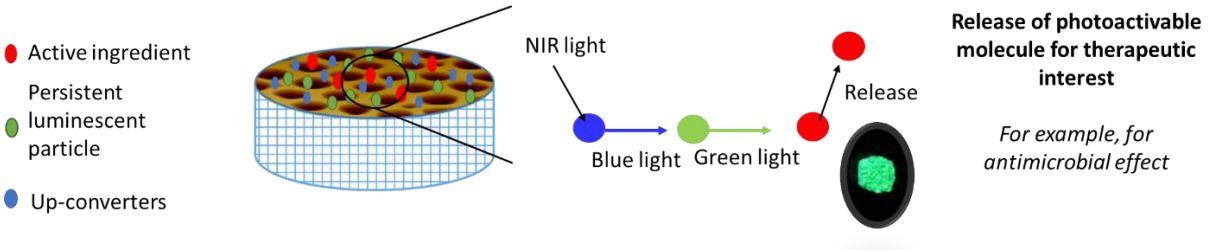

Figure 1: Schematic representation of the strategy

In this project, the trainee will design and develop the photoluminescent honeycomb membrane which will be deposited on the BAG scaffold. The fabrication method of the honeycomb membrane will have to be optimized in order to add the photonic particles. The new membrane will be characterized by Scanning Electron Microscopy – Energy Dispersive X-ray spectroscopy (SEM-EDX) and Atomic Force Microscopy (AFM). The integrity of the photonic particles and the photoluminescence properties of the membrane will be investigated, in collaboration with the Photonic Glasses group (Tampere University, Finland). **The trainee will have to go for one month at Tampere University in Finland**. Preliminary experiments to study the cellular response (viability, growth, morphology) on and into the new membrane and the scaffold will be performed.

The candidate will learn about the design of bipartite scaffolds. 3D-printing technology will be used to print bioactive glass scaffolds. The candidate will be trained for cell culture. Different techniques of microscopy (SEM, AFM, confocal microscopy) will be used, and the trainee will learn about images analyses.

Send your resume and cover letter to the supervisors: Amel Houaoui (amel.houaoui@cyu.fr), Emmanuel Pauthe (emmanuel.pauthe@cyu.fr), Laeticia Petit (laeticia.petit@tuni.fi)

[1] A. Deraine, M. T. Rebelo Calejo, R. Agniel, M. Kellomäki, E. Pauthe, M. Boissière, and J. Massera. *ACS Applied Materials & Interfaces* **2021** *13* (25), 29984-29995. DOI: 10.1021/acsami.1c03759

[2] Coquen AD, Bondzior B, Petit L, Kellomäki M, Pauthe E, Boissière M, et al. *J Am Ceram Soc*. **2024**; 107: 154–165. https://doi.org/10.1111/jace.19406