Material and process development for high resolution 3D printing

Additive manufacturing technologies (also known as 3D Printing) appear as a new paradigm for integrated microsystem manufacturing. Indeed, the ability to design and print three-dimensional objects, according to a direct fabrication scheme and adapted to rapid prototyping, has the potential to transform current production methods in the field of research and industry. The fields of application are very large and multi-scale: they cover robotocs, aeronautics, biomedical (dental implants, prostheses, ...) or even jewelry sectors.

Despite their potential, the printing methods currently used are limited by certain technological barrier related in particular to the resolution (the limit of 50 microns remains difficult to cross) and the ability to perform multimaterial printing to manufacture 3D heterogeneous components integrating, for example, electrical or optical functionalities.

These constraints are particularly important in the fields of microelectronics, integrated optics, microfluidics, medical detection devices, tissue engineering for which the current methods, although offering a nanometric resolution, remain incapable to structure matter in the third dimension. In these applications, the development of methods and processes for the integration and 3D structuring of functional materials with micrometric dimensions is essential to continue R&D developments at both academic and industrial levels.

Among the many existing approaches in the field of 3D printing, stereolithography (based on a principle of laser-assisted photo-polymerization) is one of the most promising techniques to fill the current limitations in terms of resolution.

In this talk, after a brief introduction on 3D printing technologies, the manufacturing of bio-inspired 3D scaffold of intestinal epithelium[2] will be presented. First, material and process development of conventional photoresist and homemade formulations based on photosensitive PEGDA hydrogel made onto a high-resolution 3D printing equipment[1] will be showed. A second part will be dedicated to the presentation of a second generation of high multi-resolution 3D printers: process development and reduction time to make the same 3D scaffold dimension will be discussed.

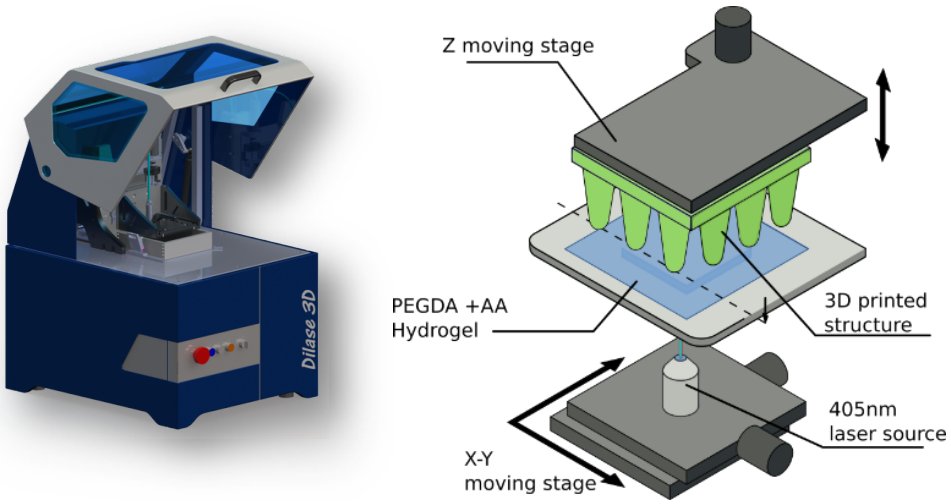

Figure 1: "Dilase 3D" stereolithography equipment

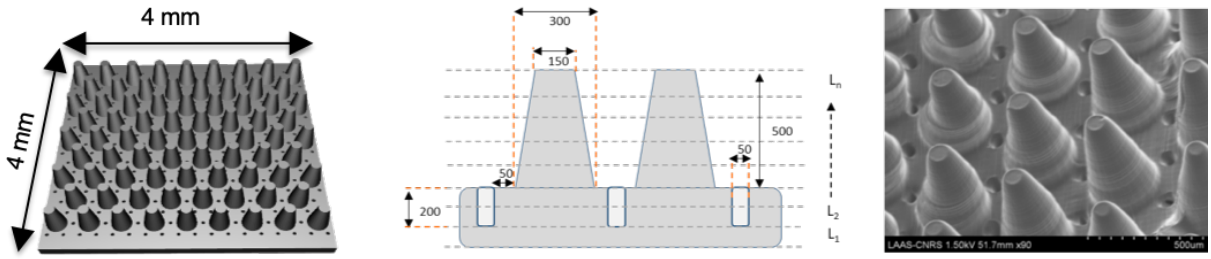

Figure 2 : 3D scaffold of intestinal epithelium. STL file on the left and PEGDA 3D printed structure on the right.

[1] A. Accardo, R. Courson, R. Riesco, V. Raimbault, L. Malaquin, Direct laser fabrication of meso-scale 2D and 3D architectures with micrometric feature resolution, *Additive manufacturing*, 2018, 22, 440–446.
[2] J. Creff, R. Courson, T. Mangeat, J. Foncy, S. Souleille, C. Thibault, A. Besson, L. Malaquin, Fabrication of 3D scaffolds reproducing intestinal epithelium topography by high-resolution 3D stereolithography, *Biomaterials*, 19, 221, 119404.