ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΥΛΙΚΩΝ

ΠΑΡΟΥΣΙΑΣΗ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

Τίτλος

«4D printing of biomaterials scaffolds for tissue engineering»

της Λευκής Χανιωτάκη, μεταπτυχιακής φοιτήτριας του

Τμήματος Επιστήμης και Τεχνολογίας Υλικών του Πανεπιστημίου Κρήτης

Επιβλέπουσα καθηγήτρια: Άννα Μητράκη

Δευτέρα 18/10/2021

10:00

Η παρουσίαση θα πραγματοποιηθεί στην **αίθουσα Τηλε-εκπαίδευσης Ε130,** στο κτήριο του **Τμήματος Μαθηματικών και Εφαρμοσμένων Μαθηματικών** του Πανεπιστημίου Κρήτης.

ABSTRACT

The use of Fused Filament Fabrication 3D printer has been launched in the last decade as it is easy to use and accessible to everyone. It is a common way to alter the surface of the 3D printed scaffold after is printed with subtractive manufacturing techniques. The most well-known subtractive techniques used are either with laser (ablation, cutting and others) or with chemical etching. Although, with laser ablation technique, you could abstract more specific, small designs and use a variety of materials. Until now, they only alter the surface of the scaffolds and at some of them the second layer by changing of the focus. In this way, you could alter the surface of the scaffold with designs more complex and smaller than the resolution of the printer or you could make it more porous. In this research project, we combined the subtractive and the additive manufacturing technique to construct advanced 4D scaffolds with PLA for tissue engineering applications.

In this work, we changed 2 set-ups before we ended up with the last and better set-up where we combined the Ytterbium Picosecond Fiber Laser, wavelength 1060 nm, a galvo scanner and Fused Filament Fabrication (FFF) 3D printer. The use of Galvo is to scan surfaces faster and to have less vibrations. Moreover, there are many techniques to make 3D

scaffolds, but the FFF is a cheap technique, with resolution approximately 100 μm. With combination of laser and galvo, the resolution of laser will be approximately 35μm. So, we can construct structures with laser, with smaller resolution than that of the 3D printer. In addition, there are some biocompatible polymeric filaments (PLA, PCL, PLGA, PEEK, PET, PLLA) but the most well-known is the natural PLA which is the one that we used. PLA is capable for tissue engineering applications because it is biocompatible, biodegradable and it is used in a wide range of applications. Furthermore, this combination aims to remove material with specific structure at any layer of the 3D printing structure.

To achieve this novel and advanced 4D printing mix-and-match, we performed many changes at the ender 3 pro printer, we constructed an optical path, and we worked on a new more functional program with python. We could ablate circles, lines and spots only with galvo or we could 3D print designs or we could ablate designs with laser, or we could combine them. Furthermore, we could do many changes in the laser's design such as minimize its dimensions at xy axis, multiply the laser's design, choose the layers that the laser ablation started and stopped and others.

Finally, we managed to make a successful combination of additive manufacturing and subtractive technique to make 4D scaffolds with PLA for tissue engineering applications. We characterized them with SEM (structural and morphological properties), UV-Vis (optical properties after laser treatment) and contact angle measurements. At last, the interaction of these 4D scaffolds with MSC cells was investigated. Specifically, we studied MSCs proliferation and morphology with SEM. We also observed the effect of the 4D scaffolds in terms of cell cytoskeleton (actin Phalloidin), cell mechanotransduction (YAP/TAZ), cell nucleus (DAPI) and finally osteopontin (OPN) to observe if they will actually differentiate to osteogenic lineage with and without osteogenic differentiation medium at different time points via confocal microscopy.