ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΥΛΙΚΩΝ

Πρόσκληση σε Δημόσια Παρουσίαση της Διδακτορικής Διατριβής του

κ. Γεωργίου Φλαμουράκη

(Σύμφωνα με το άρθρο 41 του Ν. 4485/2017)

Την **Πέμπτη 15 Σεπτεμβρίου 2022** και ώρα **17:00** στην **αίθουσα Τηλε-εκπαίδευσης Ε130,** στο κτήριο του **Τμήματος Μαθηματικών και Εφαρμοσμένων Μαθηματικών** του Πανεπιστημίου Κρήτης, θα γίνει η δημόσια παρουσίαση και υποστήριξη της Διδακτορικής Διατριβής του υποψήφιου διδάκτορα του Τμήματος Επιστήμης και Τεχνολογίας Υλικών κ. Γεωργίου Φλαμουράκη με θέμα:

«3D Mechanical Metamaterial Scaffolds for Tissue Engineering Applications»

«Τρισδιάστατα Μηχανικά Μεταϋλικά ως Ικριώματα για Εφαρμογές στην Μηχανική Ιστών»

Abstract

Multiphoton Lithography is a powerful technique that enables the fabrication of submicron scale structures with unprecedented resolution. By exploiting the excellent mechanical properties of the photo resin SZ2080, we were able to fabricate and characterize two main mechanical metamaterials: the auxetic reentrant honeycomb, (also known as bowtie) which shows auxetic properties and the ultra-stiff ultra- light tetrakaidekahedron (also known as Kelvin foam) which displays very high hardness and porosity by mainly consisting of empty space. By altering the unit cell architecture, those two different mechanical environments were created even though the starting material was the same.

Initially, SZ2080 was mechanically characterized via micro-indentation, and Auxetic bowtie structure was optimized, fabricated, and used as scaffold for cellular studies of fibroblast cell line NIH-3T3. Both large pore and small pore structures were created. Results showed that cells were able to penetrate the pores of the scaffolds in case of large pores, deformed it and increased their proliferation rate.

Secondly, the high autofluorescence of scaffolds was addressed. For that reason, Sudan Black B (SBB) was used as the photoinitiator of the material and as a post-fabrication treatment. In that way, large non-fluorescence scaffolds were fabricated and

used for seeding of Mesenchymal Stem Cells (MSCs). Then, confocal microscopy was used to take z-stacks and map the whole volume of the scaffold seeded with MSCs.

The third part involved the study of osteogenic differentiation of MSCs under Auxetic environment. Two main proteins were monitored with confocal microscopy and PCR: the mechanotransduction protein YAP-1 and the osteogenic marker Runx2. Furthermore, the morphology of the cells was analyzed via Scanning Electron Microscopy (SEM). Results showed that the osteogenic differentiation procedure is enhanced in Auxetic environment in comparison with the flat 2D culture and a proposed model was developed.

Finally, Digital Light Processing was used to produce large scale Triple Periodic Minimal Surface scaffolds (Swartz G structure or gyroid) with 200μm resolution unit cells and seed them with 3 different cell lines. Interestingly, no cytotoxicity was observed and cell attached well on the scaffolds and proliferated.

Concluding, Auxetic scaffolds are ideal for osteogenic differentiation as they can maintain and promote the osteogenesis efficiently even after 21 days of culture. This work paves the way for the use of more complicated metamaterials into the tissue engineering field and pushes the boundaries of what light assisted manufacturing can be used for.