MICROPATTERNED 3D-PRINTED PLLA/PLCL BIORESORBABLE STENTS: DEGRADATION AND INFLUENCE OF STERILIZATION

V. Chausse[1,2]*, T. Fox[3], F. Mücklich[3], M. Pegueroles[1,2]

[1] *Biomaterials, Biomechanics and Tissue Engineering Group, Department of Materials Science and Engineering, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain*
[2] *Barcelona Research Center in Multiscale Science and Engineering, UPC, Barcelona, Spain*
[3] *Chair of Functional Materials, Faculty of Natural Sciences and Technology, Saarland University, Saarbrücken, Germany*
*victor.chausse@upc.edu

☒ Oral presentation ☐ Poster presentation

ABSTRACT

Bioresorbable stents (BRS) are cylindrical scaffolds designed to provide a temporary support to the vessel wall while the structure slowly degrades until completely resorbed [1]. Current stent fabrication technology hinders local modification of the surface topography. This work presents a novel solvent-cast direct-write (SC-DW) 3D printing system to manufacture inner patterned BRS. Poly-L-lactic acid (PLLA) and poly(lactic-co-caprolactone) (PLCL) stents were obtained by cylindrical printing onto a Ø 3 mm rotating mandrel (Figure 1a) [2]. The ink consisted in a solution of high M_w PLLA or PLCL copolymer (95:5) in chloroform at 10% w/v and 12.5% w/v, respectively. Steel mandrels were modified by direct laser interference patterning with a femtosecond laser to obtain a linear micropatterning with a periodicity of 10 µm, which was transferred onto stents' luminal surface (Figure 1b). Stents biodegradation was characterized by an accelerated degradation assay in PBS at 50ºC over 4 months and characterized in terms of mass loss, SEM, DSC, mechanical tests, GPC and ^{1}H-NMR. PLLA and PLCL stents underwent bulk degradation, with a sustained decrease in molecular weight and an increase in crystallinity as degradation proceeded. PLCL stents degraded 1.5 times faster than PLLA stents due to higher water penetration in amorphous regions. Finally, two sterilization methods were evaluated: γ-irradiation (8 kGy) and ethylene oxide (EtO). Whereas γ-irradiation induced chain scission and a marked decrease in molecular weight, no structural or chemical alterations were found after EtO sterilization (Figure 1c). In conclusion, customizable PLLA and PLCL BRS were successfully fabricated through SC-DW technique, showing luminal micropatterning for enhanced endothelialization and adequate degradation timeframe for resorption.

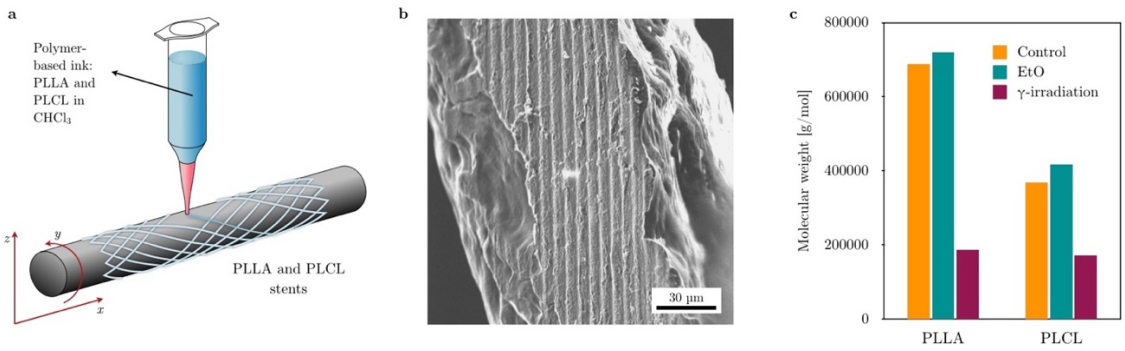

Figure 1. (a) 3D Printing scheme strategy. (b) PLLA stent with a linear micropatterning on the luminal surface. (c) Molecular weight before and after EtO and γ-irradiation sterilization for PLLA and PLCL stents.

[1] J. Wiebe et al., J. Am. Coll. Cardiol., 64 (23) (2014) 2541–2551.
[2] V. Chausse et al., Addit. Manuf., (2021) 102392.