# Next generation of 3D-printed drug-eluting meshes for tissue engineering applications

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## INTRODUCTION

Surgical vaginal meshes suffer from several limitations (e.g. infections, chronic immune reactions, pain, limited customisability[1,2] and inadequate biomechanical behaviour[3]). Also, they are now subjected to tight regulations and have been banned in many countries[1,2]. Therefore, there is a strong call for the use of emerging technologies (3D Printing), new material and drug-based approaches for the production of these devices.

**Aim: Evaluate the potential of 3D printing for the manufacturing of novel vaginal meshes**

## MATERIALS AND METHODS

Polycaprolactone (PCL, Polyscience, 50KDa) and Elastollan® Thermoplastic polyurethane (TPU, Distrupol Ltd, shore hardness 70A) meshes were printed using the 3D Bioplotter (EnvisionTEC) with two different designs (45° and 90°) (Figure 1, Table 1). Meshes were characterised via SEM (accelerating voltage of 40kV and distance of 40mm) and µCT (40 kV) . Uniaxial tensile test was performed on each sample type (n=5, stretch rate of 5 mm/s) to investigate the mechanical properties.

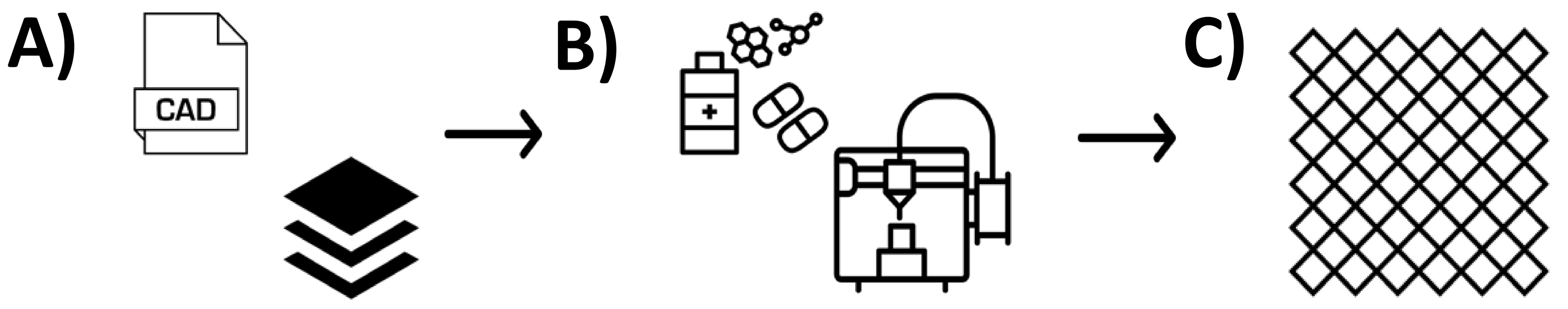


**Figure 1:** Schematisation of the manufacturing process. A) creation of CAD design; B) printing process; C) final product.

**Table 1:** Optimised printing parameters.

| Parameter | PCL | TPU 70A |
|---|---|---|
| **Temperature** | 130°C | 190°C |
| **Pressure** | 6 bar | 2.5 bar |
| **Speed** | 1 mm/s | 1 mm/s |
| **Needle tip** | 22g (0.4mm) | 22g (0.4mm) |

## RESULTS

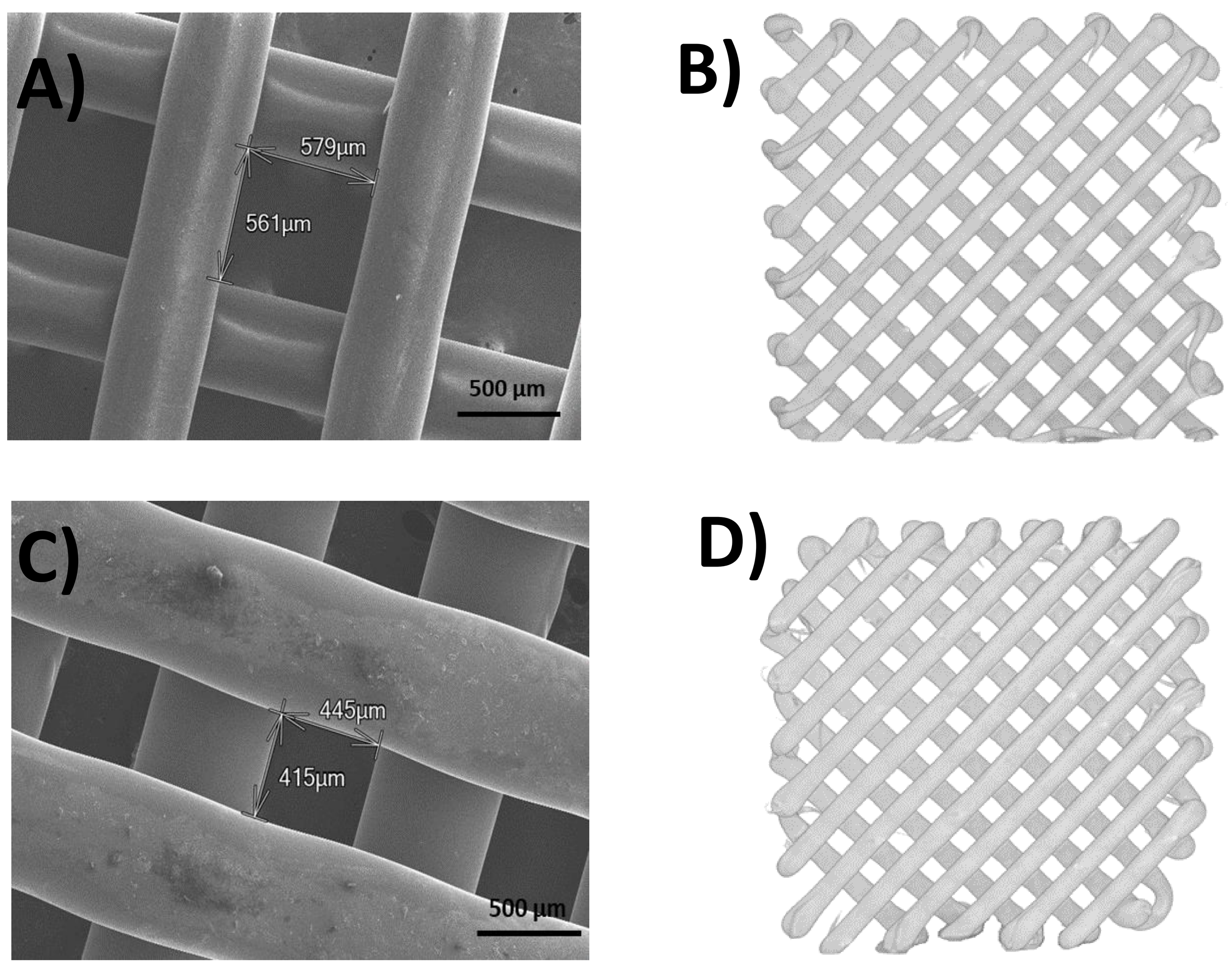


**Figure 2**: SEM images and µCT reconstruction of A)-B) PCL 45° and C)-D) TPU 70° 45° meshes.

Among all the tested samples:

- PCL meshes exhibited a more defined structure, characterised by bigger pores (Figure 2).
- PCL 45° meshes had intermediate biomechanical properties, closer to the one of the native tissue (Figure 3, Table 2).
- TPU 70A meshes showed the highest elasticity (much more elastic than the vaginal tissue) (Figure 3, Table 2)

**Table 2**: Biomechanical properties of the human healthy vaginal tissue.

| Healthy tissue | E [MPa] | UTS [MPa] | Max Elongation |
|---|---|---|---|
| **Pre menopause[4]** | 6.65±1.48 | 0.79±0.05 | 1.68±0.11 |
| **Post menopause[4]** | 10.26±1.10 | 0.42±0.03 | 1.37±0.04 |

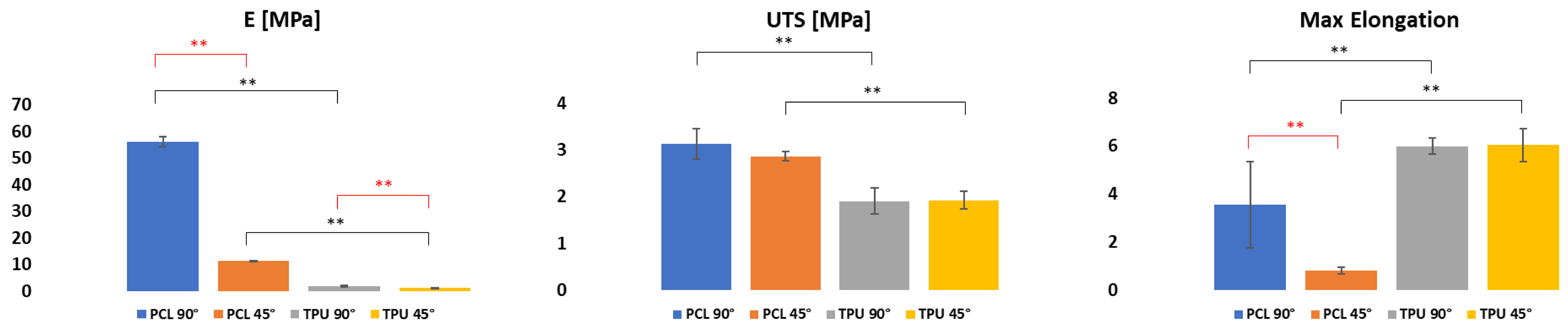


**Figure 3**: Evaluated elastic modulus (E), ultimate tensile strength (UTS) and maximum elongation for the 3D printed meshes.

## CONCLUSIONS

Meshes were successfully printed via 3D printing. Among all the printed samples, PCL 45° meshes showed the most promising behaviour in terms of pore geometry and mechanical properties and could be selected for future works, such as the development of drug-loaded antibacterial vaginal implants.

**REFERENCES:** [1]Mancuso *et al.*, Journal of Biomedical Materials volume 108, 771-789, 2019. [2]Farmer *et al.*, International Journal of Pharmaceutics; volume 585, 119512, 2020. [3]Chen *et al.*, Current Urology Reports volume 15, 425, 2014. [4]Lei *et al.*, International Urogynaecology Journal volume *18, 603–607, 2007.*