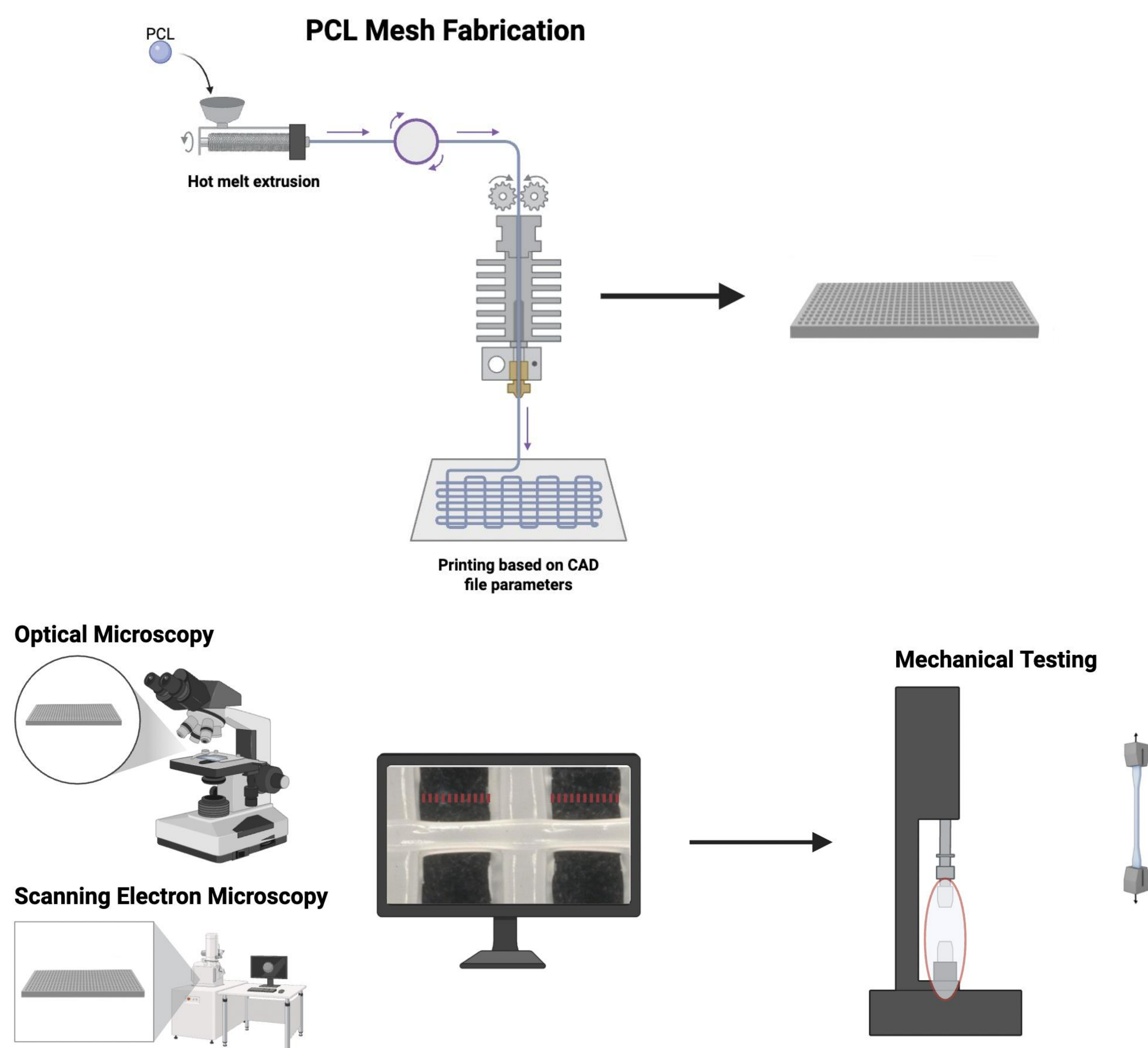


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## Introduction

Extrusion-based 3D printing is a promising technique to fabricate customizable porous structures for tissue engineering, as it allows precise control over scaffold geometry. This process also enables the design of patient-specific implants that fit individual anatomy. [3] Among the thermoplastic polymers compatible with this technique, Polycaprolactone (PCL) is widely used due to its biocompatibility, biodegradability and tunable mechanical properties. PCL combines flexibility and mechanical resistance, making it suitable for various biomedical applications, including scaffolds for tissue engineering, drug delivery systems, and absorbable sutures. [1] However, achieving mechanical compatibility between 3D printed scaffolds and soft tissues remains a challenge. Scaffolds intended for soft tissue support, such as smooth muscle, must exhibit mechanical properties that match those of the native tissue to ensure proper integration and function. [2] The aim of this work is to design and fabricate a customizable PCL 3D printed mesh intended for smooth muscle support and regeneration. In the present study, the reproducibility of the fabrication process and the structural and mechanical properties of the meshes were investigated to assess their potential for soft tissue applications.

## Methods

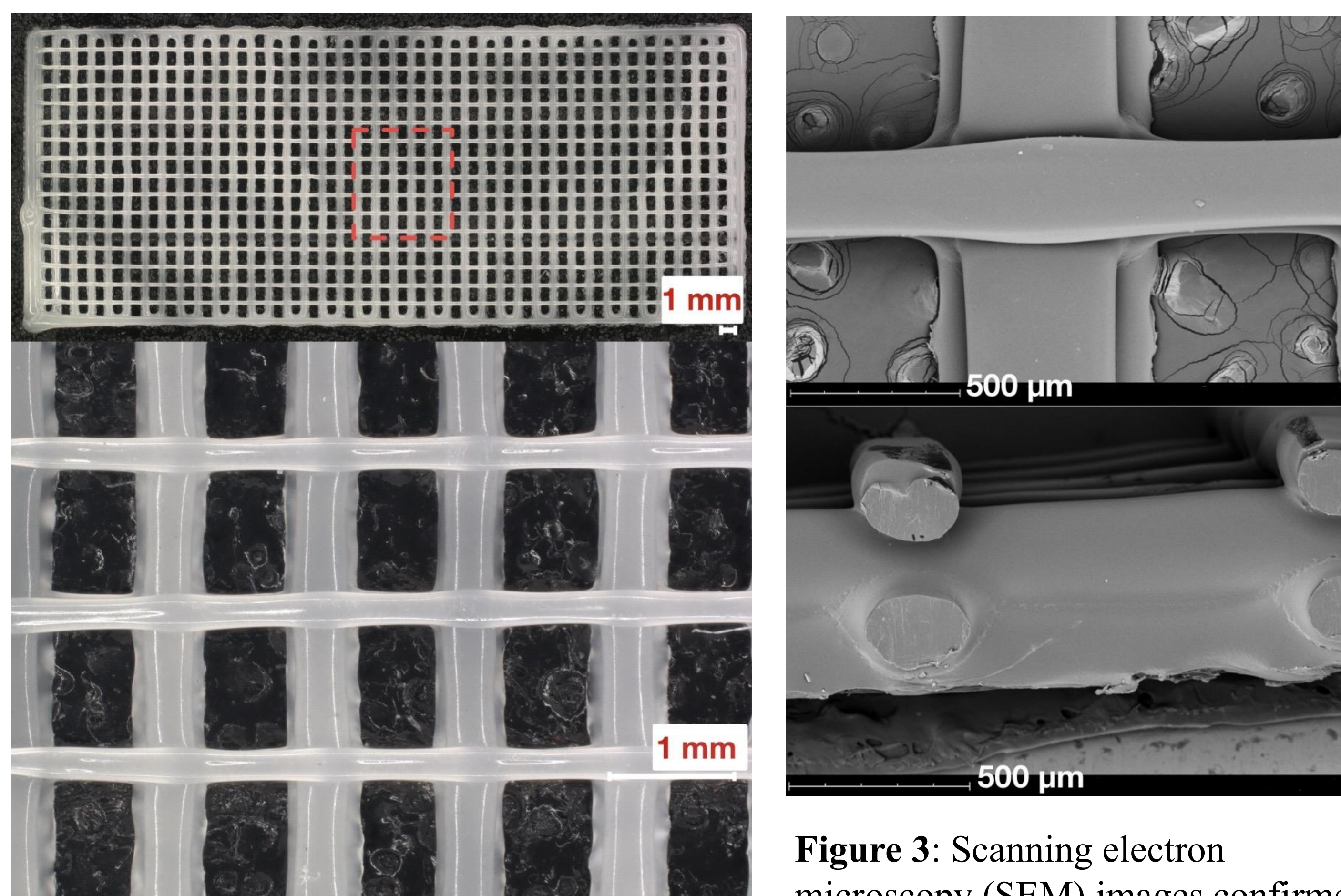


**Figure 1:** Experimental workflow for fabrication and characterization of PCL meshes.

## Optimization

- Nozzle temperature of 100°C revealed delamination and weak points in the mesh
- Nozzle temperature of 150°C posed a risk of overheating the polymer and inconsistency throughout the mesh
- A faster speed of 10 mm/s gave the material less time to adhere to the bed and yielded poor interlayer cohesion
- Printing was optimized with nozzle temperature of 120°C, bed temperature of 50°C, and a speed of 5 mm/s

## Microscopy



**Figure 2:** Optical microscopy revealed uniform filament deposition and consistent pore architecture in the 3D printed meshes.

**Figure 3:** Scanning electron microscopy (SEM) images confirmed complete interlayer fusion with no delamination, indicating that mechanical results were not confounded by fabrication defects.

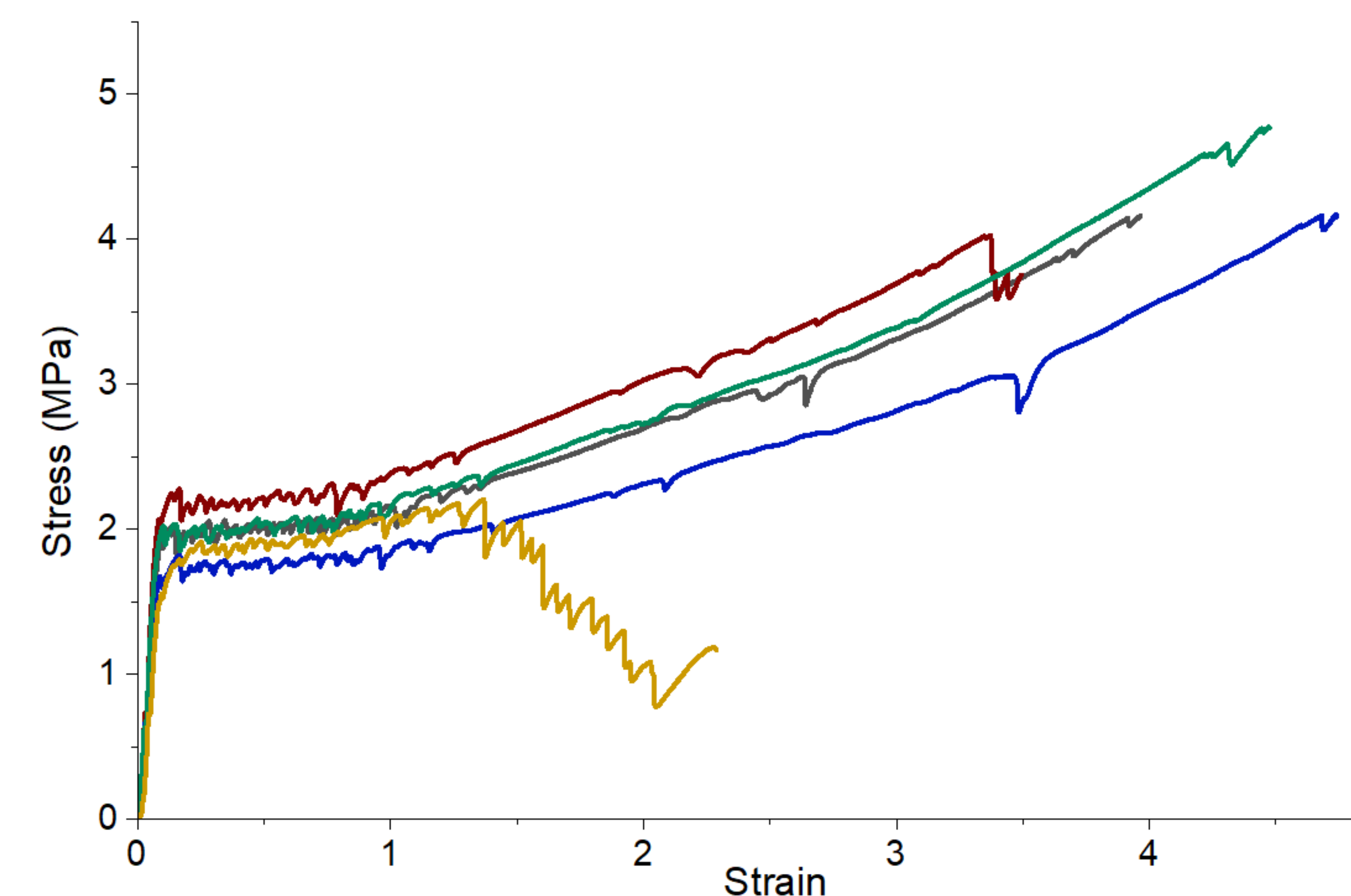
**Table 1:** Quantitative pore size analysis of 6 meshes fabricated from the same CAD parameters confirm reproducible dimensional accuracy.

Average Pore Size	Coefficient of Variation	Uniformity Factor (Length)	Uniformity Factor (Width)
0.53±0.03 mm <sup>2</sup>	5.13%	1.003±0.001	1.03±0.01

## References

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2. Echeverria Molina, M. I., Malollari, K. G., & Komvopoulos, K. (2021). Design Challenges in Polymeric Scaffolds for Tissue Engineering. *Frontiers in bioengineering and biotechnology*, 9, 617141.
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## Mechanical Testing



Elastic Modulus	Elongation at break	Average ultimate tensile strength
32.80±7.39 MPa	391.78±91.82%	3.78±0.87

**Figure 4:** Tensile tests of 6 3D-printed meshes served to check the repeatability of the printing process.

## Conclusion

This study demonstrates that the selected printing parameters enable the reproducible fabrication of PCL meshes with consistent structural and mechanical properties. The high flexibility of PCL shown in this study makes it a promising candidate for soft tissue support applications. Future work will focus on the incorporation of therapeutic molecules and the assessment of biocompatibility.

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