SCHOOL OF ENGINEERING & COMPUTING

Evaluating Dimensional Accuracy in filament 3D Printing of PCL for Biomedical Grade Structures

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BACKGROUND

- Electrospinning requires micro-scale scaffolds with high dimensional accuracy
- Standard FDM printers face limitations printing fine-featured bio-compatible geometries
- Facilan™ PCL 100 is a medical-grade filament with properties ideal for scaffold fabrication
- Improving resolution using low-cost FDM printing can democratize access to tissue scaffold production

OBJECTIVES

- To evaluate whether consistent fabrication of microscale scaffolds suitable for electrospinning applications is achievable through optimized FDM printing parameters, including low print speed, reduced nozzle temperature, and the use of the Classic perimeter generator.

METHODOLOGY

- Printer setup (Fig. 1) and print parameters (Table 1) were iteratively adjusted to improve scaffold definition and consistency
- Key settings included low nozzle temperature, reduced print speed, and custom slicer adjustments
- Slicer: PrusaSlicer was used in order to convert the STL file into GCode
- Multiple prints were conducted to validate repeatability and fine-tune print fidelity

Table 1. Settings used for final prints

Printer	Prusa Mk4
Filament	Facilan™ PCL 100
Nozzle	0.25 mm
Nozzle Temperature	157°C
Bed Temperature	0°C
Print Speed	5 mm/s
Perimeter Generator	Classic

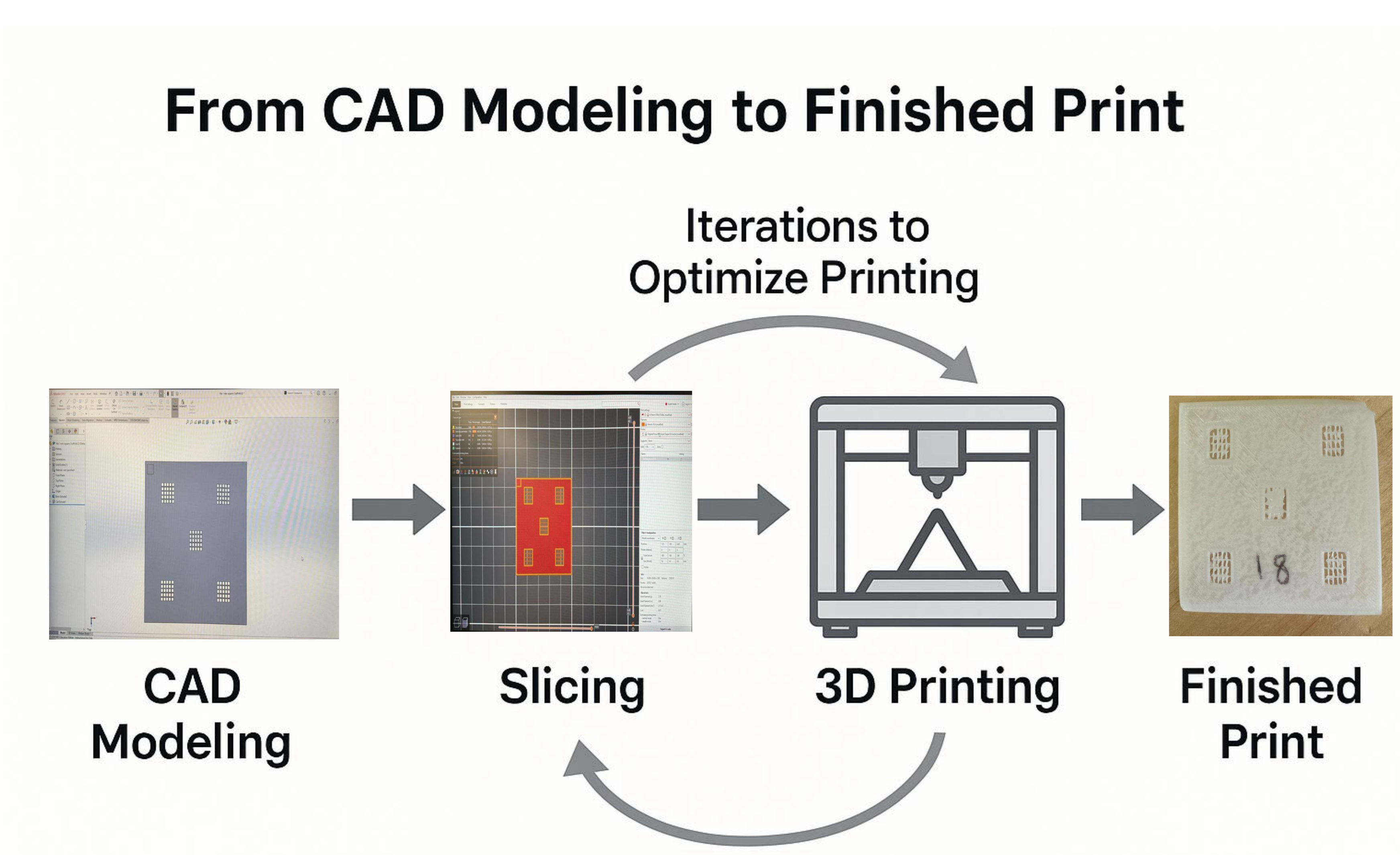

Fig. 1. Flow diagram illustrating the process from CAD modeling to the finished print. Iterative slicing and printing cycles were performed to optimize scaffold quality.

RESULTS

- Among the tested scaffold geometries, triangular designs showed the highest dimensional accuracy with a 26.17% deviation from expected dimensions. Hexagons followed with a 30.63% deviation, while squares and rectangles exhibited greater dimensional loss at 49.30% and 41.79% respectively, highlighting geometry as a key factor in print reliability.
- High-resolution images captured with the Keyence Digital Microscope (Fig. 2) revealed distortion and inconsistent edges in printed squares and rectangles, supporting observed deviations in their measured dimensions.
- The graph below (Fig. 3) visually compares measured and expected scaffold areas, confirming that triangular scaffolds most closely matched CAD models, while other geometries showed larger discrepancies.

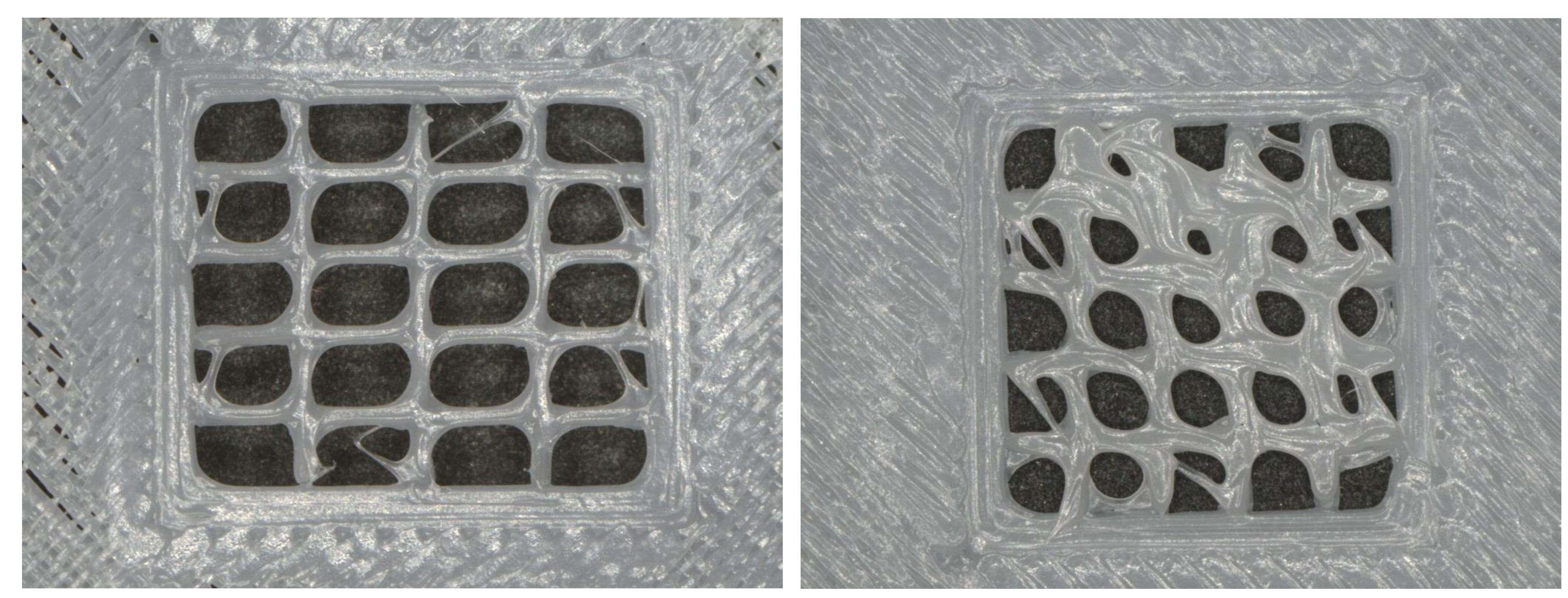

Fig. 2. Images taken using the Keyence Digital Microscope, showing rectangles (left) and squares (right). This was used to measure the areas of each section.

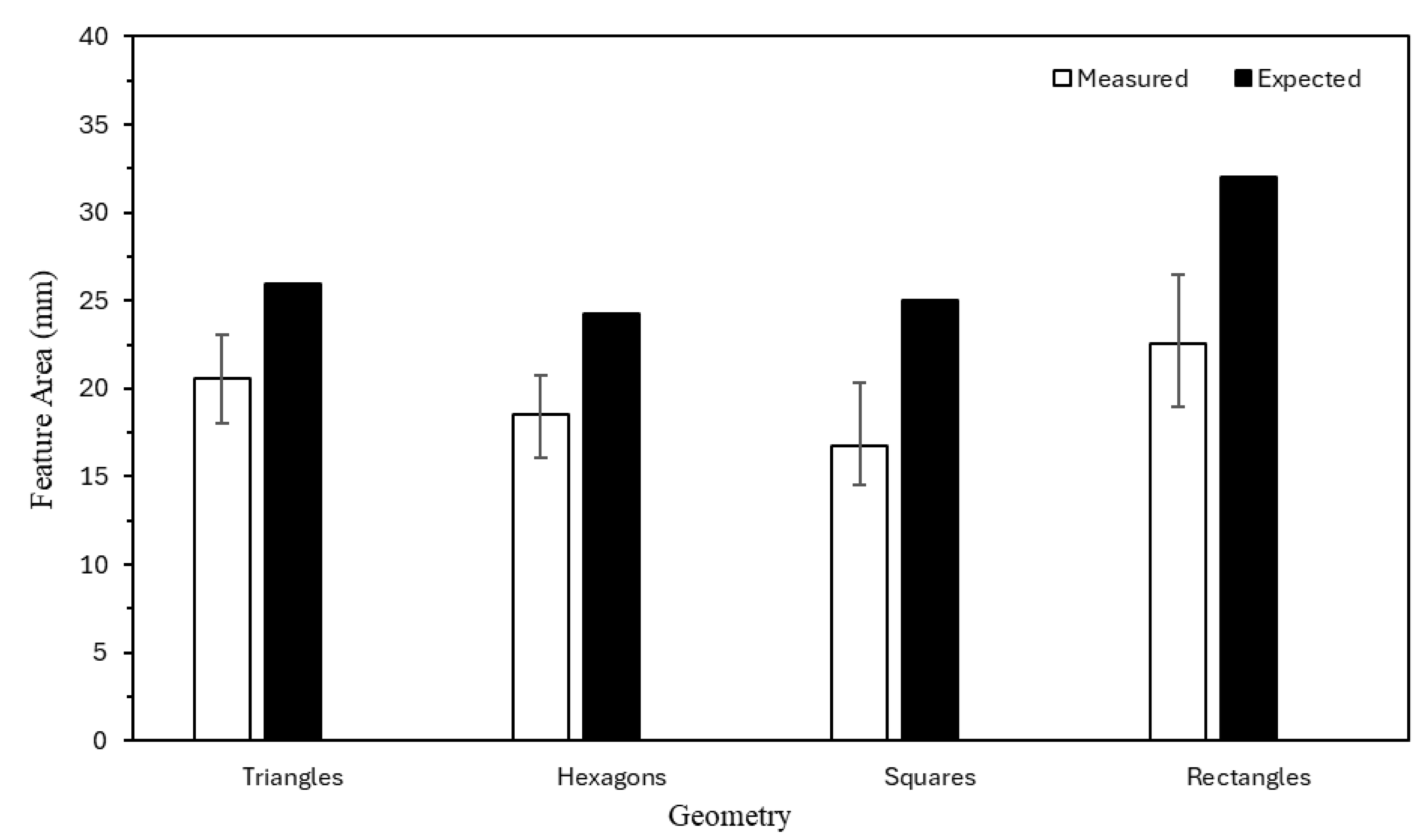

Fig. 3. Comparison of the measured (printed) and expected (CAD Model) areas of each different geometry.

CONCLUSIONS

- Low-speed printing with a 0.25 mm nozzle and tuned slicer settings were unable to achieve precise and consistent scaffold fabrication
- Classic perimeter generator helped to avoid overlap defects seen when using Arachne perimeter generator
- Future work: Integrate Melt Electro Writing printing into our process in order to get accurate fabrications

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