World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:19, No:02, 2025

# Crystal Nucleation in 3D Printed Polymer Scaffolds in Tissue Engineering

**Authors :** Amani Alotaibi

**Abstract :** 3D printing has emerged as a pivotal technique for scaffold development, particularly in the field of bone tissue regeneration, due to its ability to customize scaffolds to fit complex geometries of bone defects. Among the various methods available, fused deposition modeling (FDM) is particularly promising as it avoids the use of solvents or toxic chemicals during fabrication. This study investigates the effects of three key parameters, extrusion temperature, screw rotational speed, and deposition speed, on the crystallization and mechanical properties of polycaprolactone (PCL) scaffolds. Three extrusion temperatures (70°C, 80°C, and 90°C), three screw speeds (10 RPM, 15 RPM, and 20 RPM), and three deposition speeds (8 mm/s, 10 mm/s, and 12 mm/s) were evaluated. The scaffolds were characterized using X-ray diffraction (XRD), differential scanning calorimetry (DSC), and tensile testing to assess changes in crystallinity and mechanical properties. Additionally, the scaffolds were analyzed for crystal size and biocompatibility. The results demonstrated that increasing the extrusion temperature to 80°C, combined with a screw speed of 15 RPM and a deposition speed of 10 mm/s, significantly improved the crystallinity, compressive modulus, and thermal resistance of the PCL scaffolds. These findings suggest that by fine-tuning basic 3D printing parameters, it is possible to modulate the structural and mechanical properties of the scaffold, thereby enhancing its suitability for bone tissue regeneration.

**Keywords :** 3D printing, polymer, scaffolds, tissue engineering, crystallization
**Conference Title :** ICMSE 2025 : International Conference on Materials Science and Engineering
**Conference Location :** Barcelona, Spain
**Conference Dates :** February 10-11, 2025