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# Additive Manufacturing of bioabsorbable continuous wire-reinforced composites for bone regeneration

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## Abstract

Additive Manufacturing (AM) has emerged as a transformative approach in biomedical research, particularly for addressing bone defects where complex and patient-specific structures are required. Effective 3D-printed scaffolds should replicate bone characteristics and demands while incorporating bioabsorbable materials to support bone healing. Unlike permanent implants, which remain in the body as foreign materials after and may require second surgeries for removal due to inflammatory responses, bioabsorbable implants gradually degrade, leaving only natural tissue. Composite materials are considered a promising option for bone scaffolds, as they combine the benefits of both polymers and metals. However, replicating the mechanical performance of both cortical and trabecular bone, especially the higher demands of cortical bone, remains a challenge. Among AM techniques, Fused Filament Fabrication (FFF) is the most suitable for this purpose, as it allows the processing of a broader range of materials than other 3D printing methods, including continuous wire-reinforced composites. By adjusting wire orientation during printing, implants can be customised to optimise mechanical properties for specific applications. This makes FFF a strong candidate for enhancing polymer-based scaffolds in bone regeneration, though research on bioabsorbable wire-reinforced materials for tissue engineering is still very limited, and the availability of 3D printers capable of processing such composites is equally scarce. The aim of this work is to manufacture and characterise bioabsorbable wire-reinforced polymers as a potential solution for the healing of bone

defects. Composite laminates of polylactic acid (PLA) and magnesium wires will be fabricated and analysed. The fabrication of these scaffolds has been carried out using a customised 3D printer developed within our research group. Mechanical characterisation and degradation studies will be conducted to ensure that the laminate design accounts for progressive materials degradation without compromising structural integrity, thereby aligning with the regeneration time of native tissue. Finally, biological characterisation will be carried out through in vitro testing.

**Keywords:**

Bone Regeneration Bioabsorbable scaffolds Additive Manufacturing Fused Filament Fabrication Continuous-wire reinforcement