Trinity College Dublin
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Innovative Scaffold for Enhanced Bone Regeneration

Significantly improved new bone formation and tissue repair compared to standard fused deposition modelling scaffolds

Overview

This invention addresses the need for more effective scaffolds for bone and osteochondral tissue regeneration, overcoming the limitations of conventional 3D-printed scaffolds that struggle to balance vascularisation, porosity, and structural support. The technology uses melt electrowriting (MEW) to fabricate highly controlled, multi-layered fibrous scaffolds with precisely defined pore sizes and fibre diameters, enabling enhanced bone healing and integration. The key breakthrough is the ability to create complex, multi-zonal architectures, including core-shell and gradient structures, that better mimic the hierarchical structure of native bone and cartilage, resulting in significantly improved new bone formation and tissue repair compared to standard fused deposition modelling (FDM) scaffolds.

Advantages

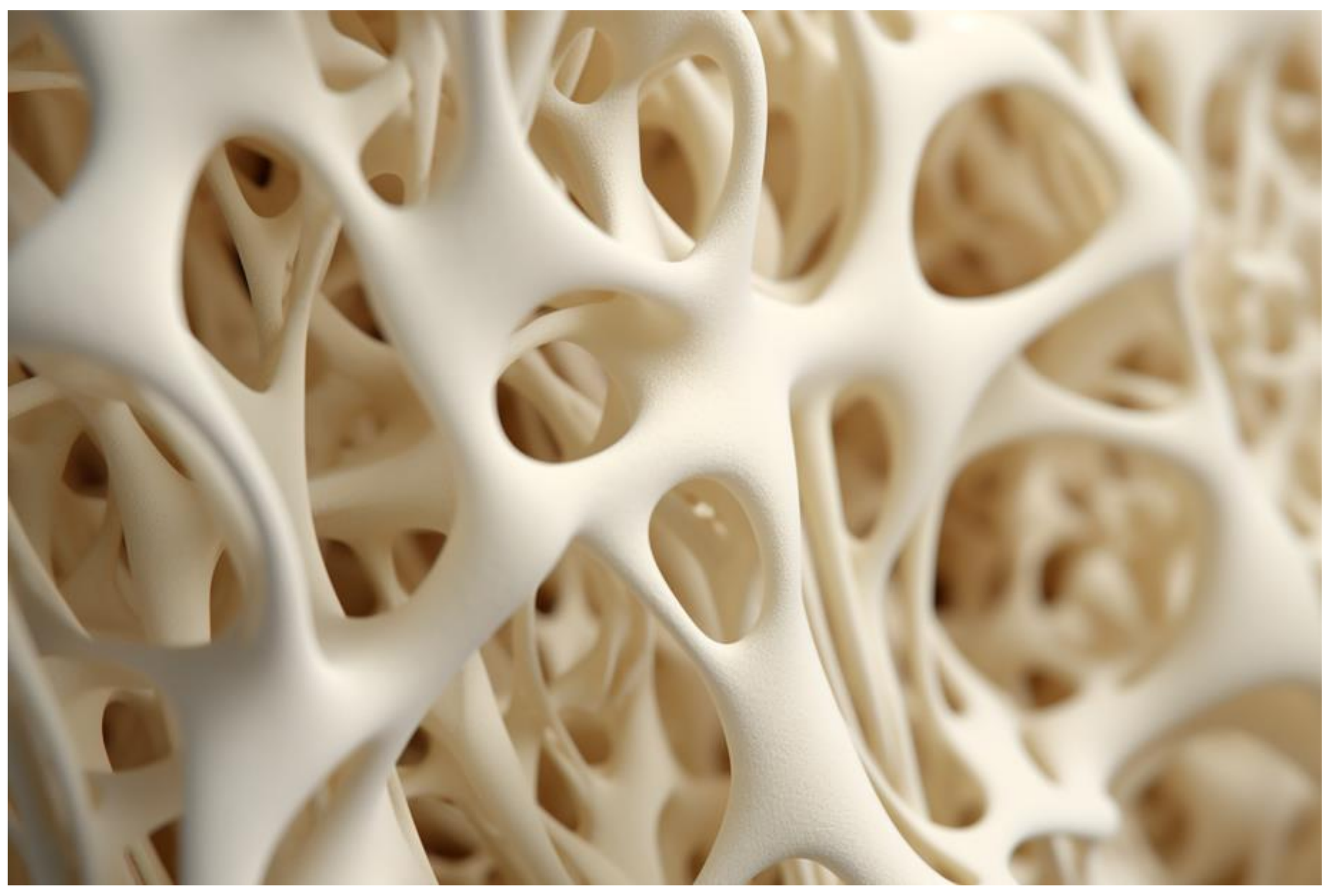
Tailored multi-zonal architecture: Enables distinct bone, cartilage, and superficial layers with optimised fibre diameters and pore sizes for each tissue type, closely replicating natural osteochondral interfaces.

Enhanced bone healing: Demonstrates significantly greater new bone volume and improved healing in preclinical models versus conventional FDM scaffolds, due to higher specific surface area and optimised microvascular environment.

Precision control: MEW allows for fine-tuning of fibre diameter (as low as 1–40 µm) and pore geometry, supporting cell attachment, proliferation, and differentiation.

Core-shell design for mechanical strength: Combines a MEW-printed scaffold core with a robust FDM-printed shell, providing both biological functionality and mechanical protection.

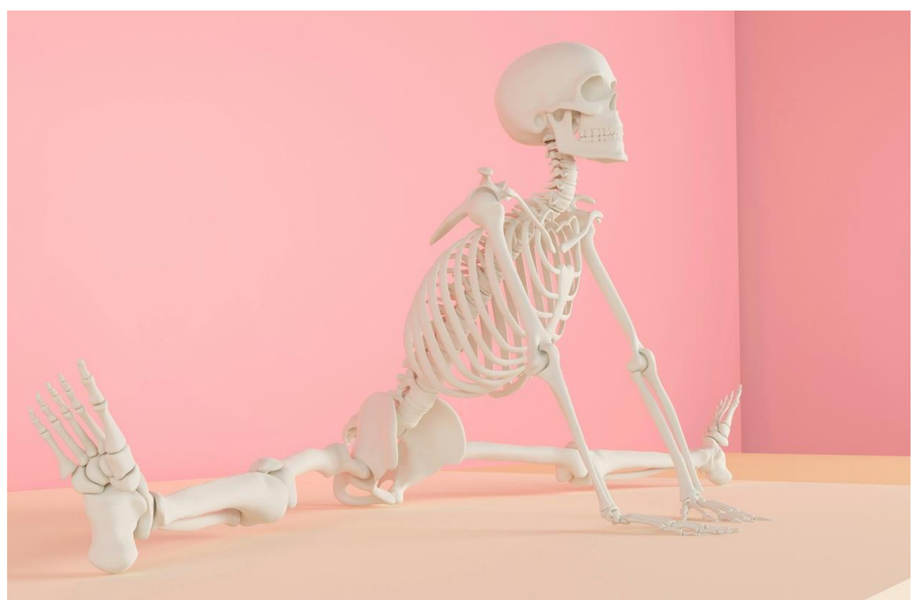
Versatile functionalisation: Supports coatings with hydroxyapatite and incorporation of growth factors (e.g., BMP2), further enhancing osteoinductivity and integration
.
Compared to existing scaffolds, this technology achieves a superior balance of biological performance and mechanical stability, enabling more reliable and effective tissue regeneration.



Applications

Primary industry classification: Tissue engineering and regenerative medicine (bone and cartilage repair).

Secondary application areas: Orthopaedic devices, maxillofacial implants, sports medicine, veterinary applications.



Technology Status

Development stage: Advanced laboratory validation with in vitro and in vivo (rat femoral defect) studies demonstrating enhanced bone formation and vascularisation.

Validation status: Preclinical data show significant improvements over FDM controls; scaffold structure and function extensively characterised by imaging and histology.

Key milestones: Patent filed; multi-layered and core-shell prototypes fabricated and tested; functional coatings and growth factor incorporation demonstrated.

Market Opportunity

Target industries/applications: Orthopaedic and maxillofacial surgery, sports medicine, veterinary orthopaedics, and regenerative medicine for bone and cartilage defects.

Prevalence: Over 2 million bone grafting procedures are performed worldwide each year, including treatment for trauma, tumour resection, and joint reconstruction. Osteochondral defects are a leading cause of disability in young, active patients.

Market size estimate: The global bone graft and substitutes market is projected to exceed $4.5 billion by 2028, with strong growth in synthetic and engineered scaffolds.

Unmet needs addressed: There remains a significant need for scaffolds that provide both mechanical support and biological integration, particularly for large or complex bone and cartilage defects where current solutions are inadequate.

Technology Sector
Med Tech

Patent Details
P14020PC00

Opportunity
Research Collaboration
Available to License
Further Development

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Reference:
DK02-927-01

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The University of Dublin
Rialtas na hÉireann
Government of Ireland
Co-funded by the European Union
Tionól Réigiúnach an Deiscirt
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