Personalized hydroxyapatite-titanium synthetic bone grafts

Specialised additive manufacturing process

Institution

CEITEC

BRNO UNIVERSITY OF TECHNOLOGY

CEITEC, Brno University of Technology

Development Status

Phase 2

Corresponds with TRL 3 and TRL 4.

Feasibility study. The validated manufacturing process and laboratory results confirm the specifications and demonstrate the technology capabilities.

TRL 3 comprises the laboratory-scale evaluation of the chemical, mechanical and in vitro biological performance of the technology.

TRL 4 is the verification of the biocompatibility and bone repair capacity of the technology in two different animal models.

IP Protection Status

Patent MX365570 valid until February 2035.

Utility model CZ36793 U1 valid until December 2032.

Partnering Strategy

Collaboration, investment, licensing, co-development.

The Problem

Bone reconstruction remains a critical challenge in orthopaedics, particularly in cases involving large, load-bearing defects where the balance of mechanical stability and biological integration are both essential. Current bone reconstruction technology relies on bone grafts that despite their demonstrated efficiency face challenges such as availability, immunogenicity, diseases transmission, and patient ethical concerns. As an alternative synthetic hydroxyapatite and tricalcium phosphate bone graft substitutes are available in the marked. However, their application is limited to non-load-bearing applications due to their low mechanical strength. Metallic implants like titanium are the alternative for bone repair in load-bearing conditions. However, metals are bioinert rather than bioactive, and implant loosening may occur due to the mismatch in elastic modulus between the metal and bone. Furthermore, empirical intraoperative adaptation of the implant shape to the individual's specific anatomy and bone defect geometry remains a challenge in personalized bone repair and reconstruction.

Technology Description

Our technology exploits metal additive manufacturing to produce customized titanium scaffolds with a low elastic modulus, tailored to individual clinical cases. The titanium architecture can be adapted in direct collaboration with the medical team to facilitate surgical implantation and optimize the restoration of biological functions. The personalized titanium scaffold is then infiltrated at room temperature with a hydroxyapatite foam, imparting bioactive, osteoconductive and osteoinductive properties that enhance bone healing. The hydroxyapatite foam simultaneously reinforces the titanium scaffold, providing additional load-bearing capacity and resulting in mechanical performance suitable for orthopaedic load-bearing applications.

Commercial Opportunity

The global market for bone grafts and similar orthopaedic technology is estimated at US$3.4B 2023 and is projected to reach US$5.3B by 2030, suggesting a CAGR of 5.7% over the analysis period 2023-2030. The primary driver of this growth is the rising demand for orthopaedic procedures due to an aging population. An additional driver is the continual advances in biomaterial technology. North America currently dominates about 43% of the market share, while Asia-Pacific is the fastest-growing region as healthcare infrastructure improves and advanced bone repair procedures become more common.

The technology aims to integrate titanium additive manufacturing, enabling patient-specific mechanical and anatomical compatibility, with the bone regenerative properties of hydroxyapatite foams, to promote effective bone healing in load-bearing orthopaedic applications.

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