Design Framework for TPMS Bone Tissue Engineering Scaffolds Based on Multi-Field Model

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Abstract

Apart from the biomaterial selection, the geometrical & pore structure of bone scaffolds, their mechanical and bio-fluid properties play important criteria in the design of 3D porous scaffolds for bone tissue regeneration. The joint multi-fields such as computer aided design (CAD), finite element analysis (FEA) and computational fluid dynamics (CFD) will be applied for the design of bone scaffolds. The motivation of this research is to predict the mechanical and fluid properties of triply periodic minimal surface (TPMS) based bone scaffolds for different geometrical and material parameters. TPMS scaffold structure using CAD provides high surface to volume ratio, high permeability and interconnections with merits of aiding cell migration. The FEA and CFD help to improve the design of bone scaffolds and predict the behaviour of complex structures for efficient bone tissue formation in mechanical loading, compression and fluid perfusion. Further, an integrated model (Mechanical & Monte Carlo models) will be applied for simulation of scaffolds degradation and a model to simulate angiogenesis & tissue regeneration in the scaffolds will also be created.

Keywords: bone scaffolds, finite element analysis, computational fluid dynamics, triply periodic minimal surfaces