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Effective Stiffness, Permeability, and Reduced Wall Shear Stress of Highly Porous Tissue Engineering Scaffolds

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Abstract : Tissue engineering is the science of tissues and complex organs creation using scaffolds, cells and biologically active components. Most cells require scaffolds to grow and proliferate. These temporary support structures for tissue regeneration are later replaced with extracellular matrix produced inside the body. Recent advances in additive manufacturing methods allow production of highly porous, complex three dimensional scaffolds suitable for cell growth and proliferation. The current paper investigates the mechanical properties, including elastic modulus and compressive strength, as well as fluid flow dynamics, including permeability and flow-induced shear stress of scaffolds with four triply periodic minimal surface (TPMS) configurations, namely the Schwarz primitive, the Schwarz diamond, the gyroid, and the Neovius structures. Higher porosity in all scaffold types resulted in lower mechanical properties. The permeability of the scaffolds was determined using Darcy's law with reference to geometrical parameters and the pressure drop derived from the computational fluid dynamics (CFD) analysis. Higher porosity enhanced permeability and reduced wall shear stress in all scaffold designs.

Keywords : highly porous scaffolds, tissue engineering, finite elements analysis, CFD analysis
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