







Design of tissue engineering scaffolds based on hyperbolic surfaces: Structural numerical evaluation

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Abstract

Tissue engineering represents a new field aiming at developing biological substitutes to restore, maintain, or improve tissue functions. In this approach, scaffolds provide a temporary mechanical and vascular support for tissue regeneration while tissue in-growth is being formed. These scaffolds must be biocompatible, biodegradable, with appropriate porosity, pore structure and distribution, and optimal vascularization with both surface and structural compatibility. The challenge is to establish a proper balance between porosity and mechanical performance of scaffolds.

This work investigates the use of two different types of triple periodic minimal surfaces, Schwarz and Schoen, in order to design better biomimetic scaffolds with high surface-to-volume ratio, high porosity and good mechanical properties. The mechanical behaviour of these structures is assessed through the finite element method software Abaqus. The effect of two parametric parameters (thickness and surface radius) is also evaluated regarding its porosity and mechanical behaviour.

Introduction

In tissue engineering, the formation of tissue with desirable properties strongly relies on the mechanical properties of the scaffolds at a macroscopic and microscopic level. Macroscopically, the scaffold must bear loads to provide stability to tissues while it is being formed fulfilling its volume maintenance function. At the microscopic level, both cell growth and differentiation and ultimate tissue formation are dependent on the mechanical input to cells. Thus, the scaffold must be able to withstand specific loads and transmit them in an appropriate way to the growing and surrounding cells and tissues.

Ideally, scaffolds must be biocompatible, biodegradable with a degradation rate matching the regeneration rate of the new tissue, highly porous structures with full interconnectivity between pores, with appropriate mechanical properties and surface characteristics [1].

The design of optimized scaffolds for tissue engineering is a key topic of research, as the complex macro- and micro-architectures required for a scaffold depends on the mechanical properties, and the physical and molecular