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TPMS SCAFFOLDS FOR BONE-CARTILAGE INTERFACE

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Summary: The purpose of a Tissue Engineering (TE) scaffold is to provide support for cells to adhere, proliferate and differentiate into a specific phenotype. These cellular phenomena are all dependant of the scaffold design and structural properties like geometry, porosity, pore size, pore interconnectivity and surface area. Therefore, the design and production of TE scaffolds with controlled pore size and distribution represents a classic optimization problem. Within this scope, TPMS (Triply Periodical Minimal Surfaces) scaffolds have been widely used for TE applications due to their ability to form fully interconnected porous structures with controlled porosity and great values of specific surface area (SSA). We are currently expanding our scope to the subchondral bone, which is not a homogenous tissue and allows for the connection between articular cartilage (AC) and the trabecular bone layer surrounding bone marrow. It also provides support for load distribution. Under the eventuality of a chondral defect, literature states that it is important to preserve the interactions between subchondral bone and AC. In fact, our research group has been focused on the study of permeability and pore size of TPMS-based 3D printed scaffolds for bone TE. These are important parameters to assess structural properties but also to quantify important cellular phenomenon such as cell seeding and distribution into the scaffold, macromolecules transport, and cell mechano-regulation stimuli like fluid shear-stress and pressure.
Focusing on pore sizes, the scaffolds we previously produced and characterize had pore sizes ranging from [160, 1015] μm. Literature defends that a mean pore size >300 μm allows for direct vascularization and osteogenic cellular differentiation on scaffolds for bone TE. In contrast, pores smaller than 300 μm might induce chondrogenic differentiation and help prevent vascularization, which is crucial given that AC is an avascular tissue. Therefore, in this work we will present how we can tune different types of TPMS in order to achieve the best combination of structural parameters like cell size, cell number, and pore size that promote the desired osteogenic cell differentiation and proliferation, and control vascularization of the tissue while maximizing SSA, permeability and scaffold's mechanical integrity from implant perspective. Porosity and pore size gradients will be explored for osteochondral interface reconstruction as well as the possible anchoring/interaction with hydrogels for viscoelastic chondral phase repair.