(OP 74) Designing Silk-Based 3D Architectures with Controlled Lamellar Morphology

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The impressive mechanical properties, along with established biocompatibility and slow degradability, render silk as an interesting biomaterial for bone tissue engineering applications. New silk-based scaffolds resembling bone lamellar structure were successfully developed using a freeze-drying technique. The structure could be controlled directly by the solute concentration and freezing parameters. The lamellar scaffolds disclosed a controlled and regular morphology (lamellar thickness: ~3.5 μm; interlamelar distance: ~15 μm). In order to induce water stability, different post-treatments were studied including methanol treatment, water annealing and steam sterilization. The resulting structures exhibited significant differences in terms of morphological integrity, structural details and mechanical properties. Steam sterilization preserved the structural integrity of the lamellar features, while improving mechanical properties of the scaffolds. Human bone marrow-derived mesenchymal stem cells (hMSCs) were seeded on these silk fibroin lamellar scaffolds and grown under osteogenic conditions to assess the effect of the microstructure on cell behaviour. The water annealing treatment promoted significantly improved osteogenic outcomes based on elevated alkaline phosphatase (ALP) activity and the deposition of mineralized matrix. Two-photon excited fluorescence (TPEF) was used to detect the presence of collagen, based on Second Harmonic Generation. Collagen was aligned along the morphology of the lamellar architecture, demonstrating that the lamellar morphology constituted a patterned surface onto which hMSCs cells attached, proliferated and guided the formation of new ECM. These lamellar-based constructs have potential for use in tissue engineering, were appropriate surface environments are important in the control of biological outcomes.