HYBRID SILK FIBROIN–GELMA SCAFFOLDS AS NEXT-GENERATION PLATFORMS FOR VASCULAR TISSUE ENGINEERING

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INTRODUCTION

Scaffolds play a central role by **mimicking** the **extracellular matrix (ECM)** and providing structural and biological cues that regulate cell behavior. The main causes of TEVG failure are thrombosis and aneurysm, which highlights the need for improved biofunctionalization strategies

Silk fibroin (SF) has emerged as a promising biomaterial due to its excellent biocompatibility, mechanical strength, and controllable degradation.

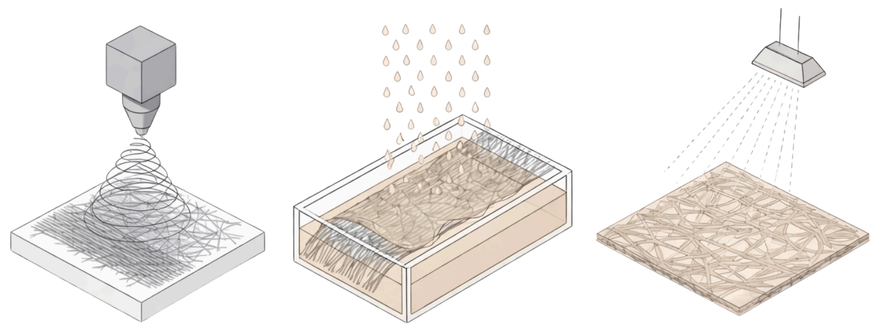
Electrospinning reproduces the **ECM** architecture**,** but its limited surface bioactivity motivates the incorporation of **functionalized hydrogels** such as **GelMA.** This approach provides a hydrophilic and bioactive microenvironment that enhances **cell encapsulation,** promotes **endothelialization,** and enables controlled **drug release, a**iming to reduce **thrombosis** and **improve graft stability.**

METHODOLOGY

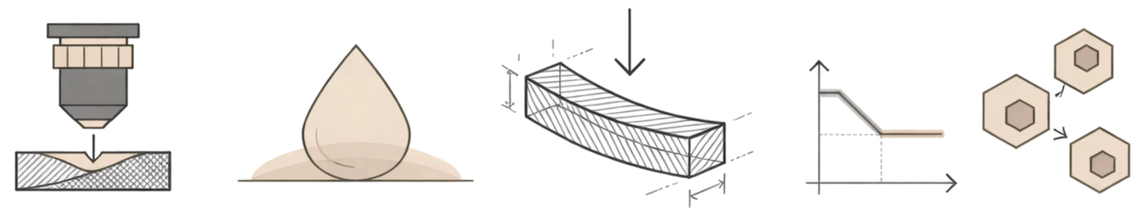
SF: Electrospun non-oriented (SF-NO) and oriented (SF-O) architecture nanofibrous membranes

Gelatin Methacryloyl (GelMA)

- **SF/GelMA**: SF immersion in GelMA



Physicochemical and biological charecterization



RESULTS

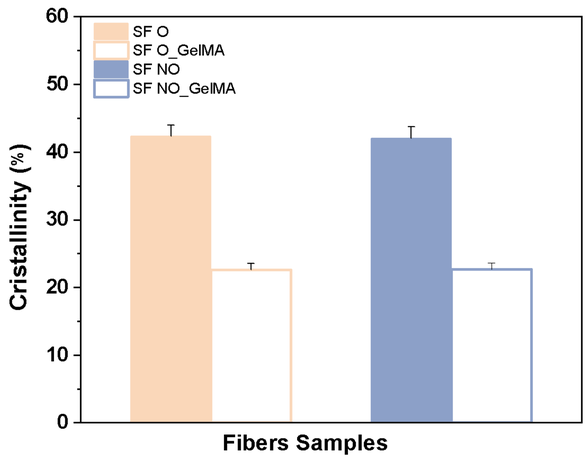


Figure 1. **Analysis of the secondary structure of SF scaffolds following the incorporation of GelMA**. Cristallinity of NO and O fibers.

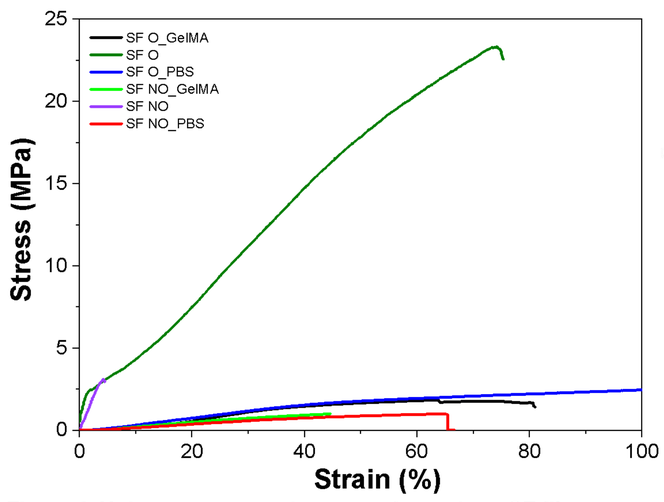


Figure 3. **Unitary stress-strain curves for various SF films.**

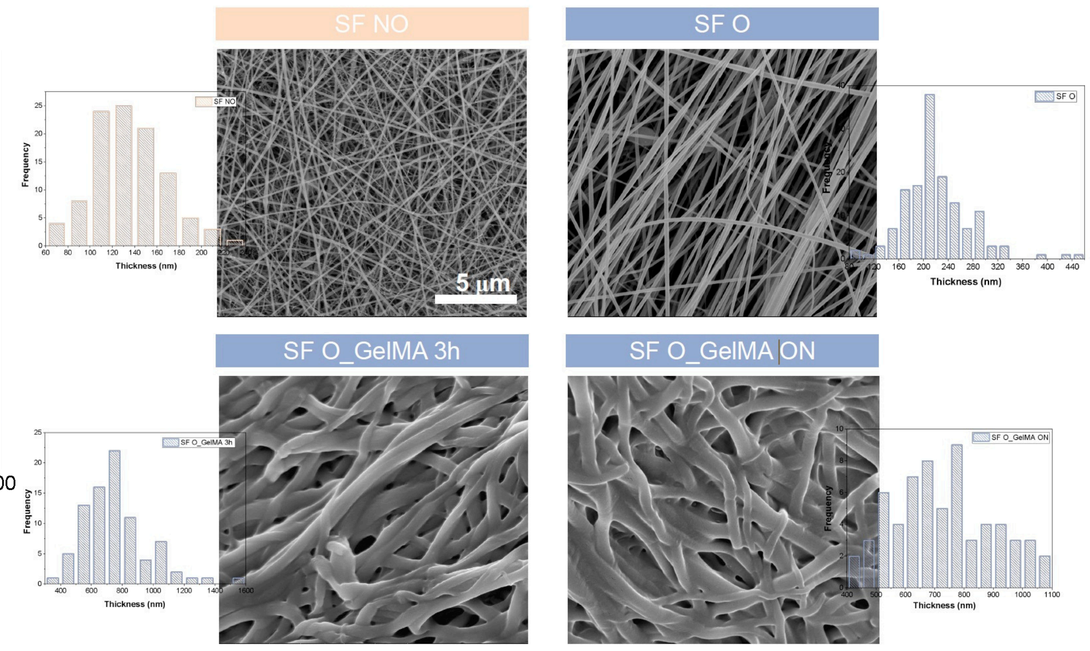


Figure 5. **Morphological characterization by SEM and fiber diameter distribution.** SF nanofibrous films in non-oriented (NO) and oriented (O) configurations. SF-O coated with GelMA by immersion 3 h and overnight. Histograms with mean fiber diameter.

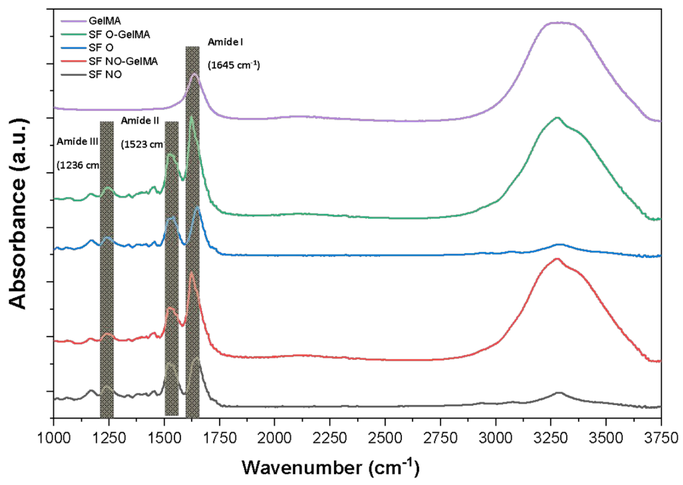
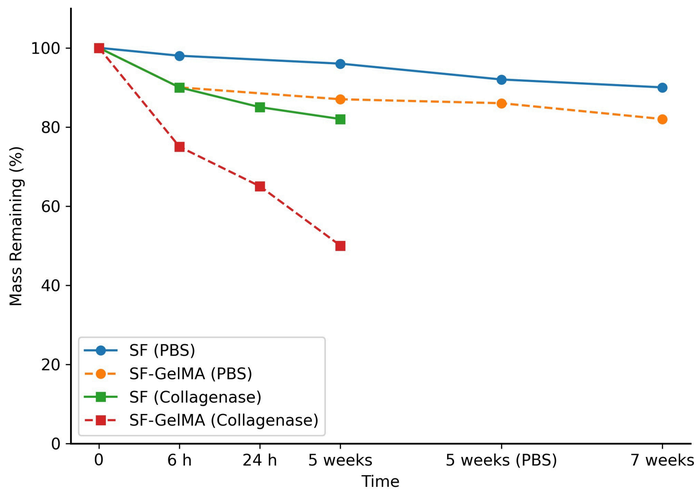
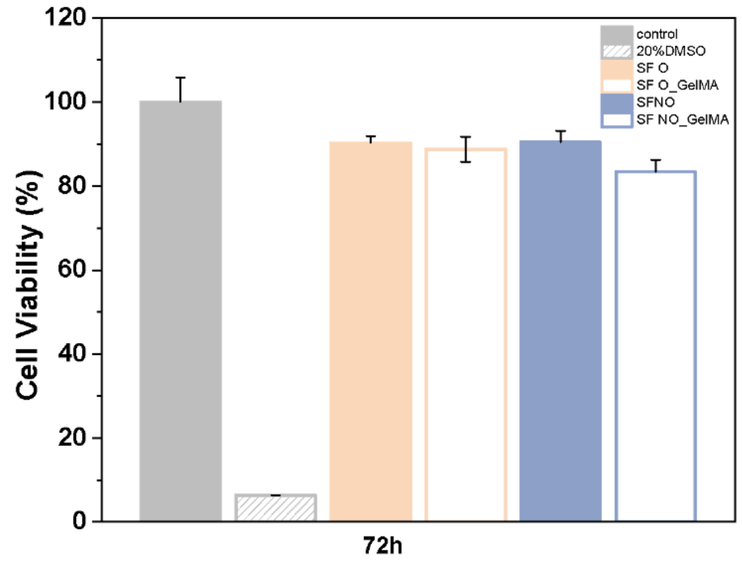


Figure 2. **FTIR chemical analysis of SF fibers and GelMA coatings.** Comparison of the spectra showing the amide I, II, and III bands



Figures 4. **Assessment of hydrolytic degradation in PBS and Collagenase respectively. 7-week and 5-week period.**



Figures 6. **In vitro evaluation of biocompatibility.** The image shows cell viability greater than 85% after 72 hours for all silk fibroin variants, demonstrating the absence of cytotoxicity compared to the negative control.

CONCLUSION

The SF/GelMA platform achieves an optimal balance between structural strength and bioactivity. The orientation of the fibers (SF-O) is crucial for maximizing mechanical stiffness and withstanding pulsatile pressures. Thanks to their controlled degradability and biocompatibility, these scaffolds are ideal candidates for vascular regeneration in preclinical stages.

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