Mechanical characterization of electrospun scaffolds for in situ tissue engineering

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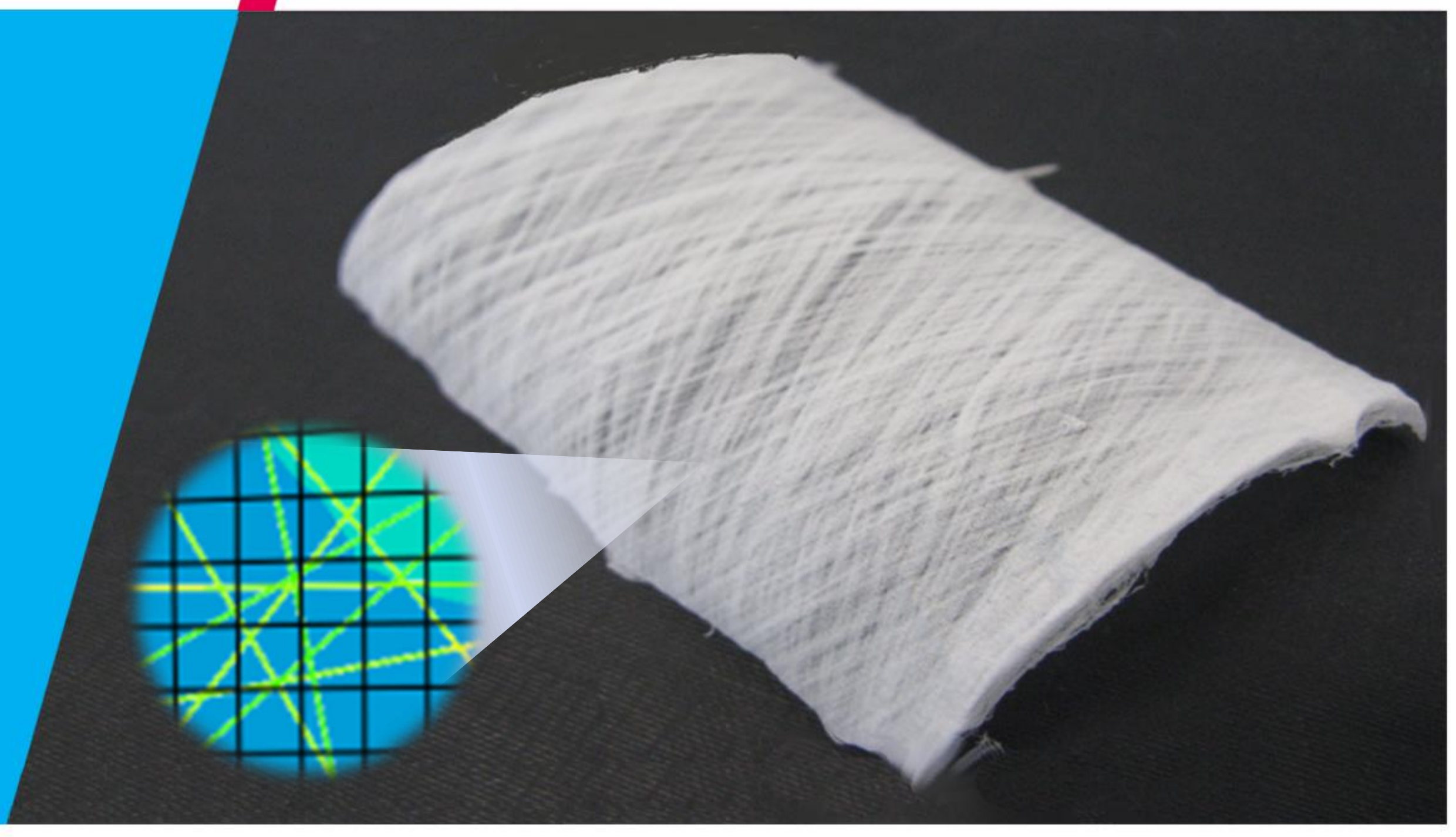
Mechanical characterization of electrospun scaffolds for in situ tissue engineering

G. Argento, M. Simonet, C.W.J. Oomens, F.P.T. Baaijens

Eindhoven University of Technology, Department of Biomedical Engineering



Introduction

In situ tissue engineering is an attractive alternative to the traditional tissue engineering approach [1] (Fig.1). It requires the design of an electrospun scaffold able to meet the hemodynamic demands when it is implanted.

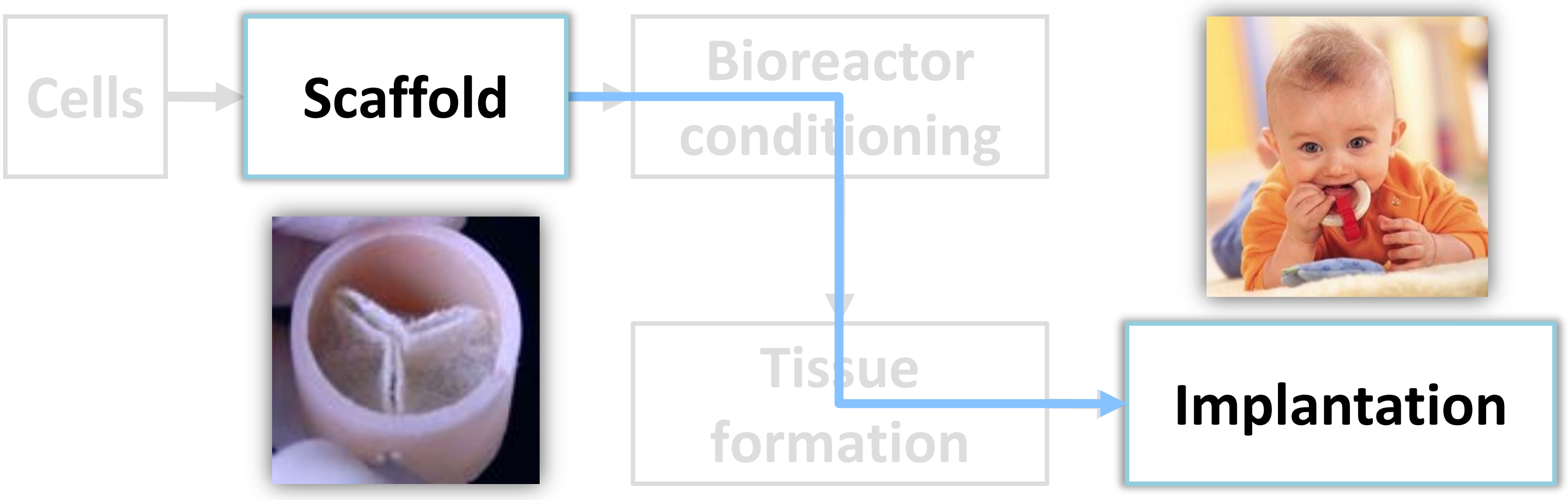


Figure 1: In situ tissue engineering approach

Aim of the work

Evaluate the mechanical properties of electrospun scaffolds with different microstructural properties.

Validate a computational framework aimed at optimizing the design of electrospun scaffolds for tissue engineering.

Materials and methods

Two electrospun scaffolds are produced, with different fiber orientation (Fig. 2).

Scaffold samples are soaked in water and the macroscopical mechanical behavior of the scaffolds is evaluated by means of biaxial mechanical tests (Fig. 3).

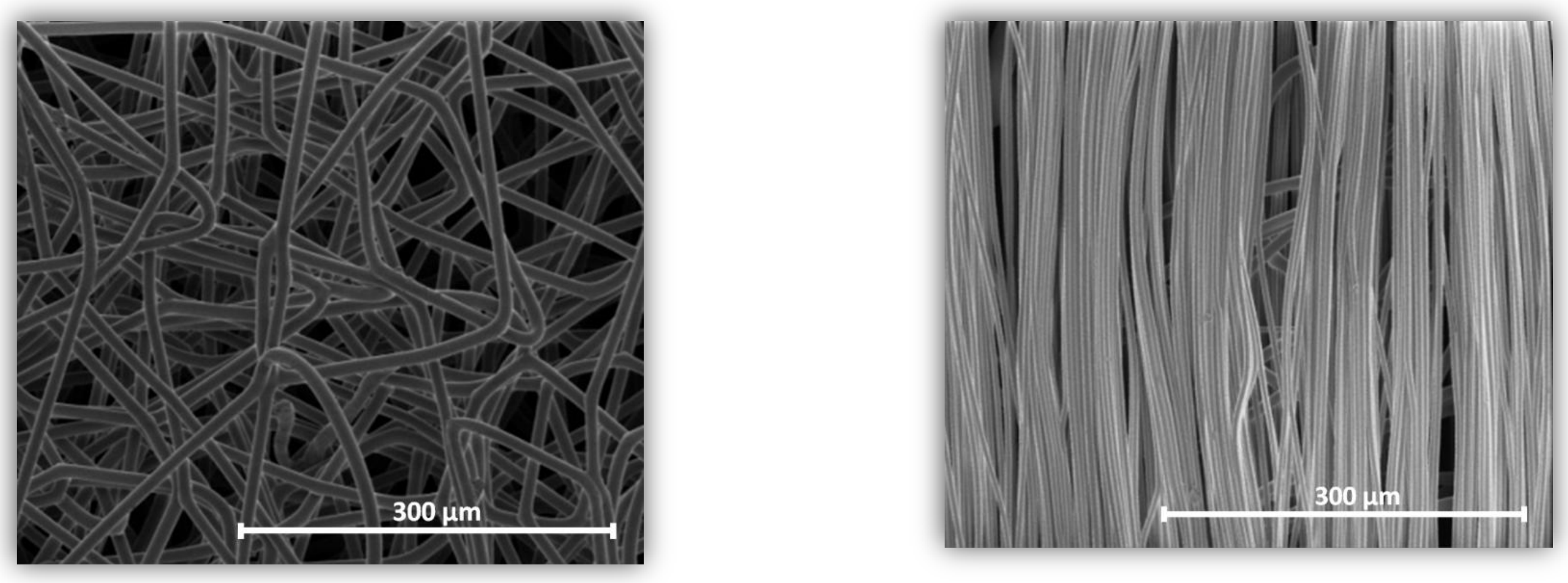


Figure 2: Electrospun scaffolds with isotropic fiber distribution (left) and scaffold with highly anisotropic fiber distribution (right).

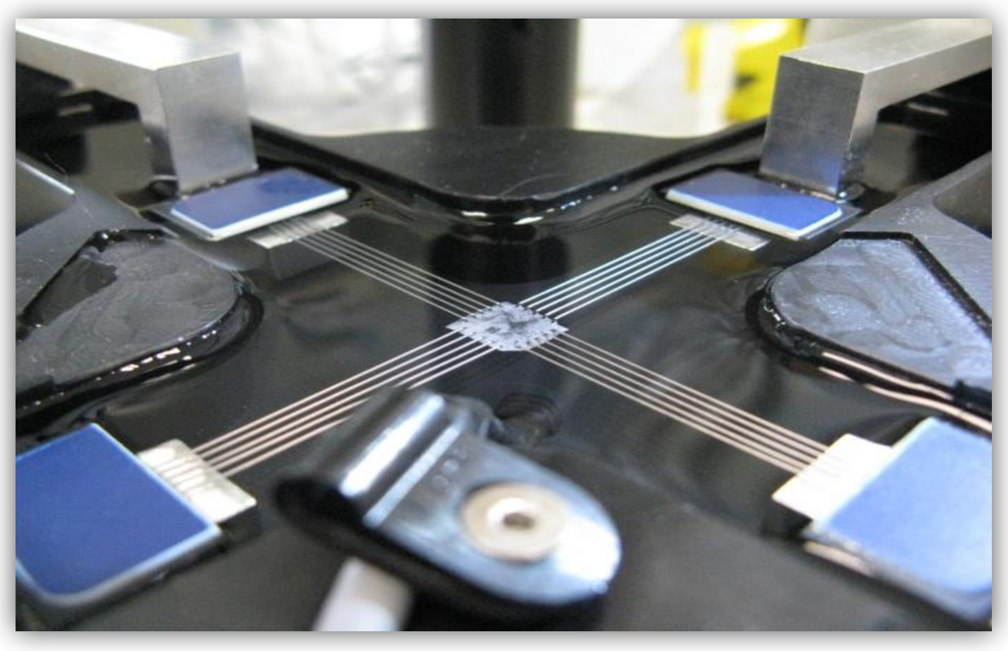


Figure 3: Biaxial tester used to test scaffold samples

The structural properties of the fibrous constructs (fiber diameter, fiber orientation, porosity, interconnection) are characterized and used to build a microstructural computational model of the scaffolds [2] (Fig. 4).

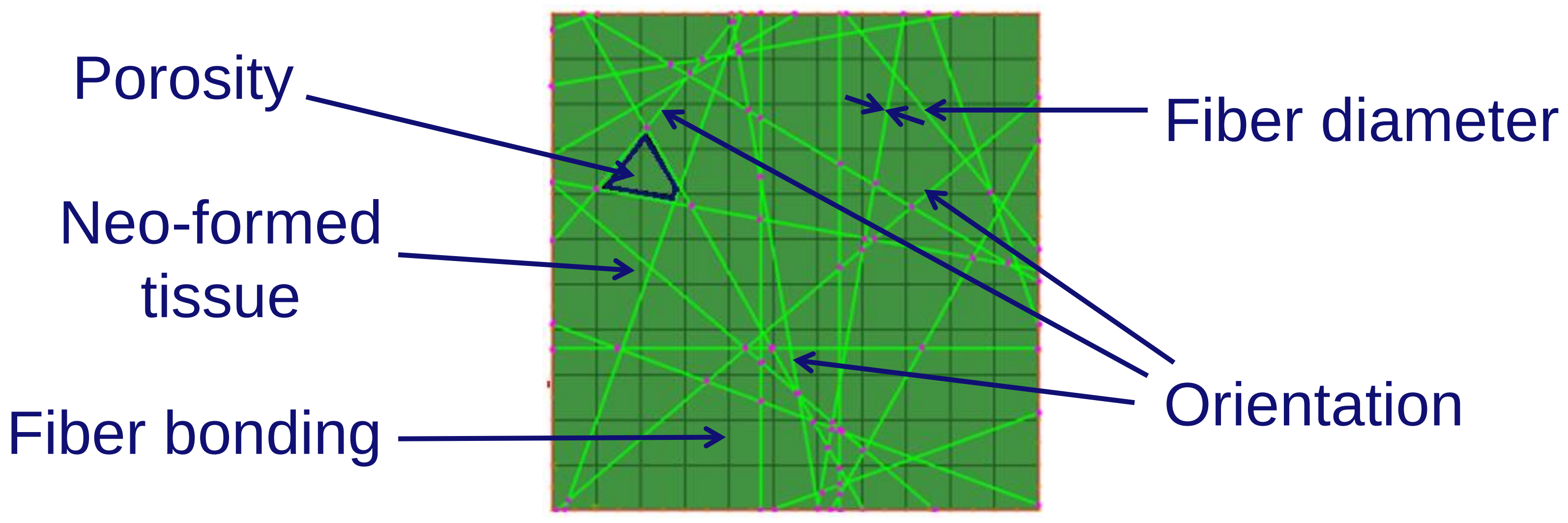


Figure 4: Microstructural model of an electrospun scaffold

The numerical framework is fully characterized with reference to the biaxial experimental results.

Results

The numerical model is suitable to describe the different mechanical behavior of electrospun scaffolds with different constitutive properties (Fig. 5).

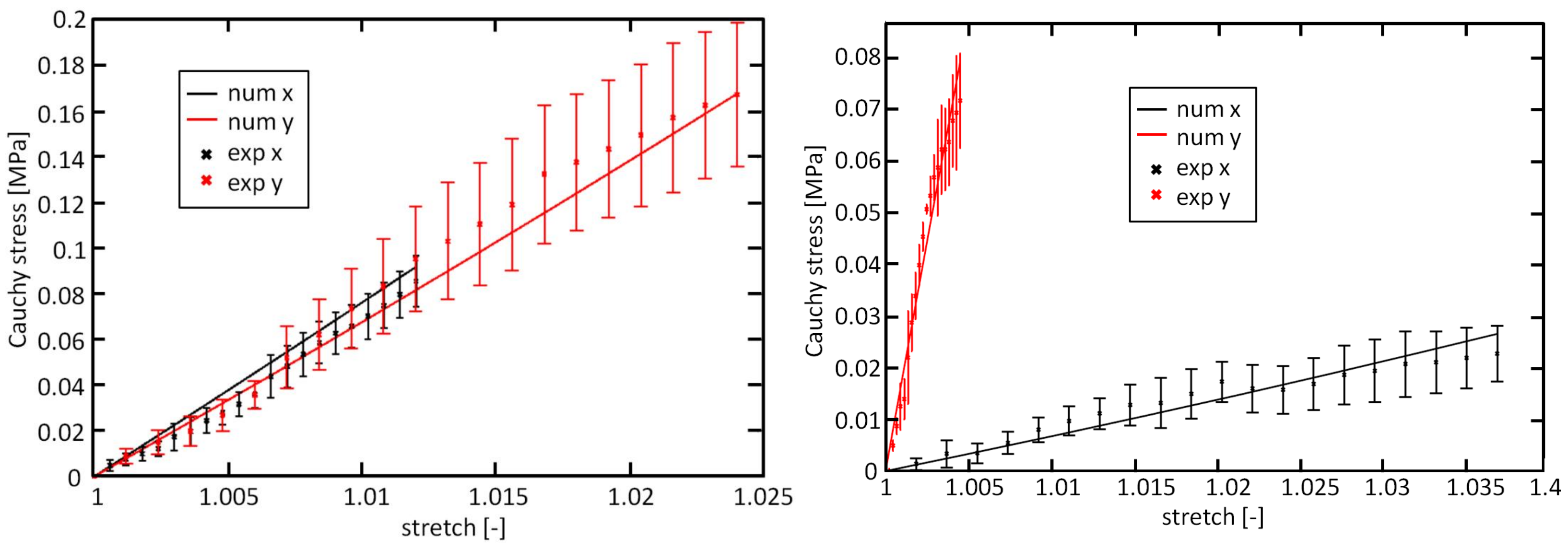


Figure 5: Numerical fitting of the experimental biaxial data for the scaffold with more isotropic (left) and the highly anisotropic (right) fiber distribution

The computational model is capable to predict the uniaxial mechanical behavior of a scaffold (Fig. 6).

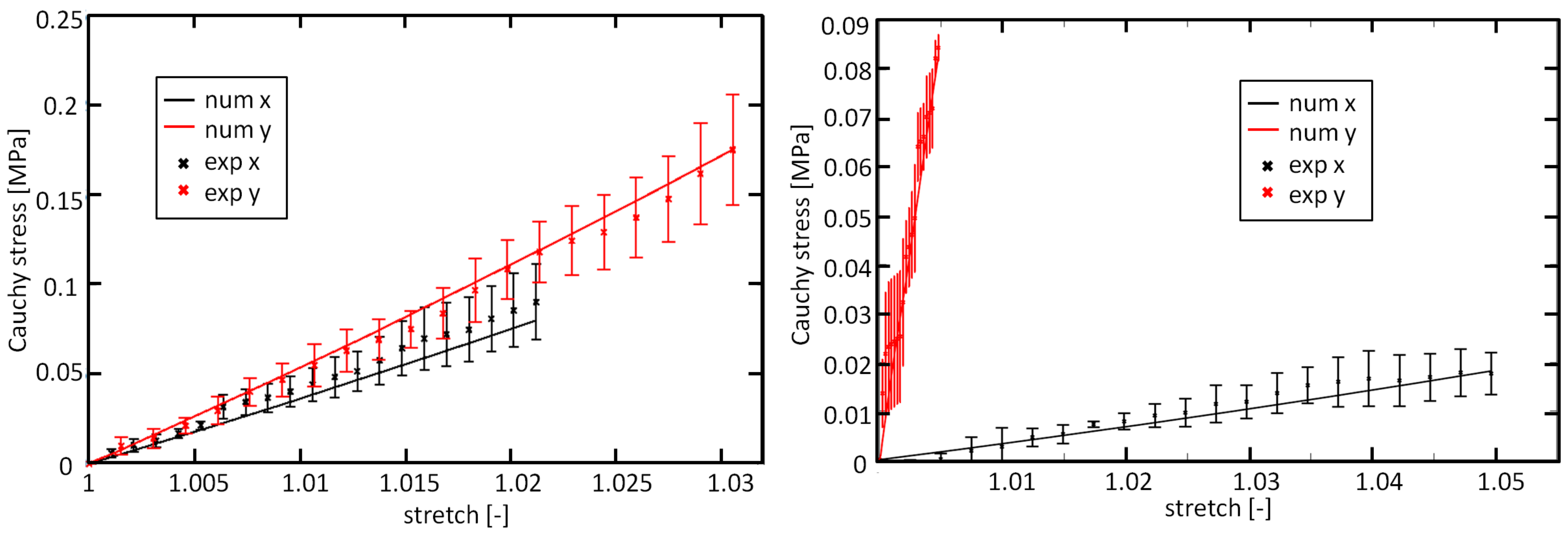


Figure 6: Predicted uniaxial mechanical behavior of the scaffold with more isotropic (left) and the highly anisotropic (right) fiber distribution

Future work

The computational prediction will be used to get information about the mechanical performance of valve shaped polymeric scaffolds.

References

[1] Mol A, Driessen NJB, Rutten MCM, Hoerstrup SP, Bouten CVC, Baaijens FPT. Tissue Engineering of Human Heart Valve Leaflets: A Novel Bioreactor for a Strain-Based Conditioning Approach. Ann Biomed Eng 2005; 12(33):1778-1788.

[2] Argento G, Oomens CWJ, Baaijens FPT. Optimal boundary conditions for the multi-scale finite element analysis of fibrous scaffolds for heart valve tissue engineering , ASME Summer Bioengineering Conference 2011

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