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A Constitutive Model for the Anisotropic Mechanical Behaviour of Electro-Spun Biodegradable Polymer Scaffolds

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In this work, a constitutive model for the anisotropic hyperelastic behaviour of electro-spun biodegradable polymer scaffolds was derived. The continuum model is microstructurally motivated and is composed of two 8-chain networks assembled in parallel, one featuring an isotropic unit cell and the other a transversely isotropic unit cell. The mechanical response of individual polymer chains is captured using a Knowles strain energy density. The continuum model is finally augmented with limiting strain energies which capture the monotonous failure behaviour of the scaffold structure in tension along and across the polymer fibres. The model was implemented as a non-linear 8-noded brick element with an enhanced strain formulation. The constitutive parameters were obtained by fitting the results of dedicated physical experiments. It was shown that the constitutive model is capable of capturing with very good accuracy the behaviour of electro-spun biodegradable polymer scaffolds.

Keywords: Polymer, biodegradable, electro-spinning, anisotropy, hyperelasticity, tissue engineering, cardiovascular