6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

3D and 2.5D computational models of electrospun mats

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Key Words: *Multiscale modelling, Electrospun scaffold, Non-woven mesh*

Electrospinning is a versatile manufacturing process to produce non-woven mats consisting of nano to micro sized fibres. To identify auspicious structures for specific applications and to understand its mechanical behaviour suitable numerical models are required [1]. As the macroscopic behaviour of fibrous materials depends mainly on the fibre material and their interaction properties [2], discrete network models, where the single fibres are meshed by finite elements, are commonly used to couple the different relevant length-scales [3]. Furthermore, discrete network models are useful to study the influence of macroscopic loads on microscopic properties, such as non-affine fibre reorientation and mechanisms of interaction between fibres.

In this contribution, we present a custom method to generate three dimensional representative volume elements of electrospun materials based on a *virtual spinning* approach. This model is used to inform, validate and enhance a reduced 2.5D approach, i.e. a planar model partially enriched by three dimensional characteristics for the identification of fibre cross-links[4]. To this end, topological parameters are extracted from the 3D RVE and used to inform the reduced approach to generate equivalent RVEs. Then, assumptions regarding the interconnection of fibres and their planarity intrinsic to the reduced approach are studied. The 3D model furthermore identifies a relationship between porosity and cross-link density in fibre networks, which is used to couple two free parameters in the 2.5D model. Finally, the effective material behaviour of the network predicted by the three dimensional and the reduced approach are compared. The results show sound agreement for high porosities whereas for lower porosities the differences become increasingly important.

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