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# Systematic mechanical evaluation of electrospun gelatin meshes

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**Abstract**

Electrospinning is a simple and efficient process for producing sub-micron fibres. However, the process has many variables, and their effects on the non-woven mesh of fibres is complex. In particular, the effects on the mechanical properties of the fibre meshes are poorly understood. This paper conducts a parametric study, where the concentration and bloom strength of the gelatin solutions are varied, while all electrospinning process parameters are held constant. The effects on the fibrous meshes are monitored using scanning electron microscopy and mechanical testing under uniaxial tension. Mesh mechanical properties are relatively consistent, despite changes to the solutions, demonstrating the robustness of electrospinning. The gel strength of the solution is shown to have a statistically significant effect on the morphology, stiffness and strength of the meshes, while the fibre diameter has surprisingly little influence on the stiffness of the meshes. This experimental finding is supported by finite element analysis, demonstrating that the stiffness of the meshes is controlled by the volume fraction, rather than fibre diameter. Our results demonstrate the importance of understanding how electrospinning parameters influence the pore size of the meshes, as controlling fibre diameter alone is insufficient for consistent mechanical properties.

*Keywords:* Electrospinning, gelatin, mechanical properties, fibre diameter, pore size.

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## 1. Introduction

Electrospinning is a cost-effective and convenient method for manufacturing sub-micron fibres [1]. The process requires a viscous polymer solution to be ejected through a narrow orifice connected to a high voltage supply. The resulting polymer jet undergoes bending instabilities as it is attracted to an earthed collector, causing the jet to stretch and evaporating the solvent sufficiently to form a mesh of nano- or micro-scale fibres on the surface of the collector [2]. The versatility of electrospinning has caused a rapid increase in its popularity and it is currently being investigated for use in many biomedical and environmental applications, as well as in energy collection and storage [2]. Electrospinning has become increasingly favoured in tissue engineering, in particular for soft tissues [3]. This is due to electrospun nanofibres having a structure very similar to the nanofibrous collagen found in the extracellular matrix (ECM) of many tissues [4]. These collagen structures are often responsible for the mechanical properties of the tissues. Mimicking these mechanical properties is key to creating a functional artificial tissue, although it is often overlooked in favour of creating the right biological environment.

Although the electrospinning process is highly versatile, it is not well understood how the process can be manipulated to affect the mechanical properties of electrospun fibres. This is partly due to the wide range of variables within the process, such as the applied voltage, solution flow rate, and the distance between the polymer source and collector [5]. The effect of some of these process variables on the morphology of the electrospun fibres

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