Leverage Machine Learning to Optimise the Manufacturing Of Nano Fibrous Non-Woven Fabrics

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Abstract

Electrospun fabrics exhibit high porosity and surface area that can be tuned through optimisation of manufacturing parameters.These properties make them promising for waterproof and breathable textiles, skin-like non-woven fabrics or smart wearable bioelectronic textiles. This research aims to establish a manufacturing optimisation methodology based on machine learning models to control fibre diameter and inter-fibre separation for textile applications.

Polyvinyl alcohol-based (PVA) fabrics were manufactured with 10%, 12%, 14% and 16% w/v of PVA/distilled water and varying the values of flow rate (0.5-5 ml/h), voltage (18-25 kV), diameter of the needle (15-23G), distance between needle and collector (5-11 cm) and revolution of the mandrel (500-3000 rpm). 2560 observations of diameter of fibres and inter-fibre separations of the electrospun meshes were used to inform 20 machine learning models to enable prediction of the diameter of the fibres and inter-fibre separation.

C5.0 Decision Trees and Rule-Based Models provided a visual route to determine the optimum set up to manufacture tailored fabrics with the desired morphology with the highest accuracy for the prediction of the diameter of the fibres (0.868) and for the inter-fiber separation (0.861). This research opens a new door to the optimisation of the electrospinning technique for textile applications.