

Modeling of Needle Punched Nonwoven Structures to Analyse Porosity

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Abstract: The nonwoven fabrics are widely used for different purposes as filters, thermal and sound insulation and others. While developing non-woven fabric, many tests need to be carried out to determine its properties, and this creates a financial burden. Modeling of nonwoven fabrics provides convenience and efficiency in the development of textile materials. Thus, many nonwoven models have been developed [1,2,3]. However, specifically needle punched nonwoven models are limited [4]. The aim of this study is to create parametric model of needled nonwoven fabrics at fiber scale and use this model in simulations.

The fiber orientation of the nonwoven fabric, fiber diameter, fabric thickness and areal density of the fabric determine the structure of the fabric [5,6,7,8]. Therefore, these parameters were taken into account and set as parameters when modeling the non-woven fabric. The fibers are assumed to be build as chains of cylinders and randomly oriented, following statistical distribution regarding the projection angles and vertical position. The mathematical model is implemented into python script, which finally visualize the structure using the 3D modelling software (TexGen) (Fig. 1).

The real nonwoven was imaged with a scanning electron microscope (SEM). The real nonwoven image and the modeled nonwoven were converted to binary mode using ImageJ (See. Fig 2) and the optical porosity value was calculated. According to this study, the modeled nonwoven fabric and the real nonwoven fabric gave similar results in terms of porosity analysis. Therefore, the created model nonwoven matched the real nonwoven structure.

The developed model can be used in subsequent steps to simulate thermal, mechanical, and other properties using finite element method (FEM) or other methods. The implementation of such an approach enables researchers and industry professionals to gain meaningful insights and accurately predict critical behavior for various applications.

Keywords: Nonwoven Modelling, Textile Modelling, 3D Modelling.

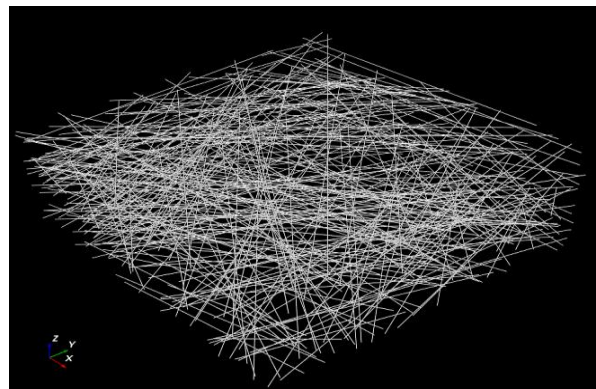


Figure 1. 3D Visualization of modelled nonwoven structure

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