Simulation and Analysis of Unbonded Nonwoven Fibrous Structures

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ABSTRACT
In this work we report on our algorithm for generating 3-D virtual structures resembling un-bonded fibrous webs. The paper discusses short and infinitely long fibers, each emulating a category of nonwoven fibrous medium. The structure Solid Volume Fraction (SVF), being the most important characteristic of a fibrous porous medium, is calculated for different fiberwebs and discussed in details. It is shown that the SVF of the fibrous structures generated by our algorithm is independent of the basis weight. In other words, the porosity of the medium is only a function of the fiber properties – this is as expected. It is also demonstrated that by decreasing the fiber diameter while keeping other properties of the virtual fiberweb constant causes the SVF to decrease almost linearly. The same is not observed for the fiber rigidity. The capability of our algorithm for generating fibrous webs made up of layers of different fibers is demonstrated and their properties are discussed. The application of such virtual fibrous structures in modeling transport phenomena in nonwoven materials and their potential applications in load-deformation studies are discussed.

INTRODUCTION
Fibrous materials such as filters, wipes, insulators, etc. have enormous industrial applications. The peculiar properties of fibrous materials, as opposed to other types of materials, are their flexibility, compressibility and permeability. Fibrous materials can be divided into two category of ordered, i.e., woven and knitted fabrics, and disordered, hereon called nonwovens. Nonwovens are made by means of assembling short (staple fibers) or infinitely long fibers (continuous filaments) on top of each other and bonding them together via a mechanical, thermal or chemical process. The majority of air filters, wipes, insulations, barrier fabrics, surgical masks, cosmetic/hygiene products and dippers