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Computational Modeling of Mechanical Performance in Thermally Point Bonded Nonwovens

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ABSTRACT

Several theoretical models have been proposed in the past for predicting the basic mechanical properties of thermally point bonded nonwovens from structural features of the constituents. However, the role of bond geometry, distribution and related fiber properties were not taken into account. We have developed a mechanics based model to help understand the behavior of point bonded materials as a function of various structural and process variables.

KEYWORDS: Image Analysis, Orientation Distribution Function (ODF), Bond Geometry, Image Simulation, Computational Modeling

Introduction

Several theoretical models have been proposed in the past in an attempt to predict basic performance. The focus of these research efforts has been mainly directed towards the understanding of the mechanical behavior of the structures. Some of these efforts are summarized below.

Backer and Patterson pioneered a fiber web theory to accommodate the broad mechanical design requirements of nonwovens [1]. This model assumes that the fibers are straight and oriented in the machine direction, and that the fiber properties and orientation are uniform from point to point in the fabric. Hearle et al, extended the model to account for local fiber curvature [2]. In this model, fiber orientation distribution, fiber curl distribution, fiber stress-strain relationships and fabric Poisson ratio must be determined before tensile properties may be accurately predicted. It is interesting to note that Hearle et al., measured fiber orientation by means of a projection microscope where the path of the fiber was manually traced on transparency. In a more recent study, Komori and Makishima [3] estimated fiber orientation and length by means of integral analysis. They hypothesized that the anisotropies frequently observed in the fiber assemblies are caused by the particular bias in distribution and orientation of constituent fibers. It was assumed that the fibers were straight-line segments of the same length

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