Investigation of Shear Characterization of UHMWPE Unidirectional and Highly-Directional Cross-plies for Finite Element Simulation of Composite Processing

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Abstract. In-plane shearing is the dominant method of deformation in many composite forming processes, including thermoforming. The shear-frame, or picture-frame, test is a widely accepted method to characterize the shear behavior of a material system to find the properties to use in forming simulations, and this test has been shown to be applicable for providing shear stiffness as a function of the state of shear for a variety of woven-fabrics based material systems. The current research explores the use of shear-frame testing of two non-woven material systems made of Ultra High Molecular Weight Polyethylene (UHMWPE), specifically DSM Dyneema® unidirectional fiber cross-ply and DuPont™ Tensylon™ highly-directional thin film cross-ply. The material systems are characterized at an elevated temperature for processing applications with a method of obtaining constant shear rate data with a nonlinear crosshead rate. The effects of sample size and sample geometry are investigated through the use of Digital Image Correlation (DIC) to evaluate the shear strain field on the sample. The load contribution from the sample arms is of particular interest for these types of materials, so an investigation of appropriate gauge area and normalization methods is performed. Finite element simulations of the shear-frame test are completed to validate the characterization methodology.