Validation of Long-Fiber Thermoplastic Composite Models

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With increased pressure to reduce energy consumption, long-fiber reinforced thermoplastic composites (LFTs) are of interest to aerospace and automotive industries due to their light weight in combination with other desirable mechanical properties and ease of manufacturing to replace common materials such as aluminum and magnesium. However, the performance of LFTs is highly dependent on microstructural variables such as fiber length and orientation, which are heavily influenced by the manufacturing process. Accurately predicting these factors would allow for more rapid advances in LFTs by reducing the experiments needed for certification and decreasing expenses. While models that serve this purpose exist, the current models require validation to be used within related industries. A secondary objective of this project is to standardize the process by which the fibers are extracted and measured with little bias. Validation is achieved by directly comparing simulation results with experimental fiber length and orientation distribution. The fiber lengths are determined by burning off the polymer matrix and extracting fiber samples, which are then separated and measured. Fiber orientation distributions are determined by using an automated process which calculates 2D orientations from polished sample surfaces. The validation process will provide input to the model, which will be iterative to obtain 15% accuracy of the model's predictions compared to experimental results. After the validation is complete, the models will be used for industrial purposes to optimize LFTs microstructures for component designs.