An optimized model of dual-scale geometry of textile reinforcement based on X-ray microtomography for modeling of RTM processes

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ABSTRACT

In the recent years, a considerable effort is put into the development of simulation approaches for production methods of high-performance composite materials. It has been motivated by the increase of complexity of manufactured parts and the fiber reinforcements used, with particular emphasis on 3D woven textiles. An accurate representation of the geometry of fibrous reinforcement is needed to perform predictions of resin flow during Liquid Composite Molding processes, for example, Resin Transfer Molding (RTM). Two approaches are currently dominating: theoretical reconstructions and X-ray microtomography-based geometries. Theoretical reconstructions provide data that is relatively easy to integrate into the simulation workflow, but at the cost of significant deviations from the real geometry of textile and providing scarce information on the distribution of single filaments in fiber tows. This limits the prediction of resin flow at the microscale. On the other hand, X-ray microtomography provides very detailed information on both tow geometry and filament distribution, but the amount of data is too large and noisy to integrate it in the simulation approaches.We propose a hybrid model of textile reinforcement that includes information on the dual-scale geometry of fibers. The model is based on the results of X-ray microtomography that were processed in two steps. First, external envelopes of fiber tows were determined by applying dual kriging algorithms. Secondly, the information on the filament distribution inside the tows has been quantified and discretized in cell structure. An example of the result is shown in the accompanying figure. The model has been tested for calculation of micropermeability in a fiber tow and compared with the experimental results of capillarity testing.

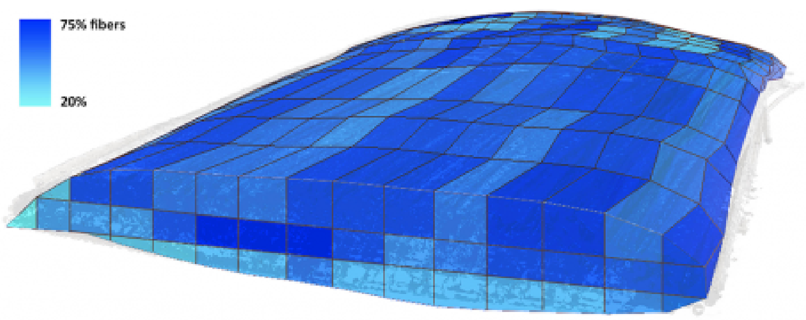

Figure: A hybrid model of fibrous reinforcement. External envelope of fiber tow reconstructed with dual kriging and discretized fiber tow with fiber volume fraction information

References

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