Mechanical Properties Enhancement Prediction for Matrix Materials

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Establishing the cost/performance trade-off of new resin systems for modern blades manufacturing is prevented by the limited understanding of the resin in-situ behavior during curing. The effect of heterogeneous and under-cured resins is of particular importance in evaluation of new formulations. Accurate understanding of the curing process is fundamental to reduce processing induced defects and to estimate the effect of in-situ properties on the cost/performance trade-off. The objective of this work is to enable the industry to make more accurate estimates of resin dominated performance measures, such as in-situ composite stiffness and strength, for a given/proposed set of resins and/or curing agents and to determine if there is potential for blade cost reduction minimizing composites defects occurrence including the effects of voids. This project achieved substantial improvements in the prediction of resin-dominated stiffness and transverse strength. We leveraged high-fidelity FEM micro- and meso-scale models to enhance the prediction of matrix dominated properties. Comprehensive thermo-mechanical characterization of Hexion resin systems as functions of degree of cure has been performed and used the data to analyze statistically equivalent Representative Volume Elements (RVEs) of different volume fractions. Mechanical testing has been performed to validate stiffness and strength prediction at the microscale. The void morphology resulting from resin infusion in TPI composites has been characterized using micro-CT. Macroscale FEM simulations linked to cost analysis performed in collaboration with UTD has shown potential for blade cost reduction.

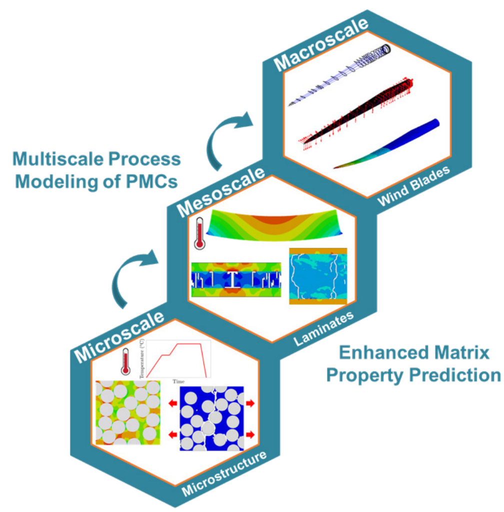

Figure 1: Multiscale approach for enhanced matrix property prediction.

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