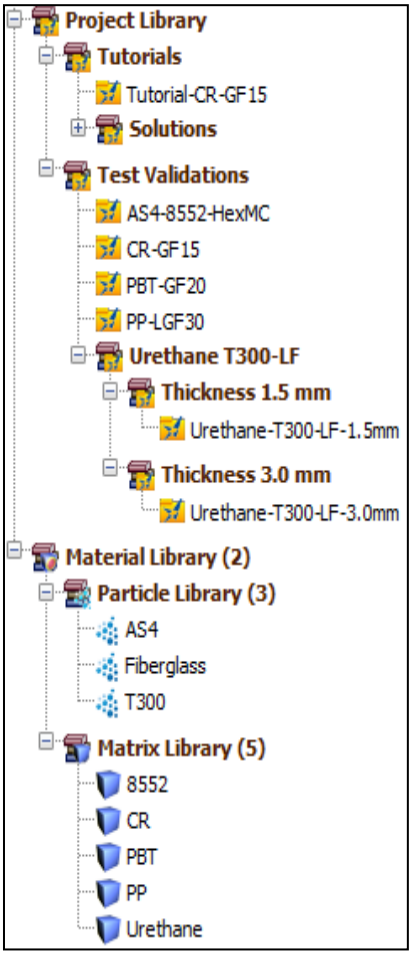
MCQ Chopped
Tested and Verified.™

## Material Characterization & Qualification – Chopped

- ***MCQ-Chopped*** *is a Multi-Scale material modeling, characterization & qualification software that analytically predicts chopped properties and performance*
- *Comes with material data, tutorial solution and test validation*

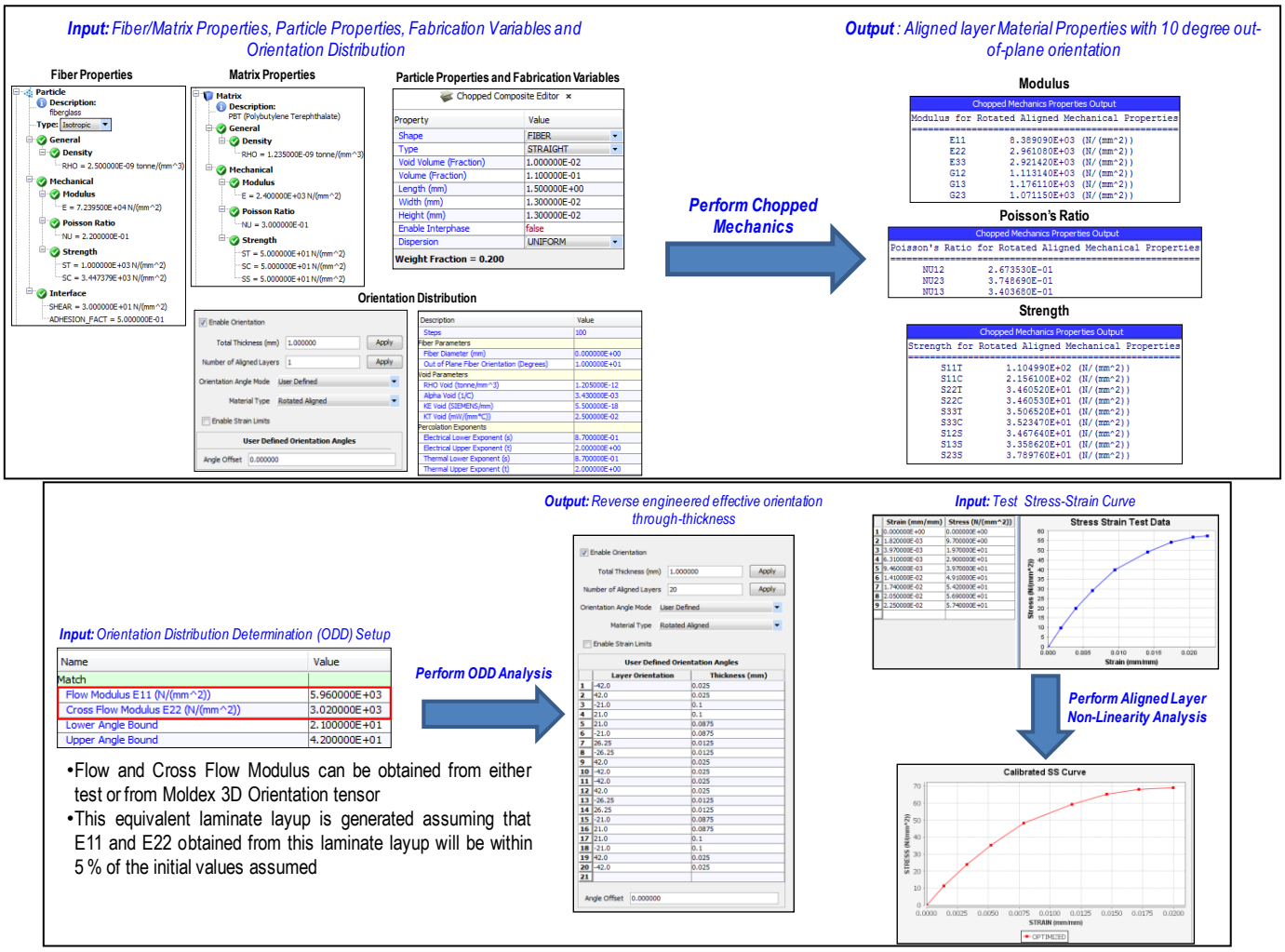
**Material Database, Tutorial, Test Validation**



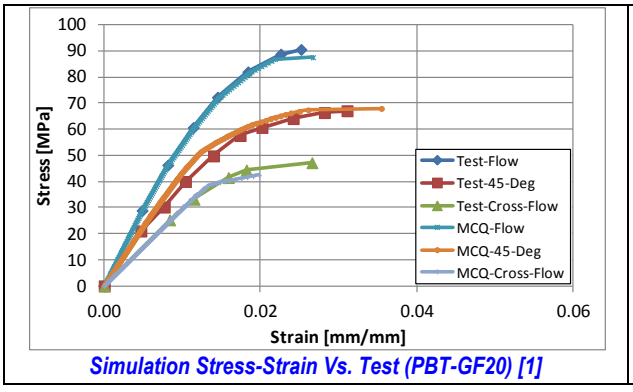

MCQ-Chopped is designed to help predict chopped properties based on effective particles (e.g., chopped fibers) and matrix material properties, it also includes: **1)** assuming **uniform orientation** through the width and length of the representative volume element (flat coupon), 2) the particles can be **aligned**, **in-plane random**, and **completely random** in orientation in three-dimensional space, 3) particles can also be **user specified** based on test observation or output from analysis using other Software packages (e.g**., Moldflow, Moldex 3D**, etc.,). MCQ-Chopped allows characterizing chopped fiber reinforced composite material properties as a function of several manufacturing, geometric, and material variables. Chopped fiber reinforced composite coupon test data in literature show lots of scatter mainly due to limited test and scatter in the manufacturing, geometric and material property variables. Material Uncertainty analysis allows estimating mean chopped fiber reinforced composite material properties for particles aligned, 2D random and 3D random situation in the matrix and for user specified orientations. MCQ-Chopped is capable of predicting chopped properties considering particle-matrix Interphase, uniform or non-uniform dispersion or particles and multiple types of particles.

## MCQ-Chopped Highlights

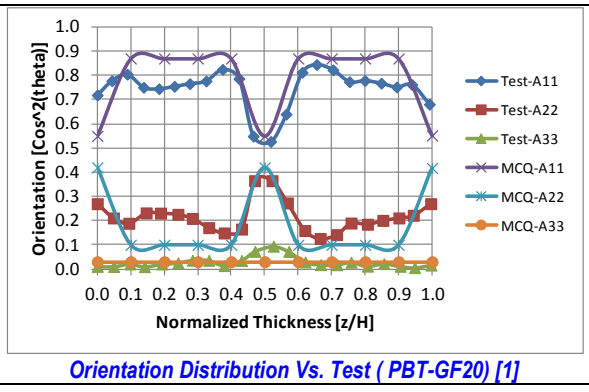
- ✓ **Chopped Mechanics:**
  - Predict aligned, in-plane random and 3D random material properties
  - Reverse engineer effective constituent material properties
- ✓ **Orientation Distribution Determination:** Predict effective % orientation distribution of the fillers through-thickness
- ✓ **Chopped Characterization:** Graphically verify the variation in aligned layer properties with variation in constituent material properties and manufacturing variables
- ✓ **Material Nonlinearity:** predict aligned layer, 2D random, 3D random and user defined layup stress-strain curve using matrix stress-strain curve as input.
- ✓ **Aligned Layer Nonlinearity:** Reverse engineer aligned layer stress-strain curve from flow or cross-flow direction test stress strain curve
- ✓ **Progressive Failure:** Predict damage evolution, damage growth and final failure for chosen orientation (e.g., user defined, flow or cross-flow direction un-notched coupons)
- ✓ **Design Failure Envelope:** Predict damage initiation and final failure of coupons subjected to biaxial loading
- ✓ **Parametric Carpet Plot:** Effective material property prediction for several different orientation % distribution of plies through-the-thickness
- ✓ **Material Uncertainty:** Predict average material properties (flow, cross-flow, user defined) directions considering material uncertainty, orientation, and thickness effect
- ✓ **Fatigue:** Predict effective S-N curve for the aligned layer, 2D random, 3D random and user defined orientation using matrix S-N curve as input




**Note:** A user defined material input for both implicit and explicit finite element analysis can be created using the above information (Aligned layer ply properties and calibrated stress-strain data)




*Simulation Stress-Strain Vs. Test (PBT-GF20) [1]*




*Orientation Distribution Vs. Test ( PBT-GF20) [1]*

**References:**

1. Abumeri, G. H., Lee, and M., (2006). A Computational Simulation System for Predicting Performance of Chopped Fibers Reinforced Polymer Composites. ERMR-2006-Elastomer-Reno.