THIN PLY TECHNOLOGY AND A STRAIN-BASED HEALTH MONITORING SYSTEM

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THIN PLY TECHNOLOGY

The first part of presentation is based on a tow spreading process developed by Kawabe [1] who blew air across a 12k or 24k tow to create thin plies down to 1/6 of the conventional 0.12 mm (5 mil) ply thickness. Because the spreading process does not induce any stress fibers are not damaged. When laminates made from these thin plies, all the anticipated ply properties are recovered. When plies were made into cross-ply, quasi-isotopic and other laminates, tests showed that micro cracking and delamination were suppressed up the ultimate strength. The failure modes changed from massive delamination for thick ply laminates to a clean break for thin ply laminate.

When the thick and thin ply laminates were used for open hole tensile tests, X-ray photos showed massive micro cracking in thick ply laminates while the thin ply stayed clean. The load was 90 percent of the ultimate load. The failure modes were very different with the thin ply laminate having a clean fracture with no delamination, consistent with earlier coupon tests.
We therefore realized that thin plies had much to offer. Laminates and structures can be made strong and damage tolerant. Lower weight and/or lower cost can come from higher design allowable with no fear of delamination. Designers now have more options to select the best combinations of materials and processes.

**A STRAIN-BASED HEALTH MONITORING SYSTEM**

Strain is a good predictor of life and residual strength and this can be done using Super Mic-Mac.[2] The predictions are based assumed validity of the master curves of the critical invariants of the fiber and matrix in a unidirectional composite, and linear cumulative damage law. Being a static system, it is intrinsically robust. It is unique in its ability to predict durability. One key component of our approach is strain mapping, a preprocessor of Super Mic-Mac, or Pre SMM. From strain recorded by sensors in a fiber optics network in a composite panel, we can map out the strain distribution and identify applied diagnostic loads. By comparing the strain recording of the composite panel with and without defect/damage, the location and severity of the defect/damage can be determined.

The scope of this system can be significantly expanded with a miniaturized light source and telemetry. It can be a real time warning system to the operator/pilot, and also a damage detection and assessment system during periodic inspection and maintenance. With accuracy in micro strain and response in microseconds, potential applications go far beyond aerospace.

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