Department of the Navy SBIR/STTR Transition Program

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Topic # N19A-T003

Interlaminar Reinforcement of Composites via Tailored CNT Nanomorphologies

Metis Design Corporation

WHO

SYSCOM: NAVAIR

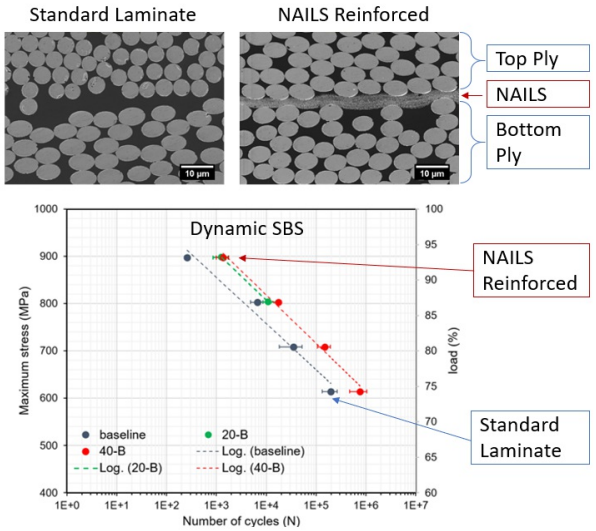
Sponsoring Program: PMA-261

Transition Target: CH-53K King Stallion

TPOC:
(301)342-7496

Other transition opportunities: H-60, H-1, CH-53E

Notes: Standard composite laminates tend to fail in the resin-rich areas between ply layers. Nanoengineered Aligned InterLaminar Scaffolding (NAILS) reinforces the resin with high-strength nanofibers, effectively creating a 3D composite laminate. Results to date have shown NAILS to prove a 5x improvement in fatigue life over standard unreinforced laminates.



Images courtesy of Metis Design Corporation & Massachusetts Institute of Technology

WHAT

Operational Need and Improvement: Composite materials are strong in their fiber direction, however their weakness is the epoxy-dominated region between layers that is susceptible to interlaminar failure such as delamination due to impacts, overloads and fatigue. This often dictates the maximum load and fatigue life of composite components and can require periodic inspection and component replacement. One component particularly effected by this limitation are flexbeams on rotorcraft that are subject to challenging cyclic loading.

Specifications Required: Any flexbeam reinforcement must improve static strength by at least 10% and at least double fatigue life to make it worthwhile. Changes to the flexbeam must not adversely effect any other material property, including those measured under cold, hot and wet conditions.

Technology Developed: Carbon Nanotubes (CNT) have been used as Nanoengineered Aligned InterLaminar Scaffolding (NAILS) to serve as reinforcing elements between adjacent ply groups. MDC has optimized the alignment, density, height and placement of these NAILS through simulation and experimentation to maximize performance. Results to date have demonstrated a 15% improvement in static strength and 5x longer fatigue life using short-beam-shear (SBS) strength testing.

Warfighter Value: The higher static strength will translated to additional maneuverability for rotorcraft, and the longer fatigue life will result in parts that will not need to be replaced within the aircraft operating life, thus averting costs and providing additional asset availability.

WHEN

Contract Number: N68335-20-C-0590 **Ending on:** November 29, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Modeling optimization	Low	Match failure locations for strategic reinforcement	TRL4	May 2021
Micro Flexbeam Static Tests Completed	Med	Quantification of static NAILS reinforcing effect on flexbeam-like specimen	TRL4	August 2021
Micro Flexbeam Static Tests Completed	Low	Quantification of dynamic NAILS reinforcing effect on flexbeam-like specimen	TRL4	October 2021

HOW

Projected Business Model: There are multiple business models that are open for discussion with potential partners. These include a spin-out company devoted to design and fabrication of CNT solutions, a Joint Venture that accomplishes the same, or potentially a licensing deal for the IP behind NAILS for an existing company that would like to market these capabilities.

Company Objectives: We are seeking program office support for customization and evaluation of this technology with respect to their application needs. We are also seeking investors or licensing partners interested in developing a business model around this IP.

Potential Commercial Applications: This technology could be applied to anything that uses composite materials ranging from aerospace to automotive and sporting good for higher performance components.

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