Topic: N161-069

Touchstone Research Laboratory, Ltd.

Fiber Reinforced Aluminum Crack Repair for Aluminum Structures

Touchstone Research Laboratory, an award-winning developer of advanced materials for commercial and government customers, has developed an innovative prepreg tape made from continuous fiber aluminum metal matrix composite (MMC) material that is four times stronger and stiffer than standard aluminum alloys. When applied to aluminum hulled ships, the MMC prepreg tape can both prevent cracks and retard crack growth and, thus, significantly reduce maintenance and repair costs. The higher strength and stiffness compared to traditional composite patches makes the MMC prepreg suitable for repairs on mechanically loaded structures as well. These benefits translate into increased time on mission across a wide range of ship classes. The plan is to add MMC prepreg to the current patch repair kit.

Technology Category Alignment:

Materials & Manufacturing Processes

Propulsion and Extreme Environments

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SYSCOM: ONR

Contract: N68335-18-C-0062

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-18-C-0062

Department of the Navy SBIR/STTR Transition Program

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Fiber Reinforced Aluminum Crack Repair for Aluminum Structures
Touchstone Research Laboratory, Ltd.

WHO

SYSCOM: ONR

Sponsoring Program: Code 331

Transition Target: CG Class Aluminum Superstructure, fast frigate (formerly LCS) Independence Variant Aluminum trimaran, Expeditionary Fast Transport (T-EPF)

TPOC:
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Other transition opportunities: Repair of aluminum aircraft/spacecraft fuselages, stringers, stiffeners, repair of military/commercial ship hulls, repair of ground vehicle body panels and chassis components

http://www.navy.mil/management/photodb/photos/151203-N-ZC343-511.JPG

Notes: The Image shows the USNS Fall River (JHSV 4) (hull material all aluminum) undergoing maintenance and upgrades at Naval Base San Diego. (U.S. Navy photo by Senior Chief Mass Communication Specialist Joe Kane/Released, SAN DIEGO (Dec. 3, 2015))

WHAT

Operational Need and Improvement: Aluminum component corrosion can have a significant effect on system performance, platform availability to execute assigned missions, and total ownership costs. Permanent repairs of cracked components are expensive and not practical when the ship is deployed. Current temporary repair methods are effective at sealing cracked areas but do not prevent further crack growth leading to more costly repairs once the mission is completed. The Navy is seeking improved temporary repair solutions to arrest/retard crack growth which can be performed by the ship's force.

Specifications Required: Develop crack arresting methods for welded aluminum ship-type components and demonstrate performance and production feasibility at lab scale under low cycle tension-tension fatigue loading conditions; stress levels and loading rates to be provided by the Navy sponsor. Demonstrate on a ship scale flat plate (10-mm thickness) under uniaxial and biaxial loading conditions. Expand the low cycle fatigue testing and analysis efforts to capture higher stress levels and increased stress state complexity with constant and random amplitude fatigue spectrum loading. Estimate fatigue lifetime limit and demonstrate the technology's ability to arrest crack growth or significantly decrease the crack growth rate and increase the repaired plate load cycles to failure.

Technology Developed: Touchstone Research Laboratory (Touchstone) has developed a field-friendly low-cost approach to aluminum crack repair combining the non-corrosive benefits of a metal patch with structural and fatigue-resistant fiber-reinforced aluminum (FRA), i.e., Aluminum 1100 patch containing high-strength/stiffness aluminum oxide (commercially available)FRA tape adhesively-bonded to the cracked area. This tape patching system allows for different layup options adaptable to most cracking scenarios. This approach is an affordable way to selectively reinforce metallic structures and allows for flexibility when applying the patch on cracked surfaces.

Warfighter Value: The benefits are: less ship maintenance time equates to more ship deployment time; a lower-cost alternative to the current cut-and-weld repair method. If used for structural repairs, FRA patches could save as much as $1M per CG 47 ship (cost avoidance of as much as $15 million for 15 ships serviced within five years). On the fast frigate, structural components located near the hot exhaust system could be repaired in place instead of replacing the entire structure with the repair cost being less than half of the replacement cost.

WHEN

Contract Number: N68335-18-C-0062 **Ending on:** November 8, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Optimize Patch via Analysis and Lab-Scale Testing	Low	Improvement in Stress State over Baseline	3	1st QTR FY19
Verify MMC Patch Through Large-Scale Testing	Med	Improvement in Stress Sate Over Baseline	4	1st QTR FY20
Validate MMC Patch Through Representative Testing	Med	Improvement in Stress State Over Baseline	5	1st QTR FY22

HOW

Projected Business Model: Touchstone has a history of successful technology commercialization. The main avenues of commercialization thus far have been licensing of technology to commercial ventures and technology spin-outs. For its most significant product offering, carbon foam (CFOAM), Touchstone built a manufacturing business and then found an investor to take the CFOAM technology public under the name, CFOAM, Ltd. Touchstone is in the process of spinning out another business, Touchstone Advanced Composites, to manufacture composite tooling for the aerospace industry. It raised money to build this business through traditional financing, West Virginia Economic Development Authority, and an Air Force Title III program. Touchstone has a similar a plan in place to scale up and spin-out MetPreg® fiber reinforced aluminum into its own business. The production of FRA tape for crack repair will continue under this new spin-out.

Company Objectives: Touchstone will use the Forum for SBIR/STTR Transition (FST) to solicit teaming alliances and to investigate investor-partner relationships to create a clearer path towards a subsequent product release. Navy program funding will also be pursued by working through the ONR TPOC to gain exposure to the program managers for programs of record directly related to CG, fast frigate, and T-EPF ship classes. This will most likely be PMS 407. Additional opportunities will be sought to leverage the SBIR work for obtaining funding under subsequent relevant BAAs. The FST will also present an opportunity to meet with program managers and technical personnel from Huntington Ingalls and Bath Iron Works to update them on this technology.

Potential Commercial Applications: This technology could be used in commercial applications such as aerospace, sporting goods, and automotive components. FRA tape can be used to add strength and stiffness to almost any aluminum structure including aircraft and spacecraft. It can also be added to tennis rackets, skis, ski poles, and bicycle frames. Automotive applications could include stiffened body panels and chassis components.

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