Topic: N132-097

Creare LLC

Non-Destructive Inspection (NDI) for Recrystallized Grains in Single Crystal Superalloys

The technology consists of an ultra-high-frequency ultrasound transducer installed on a robotic arm that locates and sizes recrystallized volumes in single-crystal nickel-base turbine blades and vanes to assess creep-worthiness. Our innovation could provide Engine OEM's with the confidence level needed to accept or reject high-value component parts prior to engine assembly. Phase I testing has demonstrated the feasibility of detecting recrystallized volumes of representative size using ultra-high-frequency ultrasound. Creare is an engineering services company that commercializing innovations by licensing technology to existing organizations or by the creation of autonomous product companies. The ultimate goal is to integrate this technology into prime contractor and government facilities for assembly-line and maintenance-based inspection.

Technology Category Alignment:

Maintainability/Sustainability

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SYSCOM: NAVAIR

Contract: N68335-15-C-0136

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-15-C-0136

Department of the Navy SBIR/STTR Transition Program

Distribution Statement A: Approved for public release, distribution is unlimited JSF16-027

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Non-Destructive Inspection (NDI) for Recrystallized Grains in Single Crystal Superalloys

Creare LLC

WHO

SYSCOM: NAVAIR

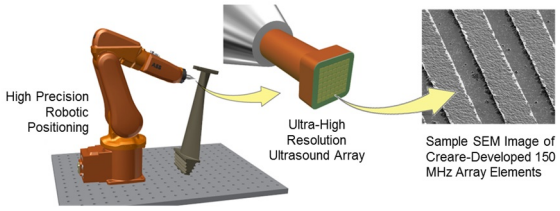
Sponsoring Program: JSF-Propulsion

Transition Target: F135 Turbine Hot Section Blades

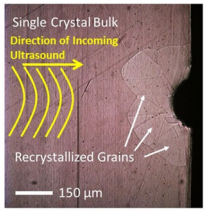
TPOC:
(301)757-0456

Other transition opportunities: The technology is applicable to locating defects in single crystal metal alloys that can limit lifetime especially in high-temperature applications. Defects including recrystallized volumes, cracks, voids, or corrosion-related products can be located.

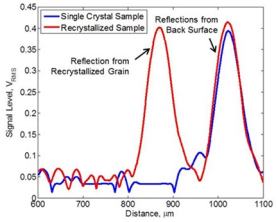
Notes: Automated inspection of single crystal blades and vanes for recrystallization-type defects using a custom-built ultra-high-frequency ultrasound transducer.



Sectioned and Etched Sample



UHF Ultrasound Return



WHAT

Operational Need and Improvement: High-performance jet engine turbine blades and vanes are single-crystal nickel-base superalloys exhibiting excellent high-temperature creep resistance. However, turbine blades and vanes have complicated features and operating environments that can promote the growth of discrete crystal grains that can lower the part's creep resistance and may lead to catastrophic engine failure. Currently, there are no means to non-destructively detect and characterize recrystallized defects of this size (25 micron). Creare is developing a non-destructive ultrasound approach capable of detecting and characterizing recrystallized grains that will enable prognostic detection and longer engine lifetimes at higher confidence levels, resulting in a reduction in lifecycle cost.

Specifications Required: Recrystallized volumes of any size are not acceptable. The non-destructive approach must be able to identify and size recrystallized volumes below 100 micron in dimension with high probability of detection (POD = 1.0).

Technology Developed: A high-frequency ultrasound non-destructive inspection approach to locate small recrystallized volumes in single-crystal nickel-base superalloy gas turbine components. The technology is also applicable to a variety of defects, e.g., cracks and voids.

Warfighter Value: Catastrophic mechanical failure of a gas turbine blade could lead to the destruction of a high performance engine and worse the entire aircraft and peoples lives. With a potential loss of over ~$100 million/aircraft, F-35 JPO and the engine manufacturer have two options; (1) lower the design life of the single crystal engine blades to correspond to the maximum expected recrystallized volume or (2) non-destructively inspect each blade to ensure recrystallization has not occurred. Since the former can only be determined from batch-level destructive testing, the design life likely has to be significantly de-rated. Creare's non-destructive inspection approach will quickly and effectively scan as-grown blades to ensure conformance with the F-35 JPO specification.

WHEN

Contract Number: N68335-15-C-0136 **Ending on:** March 16, 2017

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design Prototype	Med	Design complete backed by analysis and fabrication trials	3	January 2016
Fabricate Prototype	Med	Basic demonstration of functionality on an individual element basis	3	October 2016
Test Prototype	High	Locate recrystallized defects at or below 100 micron dimension on flat coupons	3	March 2017
Demonstrate Automated Inspection (per Phase II Option)	High	Locate recrystallized defects at or below 100 micron dimension on representative airfoil coupons	4	March 2018

HOW

Projected Business Model: Creare has a strong history in selling low-volume, high-value products into the military and civilian marketplace. Our more recent experience in commercializing technologies in our core advanced manufacturing and advanced metrology business area has involved partnering with our sister company, Edare. Edare is structured and staffed specifically to sell and support these and similar technologies. Our aim is to fabricate the transducers at Creare and have Edare integrate and support the technology.

Company Objectives: Creare is an engineering services company with objectives including performing technically excellent work and commercializing innovations by licensing technology to existing organizations or by the creation of autonomous product companies. Creare intends to remain a provider of responsive and technically excellent services while maintaining a corporate philosophy, structure, and environment that encourage and nurture commercialization.

Potential Commercial Applications: The technology, without modification, is directly suited for sale to private-sector manufacturers of gas turbines for aerospace and terrestrial (e.g., for power generation) applications. These sectors have similar needs for failure-free operation, particularly in the civilian air travel marketplace. This market is global and exceeds that of the U.S. military. With minor modifications, the system will be well suited for other applications requiring high-resolution inspection of single-crystals. Defect-free single-crystals are of concern to the semiconductor industry and are of growing concern to piezoelectric component manufacturers. These industries are very cost-sensitive and our technology would represent an attractive inspection option.

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