

WHO

**SYSCOM:** NAVAIR

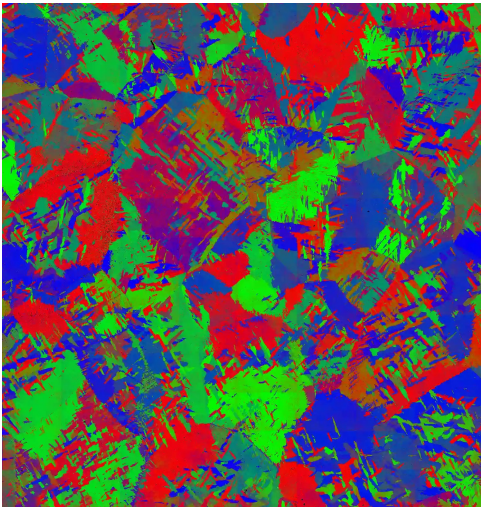
**Sponsoring Program:** JSF (Joint Strike Fighter)

**Transition Target:** Component inspection for quantification of abnormal beta grain growth and microtextured regions

**TPOC:** (301) 342-8017

**Other Transition Opportunities:** Multiple engine platforms (quantification of microtextured regions), Air platform structural components (quantification of abnormal grain growth), Materials RDT&E (processing science, novel alloys, additive manufacturing)

**Notes:** The image at the right shows the output of TiPolar for a beta-annealed Ti6Al4V plate coupon sample. This data was collected using MRL's production model TiPolarS hardware at a speed more than 100 times faster than EBSD. This dataset, which is approximately 12mm x 12mm, took less than 20 minutes to complete while maintaining an available resolution of 0.6um. More than 20 such scans can be completed by a single instrument in a single shift with minimal operator training requirements and a total acquisition cost less than 20% of SEM/EBSD.



MRL Materials Resources LLC, 2021

WHAT

**Operational Need and Improvement:** This new technology would replace an existing capability to spot check microstructure in small areas using acid etching and visual examination. It would provide a much faster, more accurate, and safer inspection to assess the material before investing the full cost of production.

**Specifications Required:** There is an increasing realization of the need to address macro-scale orientation phenomena (e.g. microtexture and abnormal beta grain growth) for critical components beyond the existing standards. Full assessment of the occurrence of such phenomena throughout the processing history of components is hampered by the lack of quantitative techniques that can cost-effectively match the scale of the features of interest (10s-100s of mm). Likewise, quality control standards will require measurement techniques that can keep up with production (i.e. minutes per scan, not hours). TiPolar is poised to provide a solution to both.

**Technology Developed:** MRL has fully developed hardware and software for automated data acquisition and data analysis of very large orientation imaging datasets. This first release, TiPolarS, is capable of scanning coupon samples up to 2" x 3" in a research or production laboratory environment. Upcoming models will be capable of looking at larger planar surfaces, cylindrical fatigue specimens, and ultimately arbitrary contoured surfaces.

**Warfighter Value:** The safe life of titanium engine and structural components is increasingly being linked to macro-scale orientation phenomena. Implementation of TiPolar for advanced research and quality control will help to increase readiness and decrease sustainment costs by maximizing time between inspection/overhaul increments.

WHEN

Contract Number: N68335-21-C-0681      Ending on: Jul 31, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Transition of TiPolarS system to an external laboratory	N/A	Completion of manufacturing, transportation, installation, and training at customer location	6	4th QTR FY22
Demonstration of orientation imaging of the outside surface of cylindrical fatigue sample (TiPolarMT)	Low	Validated data using large-grained sample with known orientations	4	1st QTR FY23
Demonstration of orientation imaging over contoured surface (TiPolarM)	Medium	Quantification of microtexture over surface of engine disk component	5	4th QTR FY23
Orientation mapping of complex structural component	Medium	Quantification of abnormal grains in complex structural comonent	7	4th QTR FY24

HOW

**Projected Business Model:** MRL has produced multiple units for evaluation of coupon samples in the laboratory environment (TiPolarS) and provides characterization services for a diverse range of government, academic, and industrial customers. MRL intends to expand the model lineup through this program to include equipment capable of larger components, contoured surfaces, and portable scanning at the component level, as well as providing toll service at each level.

**Company Objectives:** The goal of TiPolar is to become the de-facto standard for quantification of titanium microstructure and microtexture, providing quantitative metrics for quality control from ingot-breakdown to complex multi-pass forgings to additively manufactured (AM) components. This fits the broader vision of MRL to provide microstructure informed solutions to materials and manufacturing challenges including forging, joining, and additive manufacturing.

**Potential Commercial Applications:** Potential applications involve quality control of titanium material and components in the commercial aerospace, medical, and oil and gas sectors and well as research and development.