PennState
Applied Research Laboratory

MATERIALS AND MANUFACTURING OFFICE

COLD SPRAY ACTION TEAM
JUNE 24, 2020
APPROACH TO QUALIFICATION TESTING
APPLIED RESEARCH/PENN STATE

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Material Science Division Capability Overview

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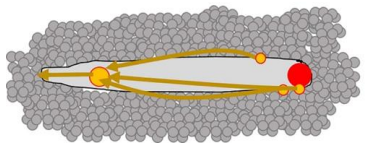
- The Material Science Division performs applied and fundamental research in developing and implementing processes and high-performance materials for a wide spectrum applications in aerospace, marine and land based systems.
- Develop long term strategic partnerships to develop, validate and implement technologies that support the warfighter and the mission of the US Navy.

Additive Manufacturing

Developing and Applying Additive Manufacturing Technology

Process Physics

Developing Sensor Technology and Control Systems for Laser Based AM

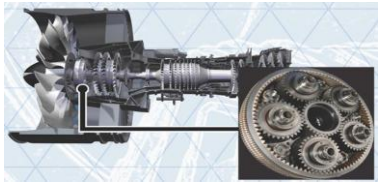


Advanced Materials

Developing High Performance Materials for Extreme Environments

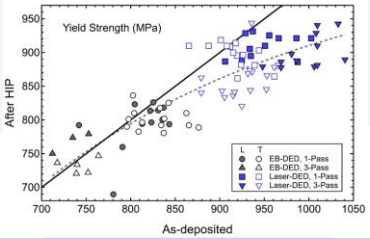
Drive Train Center

Performing Research in Gear Technology for DoD and Industry



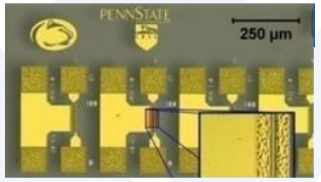
Materials Engineering

Developing Materials and Analysis Techniques



Electronic Materials

Manufacturing Technology for Electronic, Piezoelectric and Optical Materials



ARL/ Penn State SUPPORT OF NAVSEA/ONR COLD SPRAY

- Process Development – spray parameters, powder processing
- Process Qualification –Development
  - Standard test procedures for process qualifications based on ASTM or other standards
- Education /Training
- Courses developed for engineers and technicians (class and lab)
  - Personnel from the four public shipyards, TRF, Bangor, NSWCs, FRCs, FFRDCs
  - Ph.D. student from NRL – corrosion and post processing of Cold Spray Coatings
  - PSU Ph.D. student – focusing on nozzle fouling
- Shipyard Support
  - QSP testing
  - Powder selection
  - Trouble shooting
- NDE – NSWC-Carderock
  - Ultrasound
  - Eddy Current
- Structural Repair
- Helium recovery
- Hand-held Deposition
- Analysis and Modeling

Qualification Testing

Category

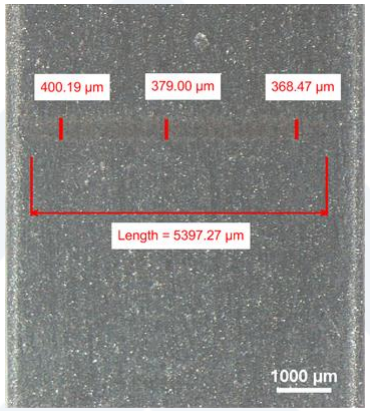
- Non-Sealing or non-bearing, does not violate wall thickness requirements
- Sealing or bearing surface, does not violate wall thickness requirements
- Violates repair standard for wall thickness and loaded in shear or compression, not load bearing or a pressure surface
- Violates repair standard for wall thickness and load bearing, restores strength of component

Sub-Category

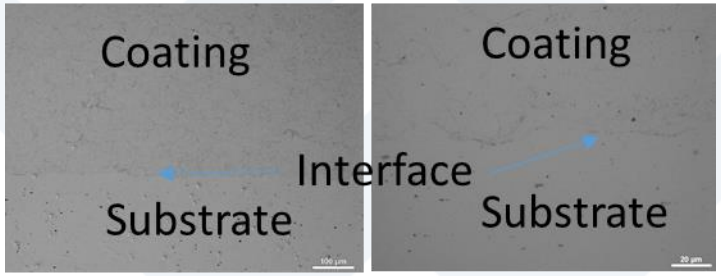
- Non-corrosive
- Corrosive
- Static
- Dynamic

Select Testing According to category and sub-category

- Microstructure
- Adhesion
- Tensile
- Shear
- Wear
- Corrosion



Wear Scar for Ni-CrC on Bronze



Unetched Microstructure Al7050 on Al7050 He (left) and N2 (Left)

Qualification Testing

Test	Test Specification	# of Samples	Criteria	Total Test Time (hrs)	Equipment
Metallography	ASTM E3, 407	2	Porosity, Oxides	4	Optical Microscope
Adhesion Testing	ASTM C633	12	Adhesion Strength	6	Oven, fixture, Tensile Tester
Tensile Test	ASTM E8	3	Tensile strength, Ductility	7 sub size 15 full size	CNC Milling Machine, Wire EDM, Tensile Tester
Shear Test	MIL-J-24445A	3	Shear Strength	4	CNC Milling Machine, Tensile Tester, Fixture
Open Circuit Potential (Cv)	AST G71	4	Difference in open circuit potential (mV)	5-7	Potentiostat (Gamry Reference 3000 or similar) Test Cell (Gamry Paracell or similar) Reference electrode (Saturated Calomel per UIPI)
Potentiodynamic Polarization (Ci)	ASTM G61	4	Coating electronegative compare to CRES 304	7-10	Potentiostat (Gamry Reference 3000 or similar) Jacketed Multiport Corrosion Test Cell (Gamry Jacketed Multiport or similar) To Include: Gas dispersion tube & reference bridge tube Flat Specimen Holder (to suit flat coated type samples) 2X Counter Electrodes (graphite rods) Reference Electrode (Saturated Calomel per UIPI) Water Circulator (for maintaining bath temperature) Thermocouple Gas Washing Bottle (for pre-saturation of purge gas) Purge Gas (Nitrogen)
Wear Testing	ASTM G77	2	Materials loss, wear scar	6	Block on Ring Wear Tester, lathe, microscope or stereoscope
Note – Open Circuit, Potentiodaynamic and wear testing require interpretation					

Multiuse End Effector for Portable Repair

Objective:

- Develop a multifunctional end effector system that can be integrated with several different robots to enable efficient repairs to a wider range of components

Vision:

- Design, fabricate and deploy a multifunctional end effector system that can be quickly adapted to several different repair technologies and integrated with a robots

Approach:

- Use commercial off-the-shelf technologies (COTS) where possible for mapping, surface preparation, repair, inspection and machining/finishing
- Use COTS quick disconnects and design the interfaces for the selected technologies
- Start with existing technologies and technologies under development such as scanning, plasma blast, laser ablation, portable cold spray, laser powder deposition and ultrasonic inspection
- Develop prototype integrated control system for the selected technologies
- Common power supply, control computer and gas supply
- Containerized
- Common computer for data collection and analysis
- Demonstrate technology

Questions

Thank You