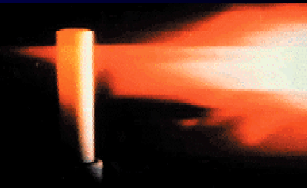




HCAT
Hard Chrome Alternatives Team

*A DoD/Industry collaboration to replace
hard chrome plating with HVOF thermal spray*



Engineered Applications of Electro-Spark Deposition (ESD) for Component Repair

AC9163-5

HCAT TWG Meeting
Toronto, Ontario
September 24th, 2002

Mike Dent - PEWG
Program Manager

Clayton Lindsay - ASAP
Mechanical Engineer

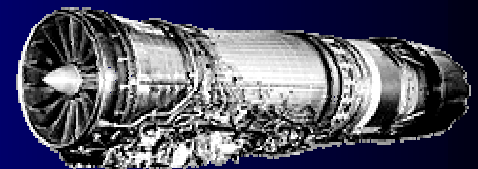
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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 24 SEP 2002		2. REPORT TYPE		3. DATES COVERED 00-00-2002 to 00-00-2002	
4. TITLE AND SUBTITLE Engineered Applications of Electro-Spark Deposition (ESD) for Component Repair				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Advanced Surfaces and Processes, Inc,85 N. 26th Ave,Cornelius,OR,97113				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 21st Replacement of Hard Chrome Plating Program Review Meeting, September 25-26, 2002, Toronto, Ontario. Sponsored by SERDP/ESTCP.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Project Objective

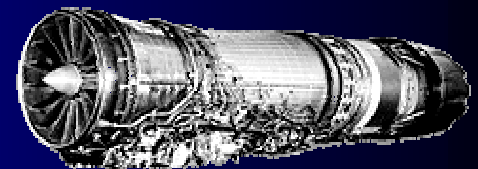
- To determine feasibility of utilizing the ESD process for cost effective repair of components
 - No known method of repair
 - Existing repairs utilize HAZMATS
 - Repair of HAZMAT coatings
 - Current repairs impractical
 - No replacement parts available



Participants

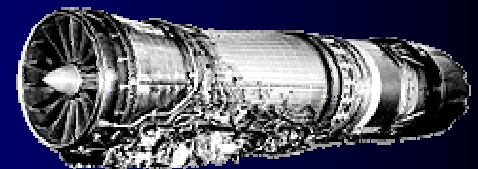
- PEWEG
- ESTCP/HCAT
- GEAE
- PW
- Oklahoma City ALC
- NADEP Jacksonville
- NADEP Cherry Point
- NADEP North Island
- Anniston Army Depot
- Corpus Christi Army Depot
- ARL
- AFRL
- NRL
- PNNL
- EWI
- NSWC Carderock
- US Army IEC
- Boeing St. Louis
- Rowan Technology Group
- Dynamics Research Corp.

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Project Scope

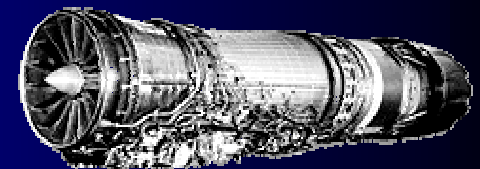
- ESD repair of Electrolytic Hard Chrome (EHC) coatings
- ESD repair of component substrate materials



Project Methodology - GTE

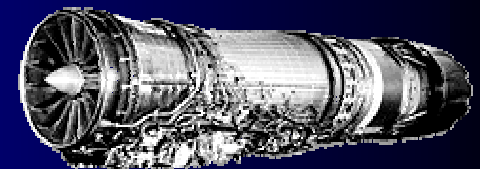
- Select candidate materials and electrodes
- Optimize ESD parameters for selected substrate/electrode combinations
- Perform materials evaluation and mechanical testing
- Create candidate part screening criteria based on test results
- Develop repair procedures for candidate parts
- Test candidate parts as required
- Implement technology

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Repair of EHC - Status

- Work Completed
 - Materials Identified
 - Some materials obtained
 - Some specification identified
 - Some candidate parts identified
 - Most information based upon HVOF JTP

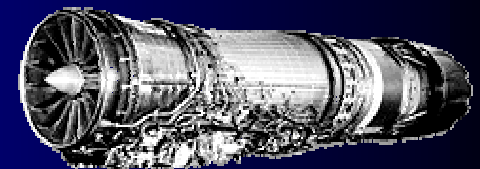


Repair of EHC - Materials

- Base Materials
 - IN718, AMS 5663
 - 4340, AMS 6415
 - 17-4PH, AMS 5355
- Possible Electrodes
 - Chromium
 - Ni-Chrome
 - Carbides
- EHC
 - MIL-STD-1501
 - Supported by QQ-C-320
 - .003" - .015" thickness

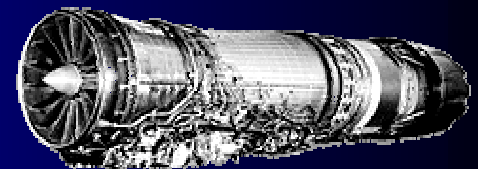


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Substrate Repair - Status

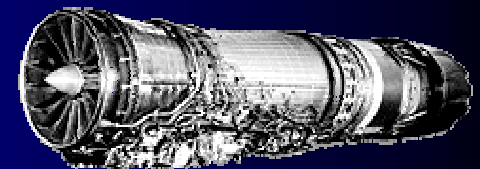
- Candidate materials selected
- Most material received
- Gathering materials and mechanical testing information
- Beginning process optimization
- Drafting process specifications based upon optimization results



Substrate Repair - Materials

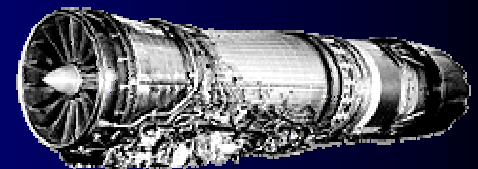
Substrate	Specification	Electrode Specification
IN 718	AMS 5663	AMS 5832
IN 625	AMS 5666	AMS 5837
Hastelloy X	AMS 5754	AMS 5798
Haynes 188	AMS 5772	AMS 5801
410 Stainless	AMS 5504	AMS 5823
17-4PH	AMS 5604	AMS 5825

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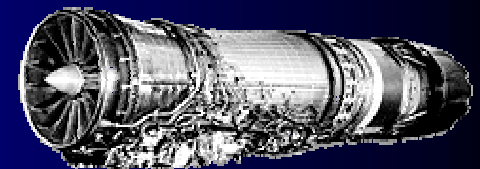
Substrate Repair - Optimization

- Using DOE approach to optimize ESD parameters
 - Varying Capacitance, Voltage and Current
 - Measuring Deposition Rate, Inclusion %, Bond and HAZ
- Repairs currently underway
 - 50% complete on Hastelloy X
 - 40% complete on IN625



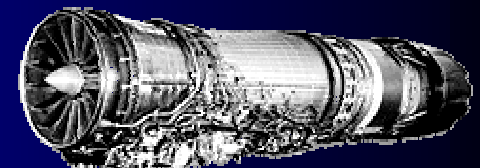
Materials and Mechanical Testing

- Materials Testing
 - Completed prior to mechanical testing
 - Iterative process to assist in ESD optimization
 - Metallurgical evaluations
 - Cracking, Porosity, Inclusions, etc.
 - Bond evaluations
 - Bond buttons, bend testing
 - HAZ
 - Micro-hardness gradients
 - Others ?? (residual stress, element mapping)



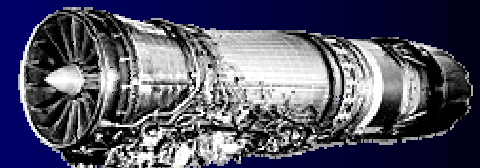
Materials and Mechanical Testing

- Mechanical Testing
 - Completed after ESD optimization, materials testing
 - Possible testing includes
 - Low Cycle Fatigue, High Cycle Fatigue (RT & Elevated) Tensile, Fatigue Crack Growth, Creep/Stress Rupture, Long Term Stability
 - DOE/Specifics needed
 - Definition of defect needed for each instance



ESD Specification & ESD Procedure

- ESD Specification - Based upon AWS D17
 - Definition of weld type (repair vs. coatings)
 - Qualification of welder
 - Acceptance Criteria
 - Initially based upon AWS D17, Class A, B & C ?
 - ESD specific criteria created during development ?
- ESD Procedure – Based upon AWS B2.1 ?
 - ESD equipment parameters
 - Technique description
 - Substrate/electrode/geometry specific



Questions -

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