Environmentally Friendly Paint Removal from Military Components

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SERDP • ESTCP
SYMPOSIUM
2019 | Enhancing DoD's Mission Effectiveness

Outline

- Conventional Paint Removal Processes
- Plasma Electrolytic De-Painting (PEDP)
- PEDP Benefits
- Paint Removal from Aircraft Wheels
- PEDP for Paint Removal from Military Components (ESTCP Program #WP18-5031)
- Current Progress
- Future Steps
- Conclusion

Conventional Paint Removal

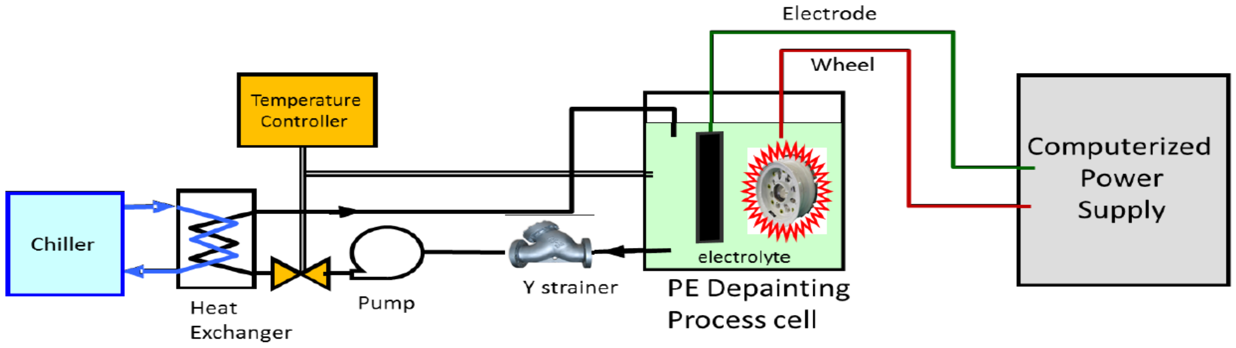
- Time-consuming
- Labor intensive
- Generate large volumes of hazardous waste, air emissions and hazardous worker exposure

♦ **Media Blasting**
- Large amount of hazardous waste
- Slow Line-of-Sight Process
- Chemical post-processing required

♦ **Chemical process**
- Typically using hazardous methylene chloride, high remediation cost
- Non-Line-of-Sight process

Plasma Electrolytic De-Painting (PEDP)

- Utilizes a plasma energy field to disbond paint and coatings from the substrate
- Water-based environmentally friendly electrolyte
- Process does not use any acids, solvents, does not produce any organic hazardous air pollutant emissions
- Removes 100% of the epoxy primer/polyurethane coating system without damaging the underlying anodized coating on Al alloys
- Eliminates the need for PMB (plastic media blasting) processes to remove residual paint, combining the entire de-painting process into a single-step process
- Works for complex geometries - non-line-of-sight process



PEDP Benefits

- Environmental Compliance at DoD Installations
  - ~ 80% of the Air Force Depot hazardous waste is created by painting and de-painting operations
  - The OO-ALC currently uses for de-painting wheels ~ 150 lbs. of plastic media pellets daily, over 36,000 lbs. annually
- PEDP Reduces Costs and Environmental Impact
  - Elimination of $MeCl_2$ and PMB from de-paint process
  - Significant reduction of hazardous waste
  - Significant cost savings associated with hazardous waste disposal costs
- PEDP Improves the Life Cycle of Military Components
  - Current plastic media blasting damages anodized layer
  - Only paint will be removed without damaging or degrading the underlying anodized coating and/or metal surfaces

PEDP for USAF Applications

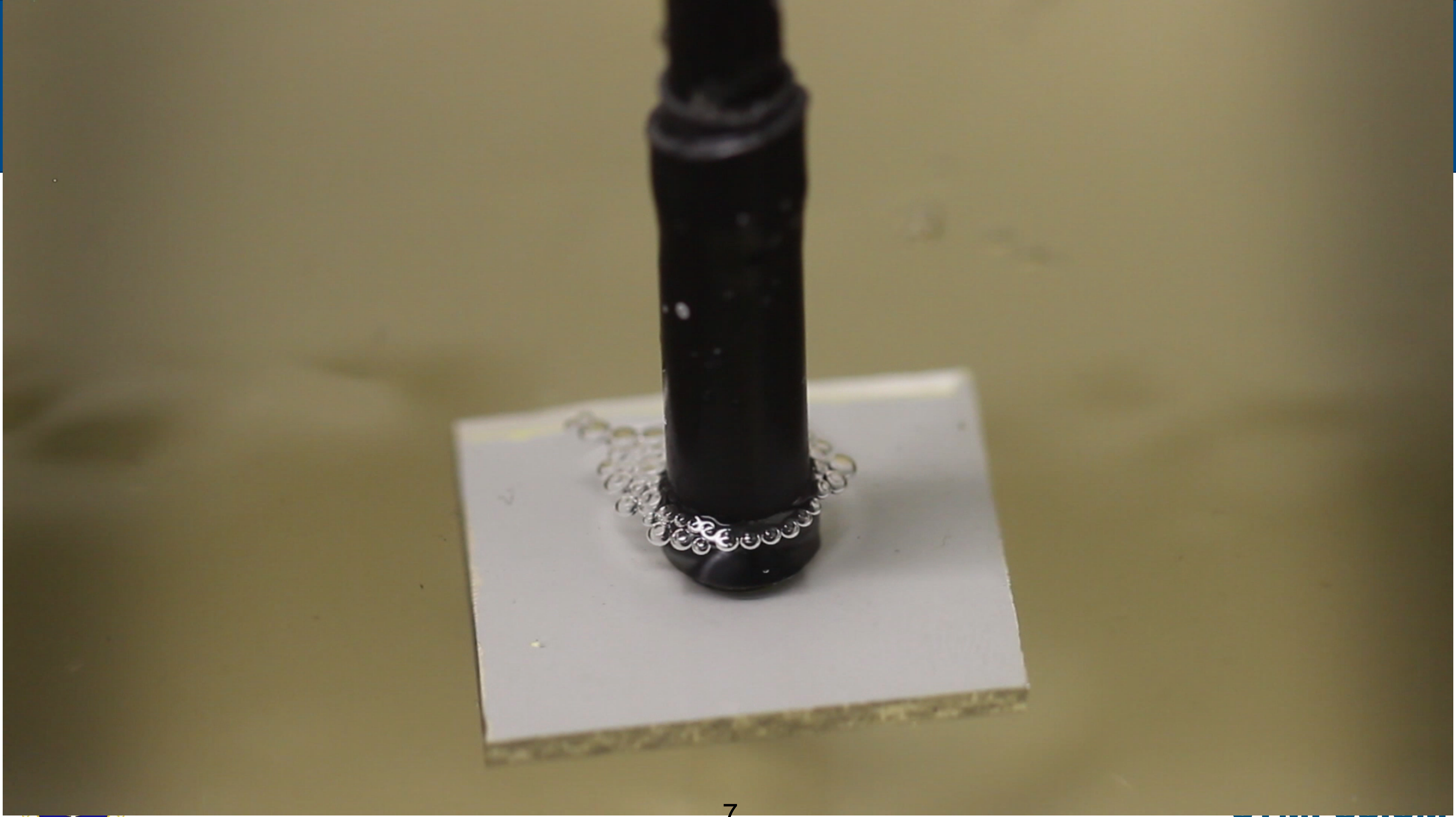
IBC Materials & Technologies

825 Hendricks Drive, Lebanon, IN 46052

Play video "PEDP"

PEDP Process Parameters

- Electrolyte Composition
- Electrolyte Temperature
- Electrolyte Flow
- Counter Electrode Design
- Electrical Waveform – Voltage Limits, Current/Voltage Control



Paint Removal from Aircraft Wheels

Lab Scale

0 min

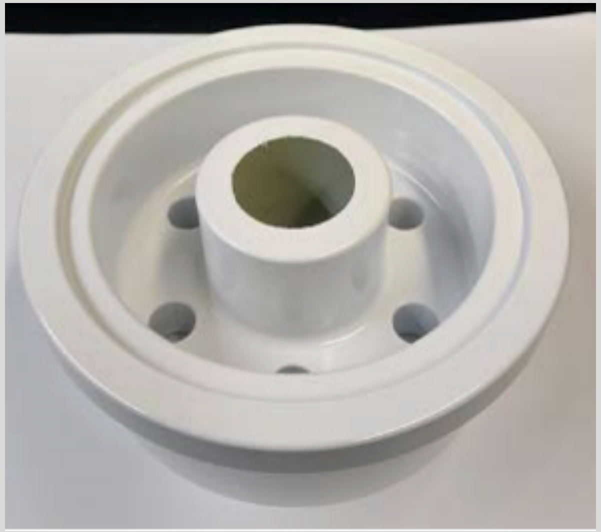
0.5 min

2.0 min

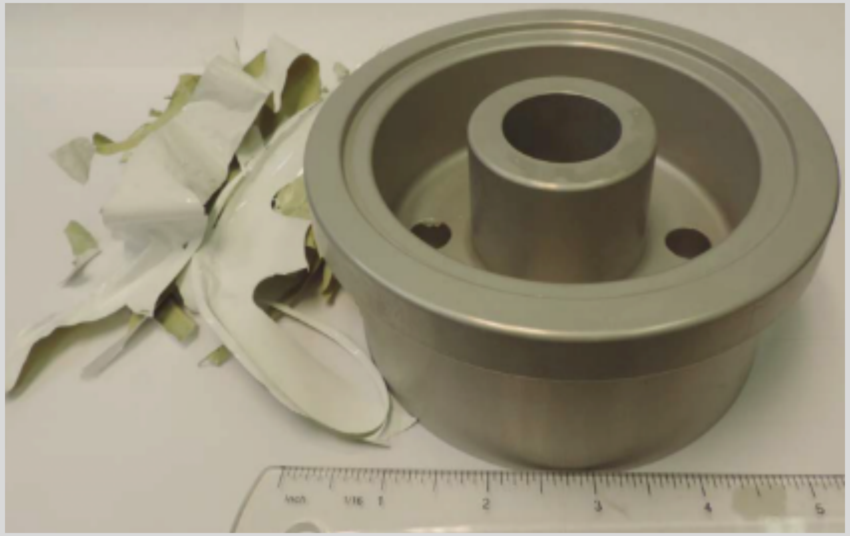
- Process time – 5 min
- Top coat and primer removed
- Anodizing remained intact

Paint Removal from Aircraft Wheels

Scaled Aircraft Wheel Mockup



75 min, 1 A/dm^2



** Aged mini-wheels at 210F for 96 hours*

- Over 90% of paint removed in 40 min (paint thickness 30-50 μm)
- Thicker paint (~ 110 μm) started to detach in 60-65 min
- Anodize layer is intact

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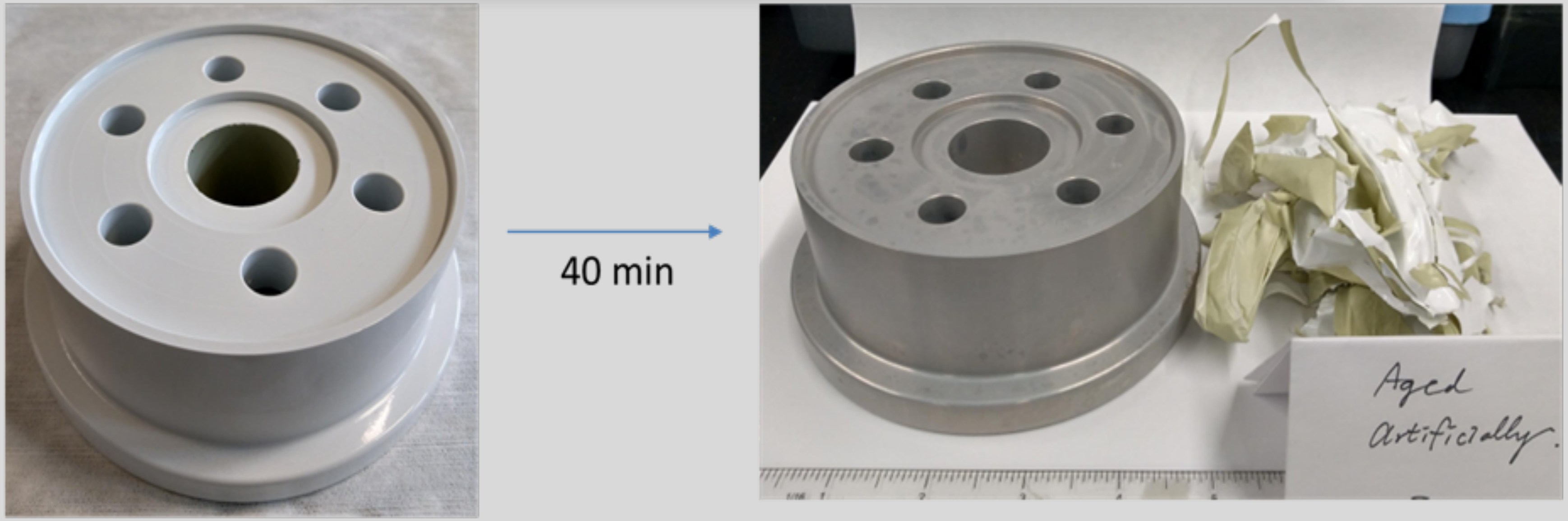
Paint Removal from Aircraft Wheels

Scaled Aircraft Wheel Mockup



- Manufactured mockup wheels with geometry similar to A-10 main wheels
- Testing produced excellent, repeatable results

Paint Removal from Military Components

ESTCP
WP18-5031

Performers:

- USAF Life Cycle Management Center (AFLCMC)
- IBC Materials and Technologies, Inc (IBC)
- University of Dayton Research Institute (UDRI)

Technology Focus

- Plasma Electrolytic De-Painting (PEDP) technology for paint removal from military components

Demonstration Objectives

- Demonstrate environmentally friendly PEDP technology for paint removal from military components:
  - Qualify the process for aluminum- and magnesium-based alloys
  - Adapt process for use on a variety of DoD applications
  - Develop all process documentation and process orders required for implementation

Program ”Phases” Approach

ESTCP **WP18-5031**

- **Phase I**
  - PEDP process optimization and “coupon-scale” technology validation
- **Phase II**
  - Stripping actual DoD components
- **Phase III**
  - Process Demonstration/ Technology Transition

DoD Components for PEDP

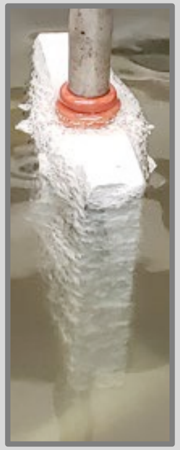
DoD Service	Part/ Component	Part Material
USAF	• Brake Housing (F-22)	Aluminum 2014-T651
Navy	• Landing Gear Wheel • LAU-128 AMRAAM missile rail	Aluminum AA 7075-T73
Army	• Intermediate Gearbox (part# 70357-06308) • Center Housing on the Tail Gearbox (part #70358-26607) • Input Housing (part #70351-08018)	Magnesium ZE41A-T5

Substrates & Coating Stack-ups

DoD Service/ Candidate Part	Substrate Material	Surface Treatment	Primer	Top Coat
USAF/ Brake Housing (F-22)	Aluminum 2014-T651 (plate)	Anodized per AMS2471	MIL-PRF-23377 Type 1, Class N	MIL-PRF-85285 Type 1 Class H
Navy/ Landing Gear Wheel	Aluminum 7075-T7351 (plate)	Anodized per MIL-A-8625 Type II Class 1 or AMS2471	MIL-PRF-85582 Type I, Class C1	MIL-PRF-85285 Type 1, Class H, color #17925 (gloss insignia white)
Army/ Center Housing on Intermediate Gearbox	Magnesium ZE41-T5 (cast)	Tagnite per MIL-DTL-32459 Type III/RockHard Resin (961-450-002) per MIL-PRF-3043	MIL-PRF-23377 Type 1 or II, Class C2	MIL-DTL-53039 (FED-STD-595 Color#36231)

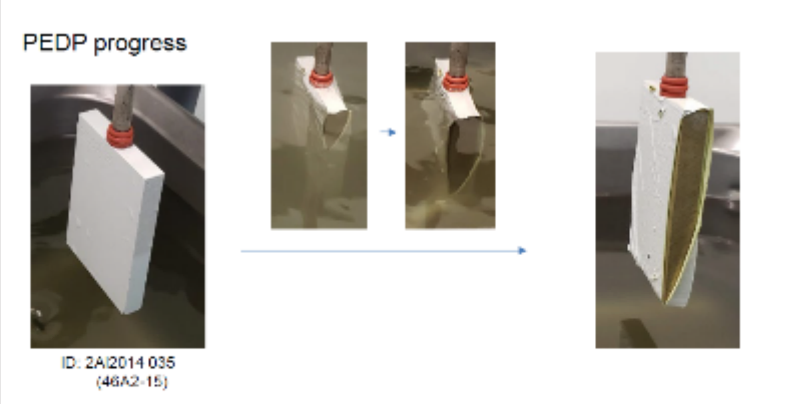
Current Progress

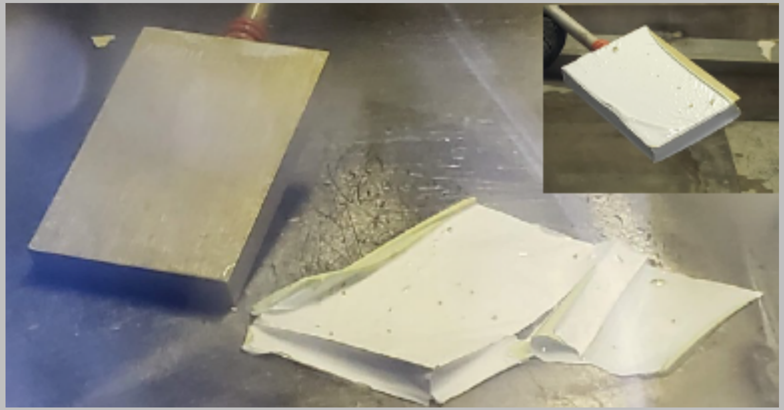
Before PEDP



PEDP – 15-30 min depending on alloy and coating

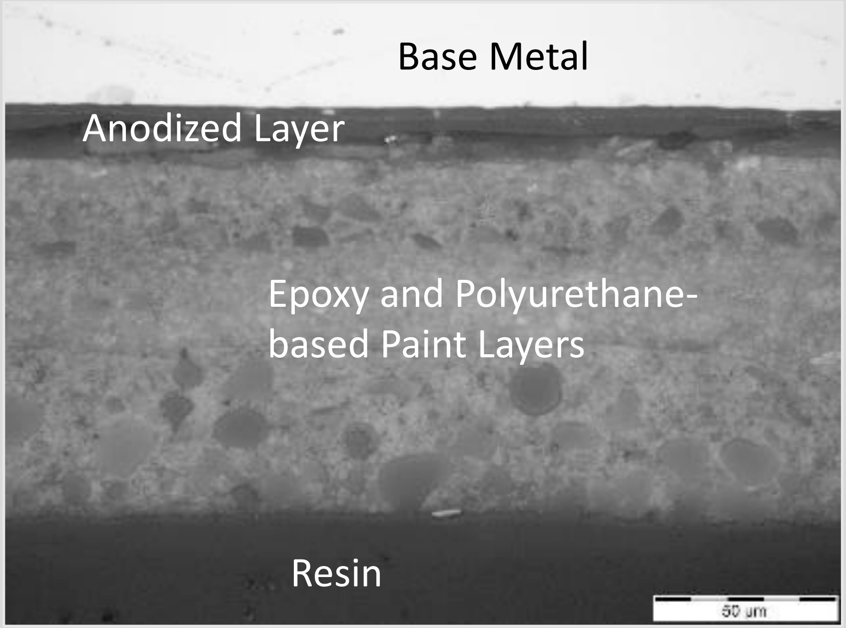
After PEDP



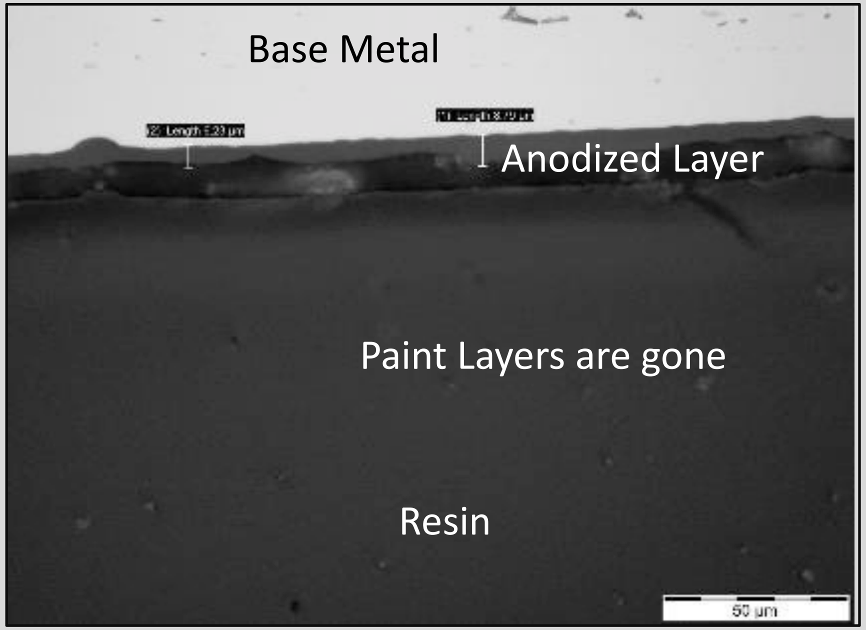


Microstructural Analysis

Before PEDP

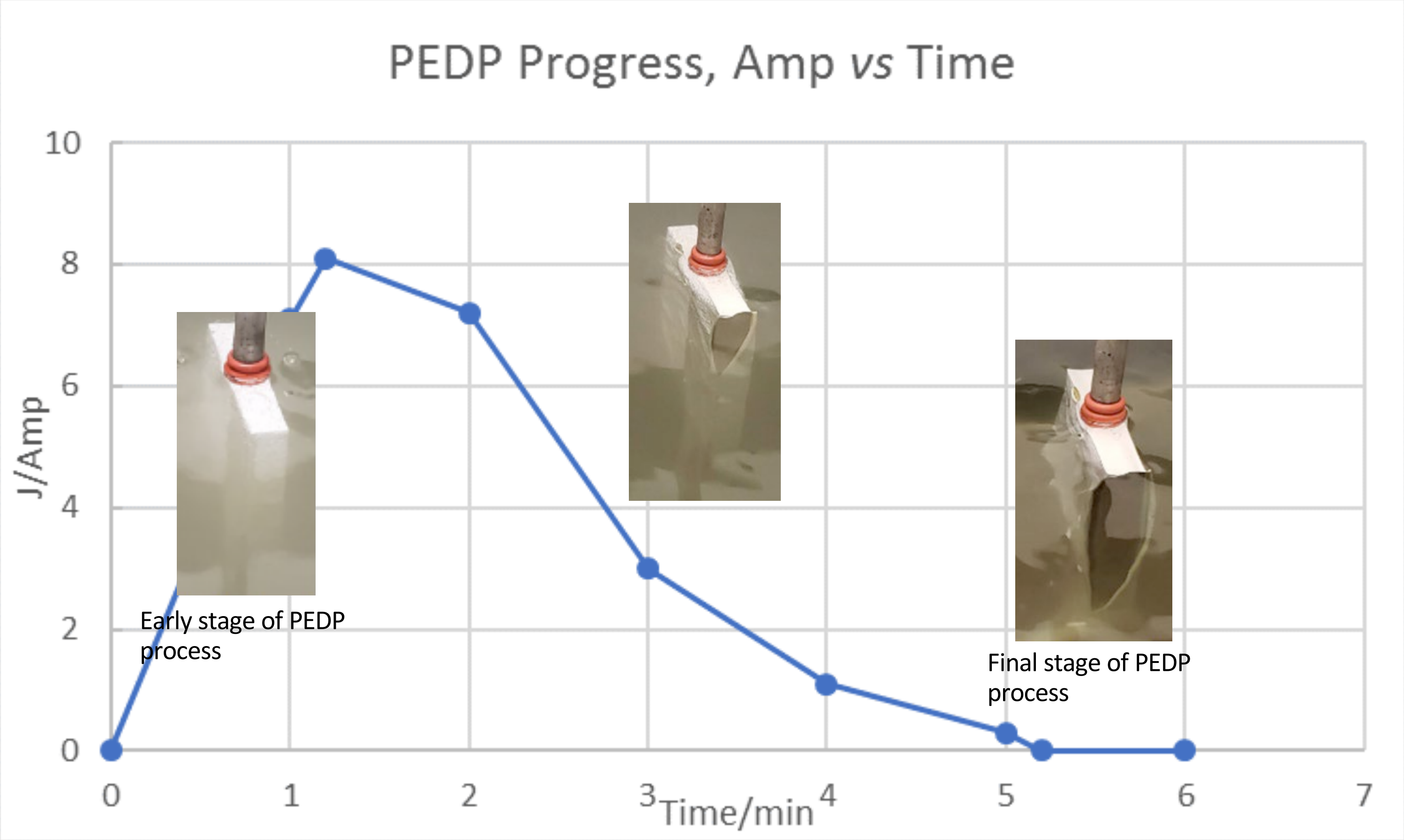


After PEDP



Anodized layer: ~ 8 microns. No changes observed.

PEDP Process: Electric Current vs Time



Current goes to “0” at the final stage of de-painting process

Future Steps

- Finalize process parameters optimization for different alloys
- Perform testing and evaluation
  - Surface characterization - roughness/topography, chemical state of the de-painted surface, microstructure, surface chemistry mapping, subsurface regions for microstructure, present phases and their sizes, micro-hardness
  - Qualification testing - paint adhesion, corrosion (Salt Spray Resistance), tensile, fatigue
- Perform stripping actual DoD components

Full Scale Production Line (IBC, Inc.)

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Conclusions

- PEDP – Environmentally Friendly Paint Removal Process
  - Water-based, environmentally friendly electrolyte
  - Utilizes plasma energy field to disbond paint and coatings from the substrate
  - Process does not use any acids, solvents, does not produce any organic hazardous air pollutant emissions
  - Eliminates the need for PMB processes to remove residual paint, combining the entire de-painting process into a single-step process
  - Hexavalent Cr stays in the removed paint
  - No airborne hexachrome dust
- PEDP – Cost Savings and Environmental Compliance at DoD Installations
  - Elimination of $MeCl_2$ and PMB from de-paint process
  - Significant reduction of hazardous waste
  - Significant cost savings associated with hazardous waste disposal costs
- PEDP – Non-line-of-sight Process
- PEDP – Extended Life of Military Components
  - Removes 100% of the epoxy primer/polyurethane coating system without damaging the underlying anodized coating on Al