AF Life Cycle Management Center

A Plasma Electrolytic Process to Remove Polymeric Coatings Without Damaging Non-Ferrous Metallic Substrate

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22 Aug 18

Outline

- **Background**
  - Developer
  - Technology development timeline
- **Plasma Electrolytic (PE) family of processes**
  - Application and removal of coatings
  - Surface polishing
- **Benefits of PE technology**
- **Plasma Electrolytic Oxidation (PEO)**
  - Coating process comparison
  - Microstructural analysis
  - Current applications
- **Plasma Electrolytic De-Painting Process (PEDP)**
  - Process
  - Current AF application
  - Tri-service military applications

Background
Developer

- **IBC Materials & Technology**
  - **Lebanon, IN**
  - **Coatings technology developer**

Background
Technology Development Timeline

- **USAF SBIR (2006)**
  - Developed Plasma Electrolytic Oxidation (PEO) coating process
- **USAF SBIR (2009)**
  - Developed PEO process and wear repair welding technologies for missile launch rails
- **USAF RIF program (2012)**
  - Scaled-up and implemented repair and localized PEO coating of high wear areas on missile launch rails
  - PEO Coatings in production with USAF since October 2014
- **USAF RIF program (2017)**
  - Validate and scale-up the PEDP process for aircraft wheels
- **DoD ESTCP program (2018)**
  - Demonstrate PEDP process for multiple military components

Plasma Electrolytic Technologies
Family of Processes

PEO

- **Plasma Electrolytic Oxidation**
  - *Converts surface into ceramic coating*

PEDP

- **Plasma Electrolytic De-Painting Process**
  - *Removes paint without damaging the underlying substrate or anodized coating*

PEP

- **Plasma Electrolytic Polishing**
  - *Produces very smooth surface with improved corrosion resistance*

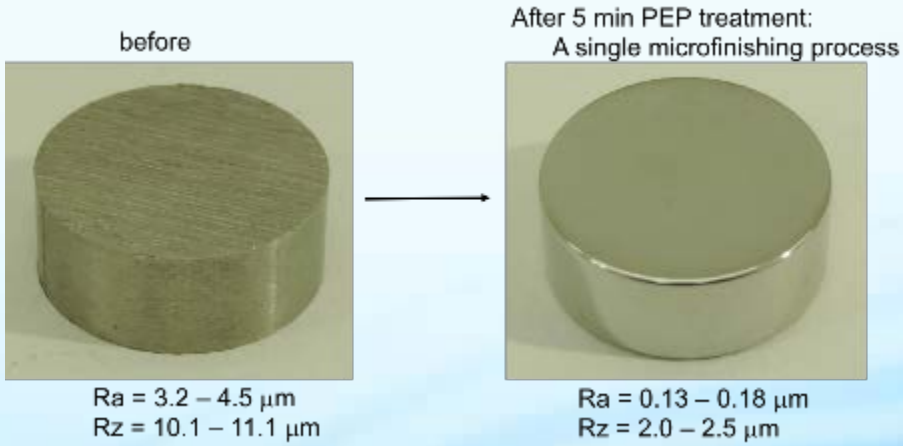
PEO & PEDP

- PEO is a single-step electrochemical processes (like anodizing) to produce nano-ceramic coating on Al, Mg, Ti with excellent wear, corrosion and thermal properties
- PEDP is a new electrochemical plasma process to remove paint without damaging the underlying anodized coating
- Both processes employ
  - ✓ non-toxic, water based electrolyte
  - ✓ high-voltage, low current density to generate very short-lived micro scale plasma discharges

Plasma Electrolytic Polishing
Surface Polishing

15-5 Stainless Steel

Inconel 600

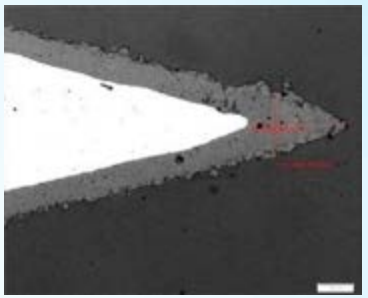


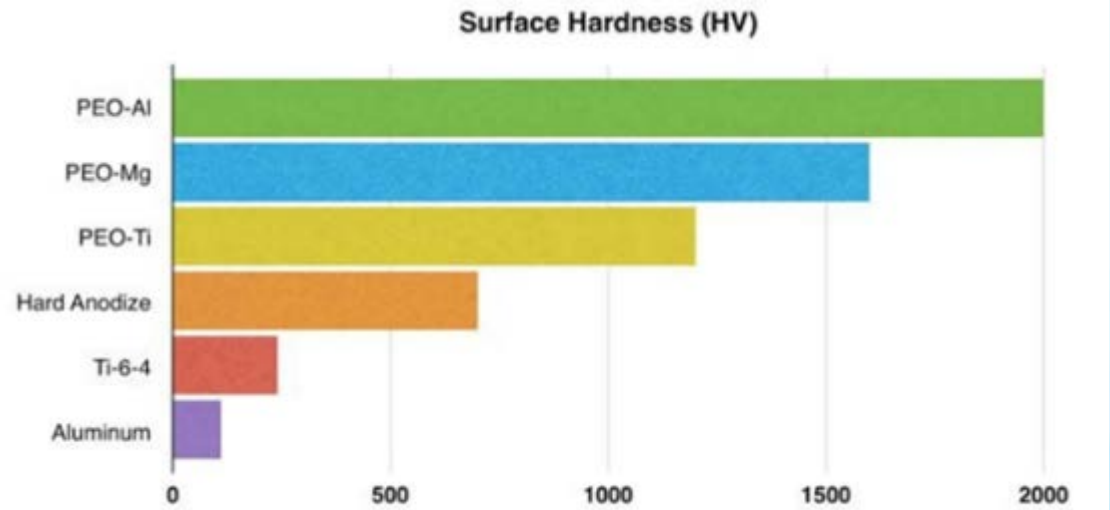
Benefits of PE Technology

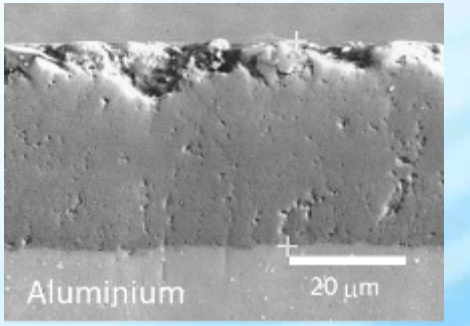
Benefits	PEO & PEDP Processes
Environmentally Friendly	✓ A water-based solution ✓ Free of organic hazardous air pollutant (HAP) ✓ Low chemical electrolyte process
Cost Effective	✓ A single-step process ✓ Eliminates the need for plastic media bead (PMB) processes ✓ Does not damage underlying substrate or anodized coating ✓ Non line-of-sight process able to handle – Complex geometries – Range of part sizes
Enhancing Military Capability	✓ Enhance the life cycle of military aircraft – Removing only epoxy primer/polyurethane coating system – Without damaging or degrading the underlying anodized coating (PEDP) – High corrosion and wear resistances (PEO) ✓ Reducing equipment down time ✓ Enhancing fleet readiness

PEO
Process Comparison

Process Characteristic	Anodize	PEO
Hazardous Chemicals	Chromic & Sulfuric Acid	None
Pretreatments	Clean, Etching, De-Oxidize	Clean
Remediation Costs	High	Very Low
Process Time	1.2 microns per min.	0.3 – 1.5 microns per min.
Fixtures / Electrodes	No	Yes
Capital Cost	Low	Moderate
Energy Consumption	Low	Moderate
Uniformity on Corners	Poor	Excellent
High Silica/Copper Alloys	Poor	Excellent







Cross-section

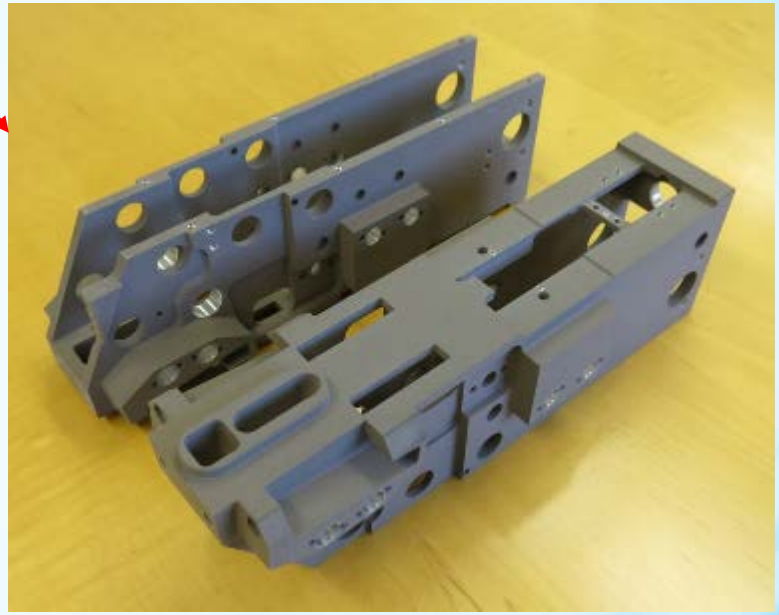
PEO
Current Applications

F-15 Applications

- PEO technologies as applied to LAU-127, 128, & 129 launch rails and AIM-120 missile rails

→ List of LAU-12X components designated for PEO development on 20 different components

Component #	Component Part #	Component Name
1	7002762-95	Housing, Detent
2	7002731-97	Housing - Dampener
3	7002792-99	Nose Fairing
4	7002591	Housing - Actuator
5	7002538	Housing - Stop, AFT
6	3825100	Release - Push
7	7002585	Guide - Umbilical Conn. Housing
8	7002817-99	Reset Stop, Detent
9	7002784-99	Cover, AFT (LAU-127, -128, -139)
10	7002599-99	Cover, Center (LAU-127, -128, -139)
11	7002782-99	Cover, Forward (LAU-127, -128, -139)
12	7002793-99	Cover, Forward (LAU-129)
13	7002794-99	Cover, AFT (LAU-129)
14	7002816-1	Cover, Detent Assembly
15	7002732-1	Plate, Dampener
16	3825105-1	Cover, Access GM
17	7002745-99	Bracket, Conn.
18	3825112	Spacer, Plate
19	X201124303	Amraam Upper Chassis
20	X201124304	Amraam Lower Chassis



Housing, Detent shown after PEO coating

PEDP Process

0 min

0.5 min

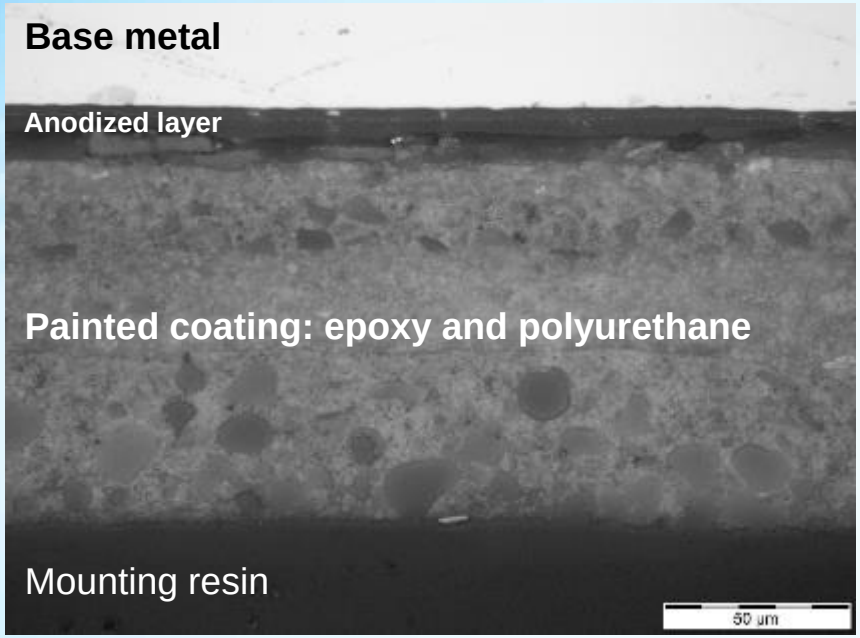
2.0 min

5 minutes process time.
Paint and primer removed.
Anodizing remains in tact.

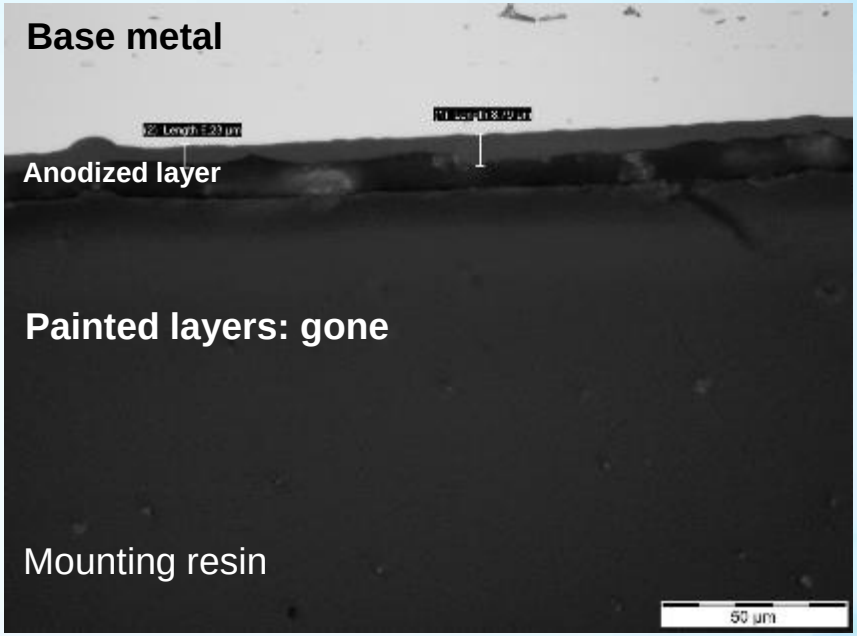
PEDP
Microstructural Analysis

Before and After PEDP

Before



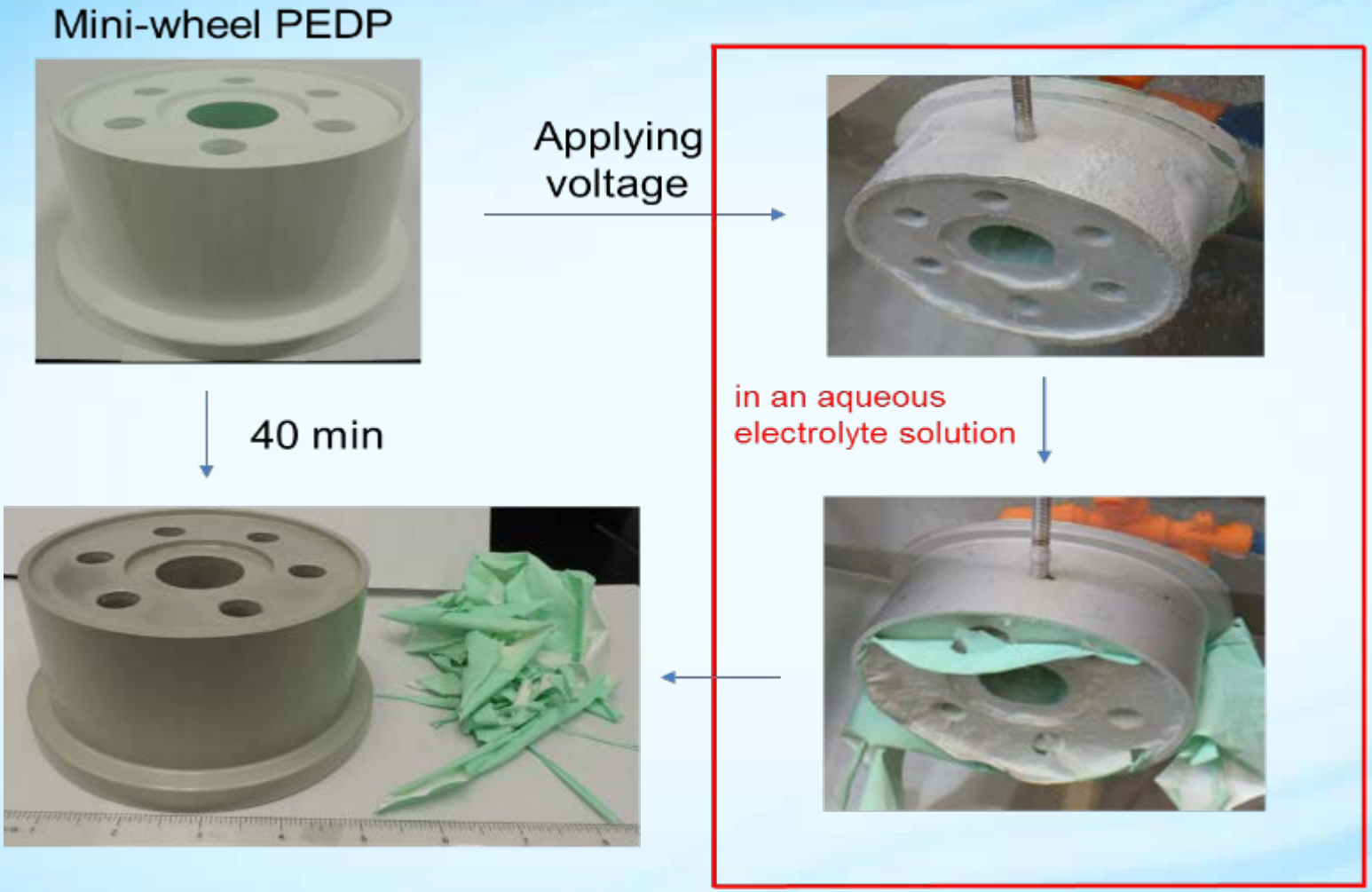
After



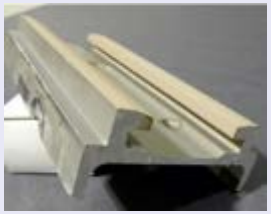
Anodized layer: ~ 8 microns, No changes observed

PEDP
Current AF Application

Aircraft Wheels



PEDP
Tri-Service Military Components

Service/ WS	Parts/ Components	Materials (substrate/ coating system)
AF: **F-22**	**Brake housings**  	❖ **Substrate**: *Aluminum 2014 -T6* ❖ **Coating**: Anodized per AMS2471 MIL-PRF-23377 Type I Class N Primer MIL-PRF-85285 Type 1 Class H Topcoat
Navy	**LAU-128 AMRAAM missile rail** 	❖ **Substrate**: *Aluminum 7075*-T73510, ❖ **Coating**: Anodized per MIL-A-8625 Type II Class 1 MIL-PRF-23377 Type I Class N Primer MIL-PRF-85285 Type 1 Class H Topcoat
Army	**Intermediate gearbox** 	❖ **Substrate**: *Magnesium ZE41A-T5* (cast) ❖ **Coating**: RockHard MIL-PRF-3043C

- ***Contact Information***

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