Kinetic Metallization™ Repair of IVD Aluminum

Military Applications - Session 1
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Overview

- Aerospace Repair Applications
- Kinetic Metallization (KM) Process
- KM - Portable and Fixed Systems
- Al-Trans® Powder Properties
- Qualification and Deployment of KM Repairs
- IVD-Al and Alumiplate coatings on high-strength steels
- Summary

Kinetic Metallization Process & Equipment

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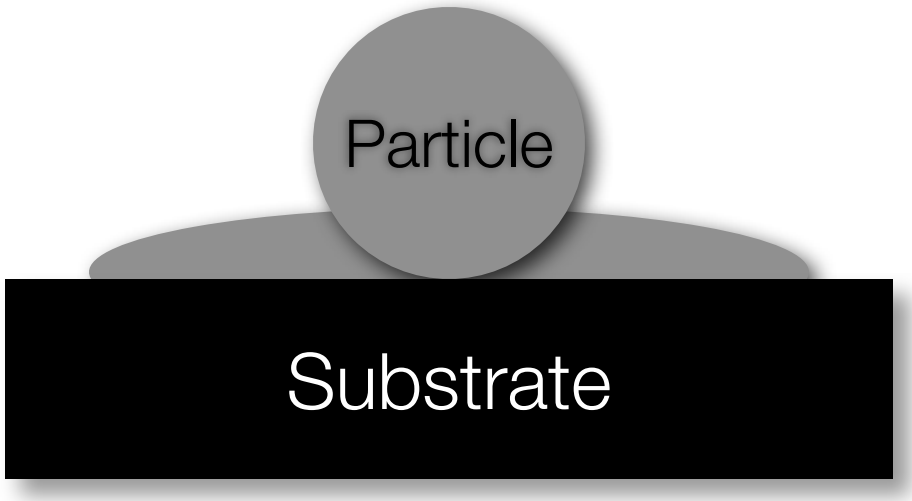
Introduction to Kinetic Metallization

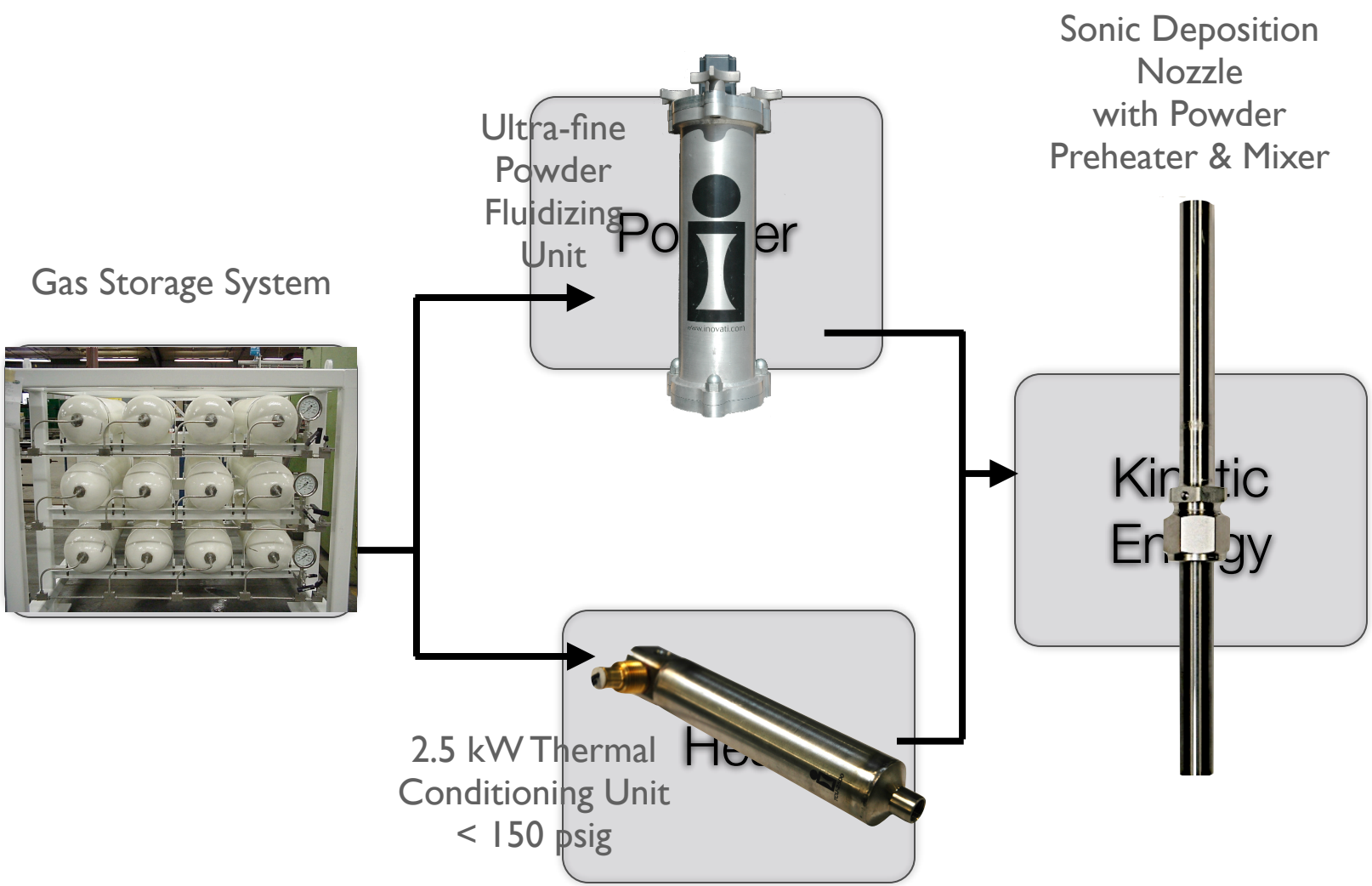
- Metal deposition through particle impact
- Low-temperature << melting point
- Low noise < 75 dBa @ 1 m
- Highest quality — Lowest cost

Sonic Mach 1 Nozzle

- High particle velocity > 750 m/s
- Pressure < 1 MPa (150 psig)
- Temperatures to 1100C
- Powder preheater & mixer
- Powder injection at nozzle inlet



Kinetic Metallization™ Process



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Latest Development

- KM-1373
- Highest temperature available
- Lowest gas flow available
- Highest quality coatings
- Lowest cost coatings

KM Systems

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KM-1373 System

- **Multiple Types Spray Guns**
  - Robotic, ID Gun, & Handheld
  - Gas blending (He & GN2)
- **Applicable Coatings**
  - 1100 °C Helium @ 60-90 psig
  - WC-Co, Ni alloys, Nb, Ta
  - GN2 (Al-Trans® , Cu, Zn, Ni)
  - Polymers (PEEK, PTFE)
- **Powder Loading**
  - ~100% gas mass flow

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KM-Mobile Coating System (KM-MCS)

- **KM-Mobile Coating System**
  - Handheld KM Spray Gun
  - Brush-sieve powder fluidizing units
  - Integrated subsystems on cart
- **Applicable Coatings**
  - GN2 (Al-Trans® , Cu, Zn, Ni)
  - He/GN2 (WC-Co, Ni alloys)
  - Composite polymers (PEEK, PTFE)

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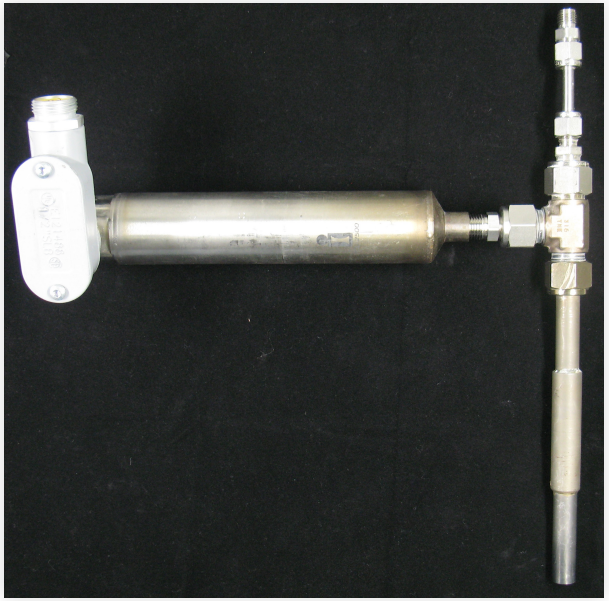
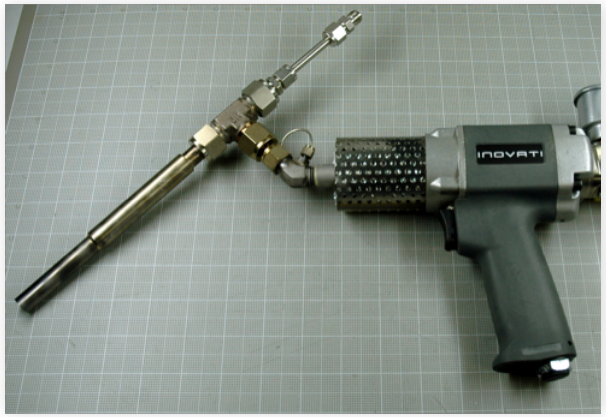
KM Guns





KM ID Gun

Bore Dimensions
Down to 50 mm ID
Bore Lengths> 1 meter

Problem - Repair of Damaged IVD Aluminum

- HSS - Landing Gear & Components
  - Problem- Brush plating Cd
  - Environmentally sustainable repair
- Opportunity - Al spray coating
  - Repair damaged IVD-Al coatings
  - Alumiplate coating repairs
- Naval Aviation FRC & IMF
  - F/A-18, E-6B, H-1, V-22, F-35

KM-Mobile Coating System (KM-MCS)

- **KM-Mobile Coating System**
  - Handheld KM Spray Gun
  - Brush-sieve powder fluidizing units
  - Integrated subsystems on cart
- **Applicable Coatings (e.g.)**
  - GN2 (Al-Trans® , Cu, Zn, Ni)
  - He/GN2 (WC-Co, Ni alloys, Nb, Ta)
  - Polymers (PEEK, PTFE)

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Kinetic Metallization
IVD Coatings

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Al-Trans® IVD Aluminum Repairs

- Surface Preparation
- Removable of topcoat, primer, & IVD Al with bristle disk abrasion
- Masking of repair area with aluminum tape to protect border areas
- Al-Trans® Coating Properties on High Strength Steels
- Adhesion of > 10 ksi without de-lamination
- Coating protection >3000 hrs in salt fog per ASTM B117
- Superior corrosion protection in SO2 salt fog per ASTM-G85
- Passed Joint Test Protocol-2003 specifications

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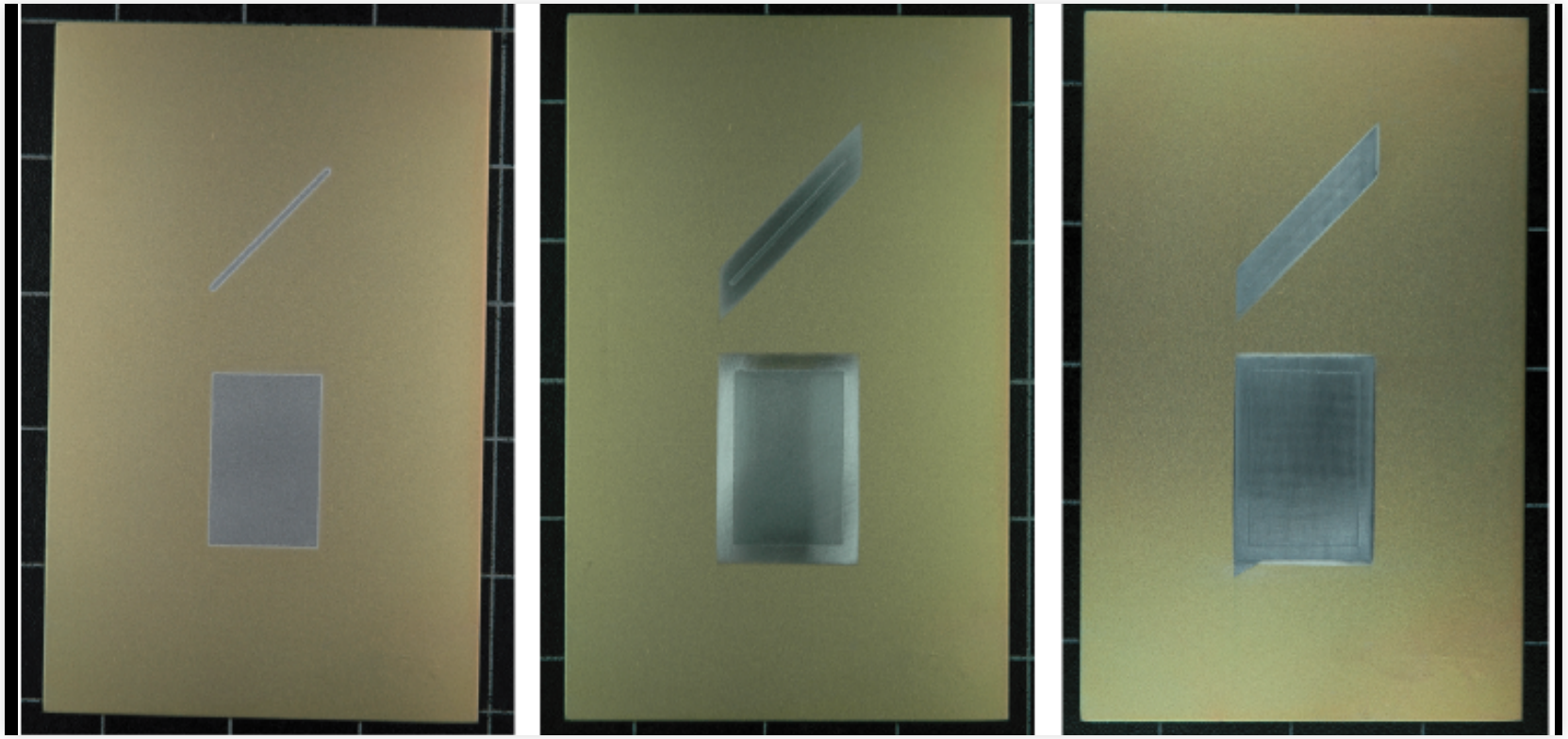
KM Repair Sequence for IVD-AI



IVD-AI Removed | Feather Edges | KM AI-Trans® Repair

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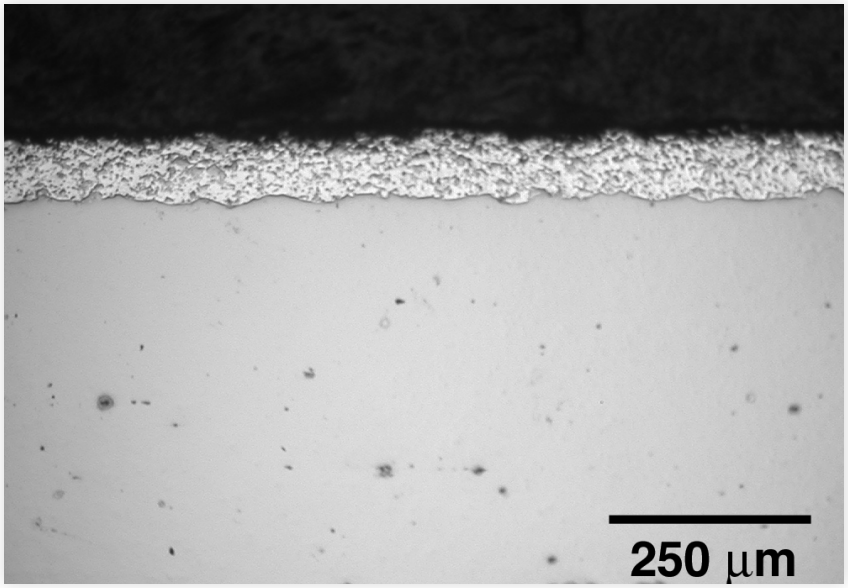
Al-Trans® Corrosion Protection
IVD-Al Repairs



Composite Al-Trans® Coating

- Composite Al-Trans®/ Cr Coating
- Properties
  - Hardness HRB = 62
  - Porosity < 0.5%
  - Corrosion - Salt Fog B117
  - 3000 Hrs
  - Substrate 4130 steel

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Al-Trans® Kinetic Metallization JTP-2003 Qualification Tests

Reparability Test	JTP	Acceptance Criteria	Pass/Fail
Unscribed Salt Fog	3.3.1 3.7.1	3000 Hrs ASTM B117-94	Pass
Scribed Salt Fog	3.3.2 3.7.1	1000 Hrs ASTM B117 94	Pass
Unscribed SO2 Salt Fog	4.1.1	500 Hrs ASTM G85	Pass
Scribed SO2 Salt Fog	4.1.2	500 Hrs ASTM G85	Pass
Unscribed Salt Fog	3.1.4	3000 Hr ASTM B117-94	Pass

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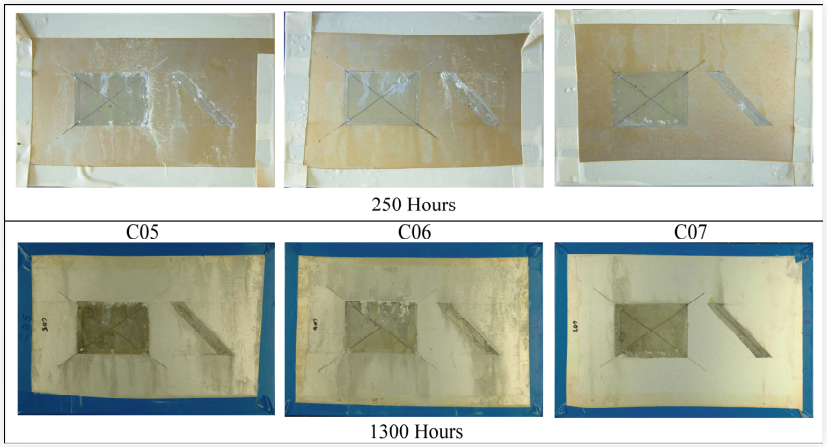
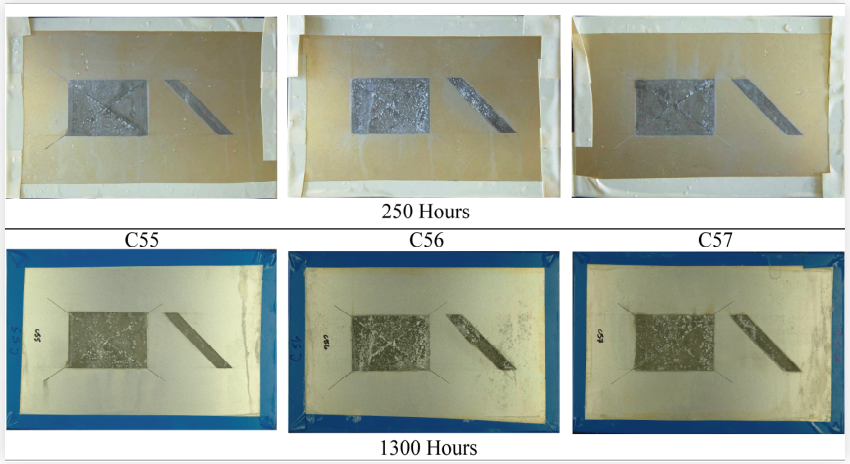
Scribed Salt Fog Testing
ASTM B-117





- Brush Cd specimens
- KM Al-Trans® repair

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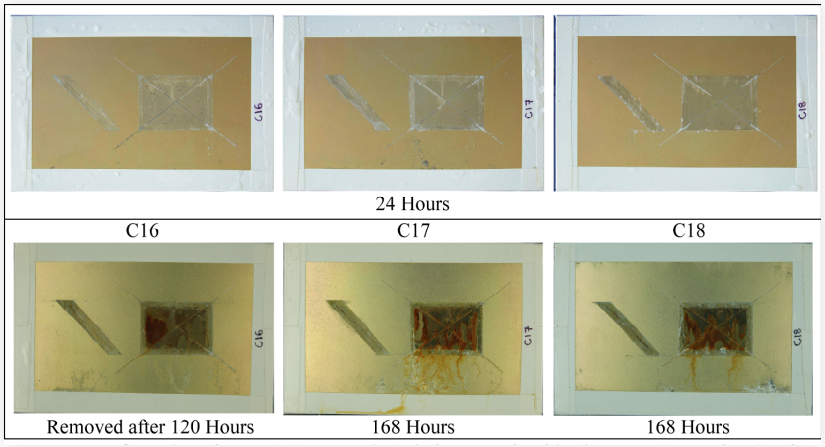
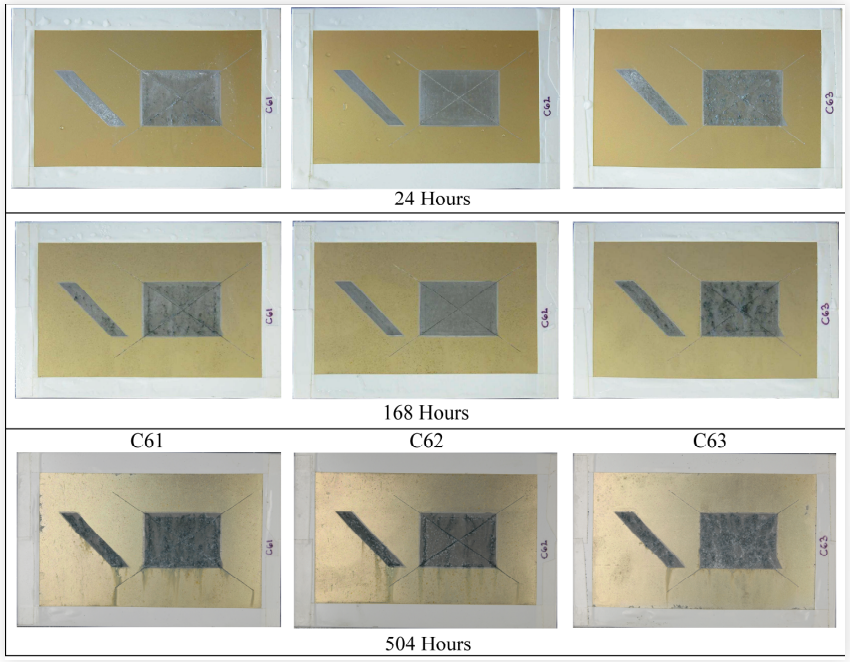
Scribed Cyclic SO2 Salt Fog (ASTM G85 annex 4, B117/SO2)





- Brush CD - 168 Hrs
- KM Al-Trans® - 504 hrs

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Al-Trans® Kinetic Metallization JTP-2003 Qualification Tests

Reparability Test	JTP	Acceptance Criteria	Pass/Fail
Hydrogen Embrittlement	3.6.1 3.7.1	200 Hr/75% ASTM F519	Pass
Hydrogen Re-Embrittlement	3.6.1 3.7.1	200 Hr/75% ASTM F519	Pass
Corrosion Resistance 14 Fluids	3.3.4	No Coat Degradation Compared to Brush Cd	Pass
Stress Corrosion Cracking	4.3	SEM Fractography	Pass
Scribed Painted Coating	3.3.5	3000 Hrs ASTM B117 - 94	Pass

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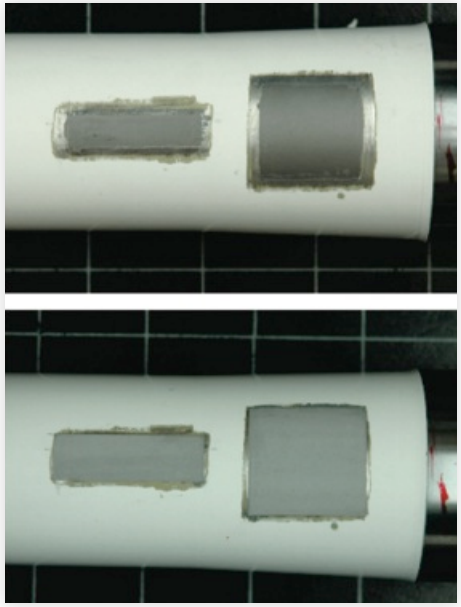
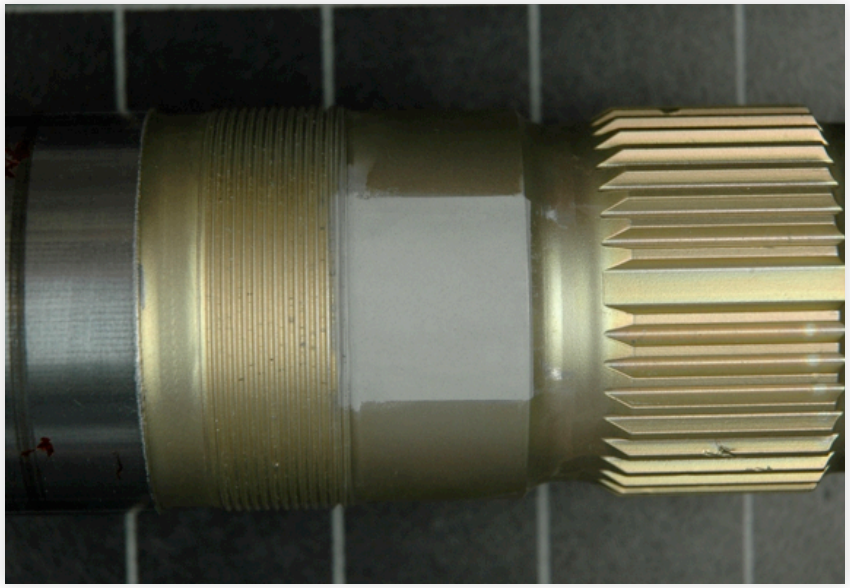
F-18 Axle





- KM Al-Trans® IVD Repairs

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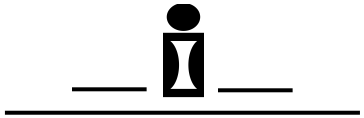

Summary

Summary of Kinetic Metallization for IVD-Al Repairs

- **Process**
  - KM IVD Aluminum Repairs with Al-Trans®
  - Kinetic Metallization enables repairs of IVD-Al & Alumiplate coatings on HSS
  - Al-Trans® coatings superior to Brush Cd for IVD Al repairs
  - Environmentally compliant
- **Equipment**
  - KM-Mobile Coating System with Handheld Gun