Kinetic Metallization™
Interior Diameter (ID) Bores

Cold Spray Equipment Session
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Overview

❖ Kinetic Metallization (KM) Process and Equipment

❖ KM ID Coating Applications
  ❖ Dimensional Restoration of Aluminum Landing Gear Bores
  ❖ WC-Co for Actuator Sleeves or Cylinders
Kinetic Metallization Process & Equipment
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 1100°C
- Powder preheater & mixer
- Powder injection at nozzle inlet
Kinetic Metallization™ Process

Gas Storage System

Ultra-fine Powder Fluidizing Unit

2.5 kW Thermal Conditioning Unit < 150 psig

Powder

Heat

Kinetic Energy

Sonic Deposition Nozzle with Powder Preheater & Mixer

INOVATI
Latest Development

- KM-1373
- Highest temperature available
- Lowest gas flow available
- Highest quality coatings
- Lowest cost coatings
KM Systems
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
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)
KM ID Gun

Bore Dimensions
Down to 50 mm ID
Bore Lengths > 1 meter
Dimensional Restoration of Aluminum Landing Gear Bores
Material & Process Requirements for LG Dimensional Restoration

- Coating
  - Application Temperature < 225°F
  - Thickness > 30 mils
  - Hardness ≈ 7075-T6
  - Chemical compatibility Type III sulfuric-acid anodize process
  - Fully dense and cohesive
  - Adherence to base alloy to prevent delamination and spalling under loads
  - Overspray dust - completely removed bore and blind holes
KM Restoration Coating

- Optical Micrographs of 7075Al-Trans®
# KM Coating Hardness

<table>
<thead>
<tr>
<th>Coating Formulation</th>
<th>Measured Rockwell F (HRF)</th>
<th>Calculated Brinell Hardness (HB)</th>
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<tr>
<td>6061</td>
<td>78</td>
<td>72</td>
</tr>
<tr>
<td>6061 Al-Trans®/Cr</td>
<td>95</td>
<td>106</td>
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<tr>
<td>6061 Al-Trans®/Ni Alloy</td>
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<td>7075</td>
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<tr>
<td>7075 Al-Trans®/Ni Alloy</td>
<td>110</td>
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</tbody>
</table>
KM Coated ID Machinability

- No Chipping or Spalling
KM Coating After Anodizing

- Coating Compatible Type III Anodizing

0.002” Nominal Anodized Thickness
Fully Dense (>99%)
OEM Landing Gear

- Rotation of LG
- KM Gun Axially Translated
WC-Co for Actuator Sleeves & Cylinders
KM WC-Co Coating

- 16” deep bore
- 3.75” ID
WC-Co Microstructure
Adhesion Strength (psi)

KM WC-Co 4 Samples
Summary
KM ID Coatings
LG Dimensional Restoration

- 7075 Al-Trans®
  - Coating hardness ≈ 7075-T6
    - PASS – Coating hardness >150HB
  - Compatible with the Type III sulfuric-acid anodize process
    - PASS – 0.002” nominal anodized layer, KM coating remains fully dense
  - Fully dense and cohesive
    - PASS – >99.5% dense
KM WC-Co

- Applicable to ID Coatings of Actuators & Cylinders
- Properties comparable to HVOF
- KM Advantage is low temperature deposition