Kinetic Metallization™
Naval Weapon System Repairs

Presented to: NAVAIR Fleet Readiness Center East

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Deposition Processes

- Gas: Vapor Deposition
- Liquid: Thermal Spray
- Solution: Electrochemical
- Solid: Impact Consolidation
- IVD: HVOF
- CVD: A/VPS
- PVD: D-Gun
- KM: Chemical Conversion
- CS: Anodize

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KM Basics

- Impact Consolidation Process
  - Feed-stock: fine powder,
  - Accelerant: inert light gas
- Solid-state Consolidation
  - No Melting
  - No Liquid Chemicals

- Environmentally Innocuous
  - No Particle release
  - No Chromate formation
  - No Hazardous Gas Emission
- Enhanced worker safety

Substrate
Kinetic Metallization™ Process

Gas Storage System

Ultra-fine Powder Fluidizing Unit

Sonic Deposition Nozzle with Powder Preheater & Mixer

2.5 kW Thermal Conditioning Unit < 150 psig

Powder

Kinetic Energy
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 ID Gun

Internal Diameter
Down to 50 mm ID
Bore Lengths > 1 meter
Low Temperature

WC-Co
WC-Co Microstructure
WC-Co on Aero Alloys

- Inconel 718
- Ti-6-4
- Hardness
Tunable Hardness KM WC-Co

HV (300g) = 1495 kg/mm²
Stator Coated Surfaces

- **Outer Shaft**
  - D = 0.445"
  - ID = 0.560"
  - OD = 1.100"

- **Blade**
  - 1.120"

- **Inner Shaft**
  - D = 0.400"
  - 0.385"

- **Coatings**
  - Ti6-4
  - W-Co Coating

**Total Coated Area per Part = 2.813in^2**
Next generation KM Coating

❖ Corrosion resistant matrix
❖ Corrosion/Wear resistant carbide
❖ Layered structure
❖ Increased ductility
❖ Patent Pending
F18 Hydraulic Gear Repair
Wear Groove

- 0.005” deep
- Detail
Better Than New

- 0.05” removed
- 0.10” sprayed
- WC-Co, Hv = 1,000
- Rz = 2 µin
3M Surface Finish Study

The graph shows the surface roughness $R_z$ (µm) for different diamond film grit sizes (µm) processed using KM and HVOF methods. The grit sizes are 30, 15, and 9 µm. KM method results are represented by blue bars, and HVOF method results are represented by gray bars. The roughness values for KM are higher than those for HVOF for all grit sizes.
Tailhook
F-18 Tailhook Arresting Gear Pivot

- WC-Co Coating (shaded)
- Photo of Arresting Gear Pivot
Trident Trim Pump
Rotor
Cover
Case
Problem

❖ Corrosion
❖ Erosion
❖ Wear
❖ Unobtainable
F18 E/F
Generator Shaft
Damage Areas

- Top
  - Beneath Permanent Magnetic Group

- Bottom
  - Journal Bearing Area
Journal Damage

- Common failure
- Bearing seizes
- Sufficient torque to continue rotation
- Shaft damaged
Antidrive End

- PMG removal damage
- Diminutional restoration
Journal Bearing Area

- Drive end detail
- Bearing
Journal Damage
AMAD Gearbox
High Value

- Damage Occures
Fretting Hydraulic Pad
KM Repair
Machined
Finished
KM Carbide Coatings

- Flying on F18 Superhornet
- Aero Engine Applications
- Automotive Brake Rotors
- Upstream Oil and Gas
KM He Recycle

- Capital Cost
  - $250K
- Footprint
  - 6’ X 3’

- He Cost Reduction
  - at today's cost
  - factor of 4

- Purity
  - 99.9%
Acquisition Cost

- KM-Production Coating System
- Including Helium Recycle System
- $650K