Enhancing Quality of WC Coatings with Kinetic Metallization™

North American Cold Spray Conference
Session 2 - Characterization
Wednesday April 3, 2013 1:30 PM

Howard Gabel, President
Ralph Tapphorn, VP of Technology
Travis Crowe, Metallurgist

www.inovati.com
Deposition Processes

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

*INOVATI*
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
Gas Storage System

2.5 kW Thermal Conditioning Unit

< 150 psig

Ultra-fine Powder Fluidizing Unit

Sonic Deposition Nozzle with Powder Preheater & Mixer

Kinetic Metallization™ Process
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
KM1000
WC-Co Coatings
WC-NiCrCo Microhardness

Bar chart showing microhardness values for In718 and Ti 6-4.

HV(300g) values:
- In718: approximately 1,600
- Ti 6-4: approximately 1,200

Scale bar: 50 μm
Microstructural Characterization

- Inconel 718
- Ti-6-4
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”

Total Coated Area per Part = 2.813 in°
Next generation KM Coating

❖ Corrosion resistant matrix
❖ Corrosion/Wear resistant carbide
❖ Layered structure
❖ Increased ductility
❖ Patent Pending

200 µm
Note: This sample was not intentionally etched, must be a result of polishing.
substrate after repolish with 1um diamond paste does not show significant variation in substrate
WC-NiCoCr on 718
F18 Hydraulic Gear Repair
Wear Groove

- 0.005” deep
- Detail
Repair and Finished

- 0.10” sprayed
- WC-Co, Hv = 1,000
F-18 Tailhook Arresting Gear Pivot

- WC-Co Coating (shaded)
- Photo of Arresting Gear Pivot
KM Carbide Coatings

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