

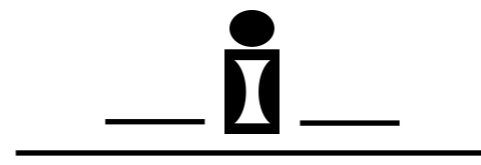
Kinetic Metallization™ Interior Diameter (ID) Bores

Cold Spray Equipment Session

24 May, 2012

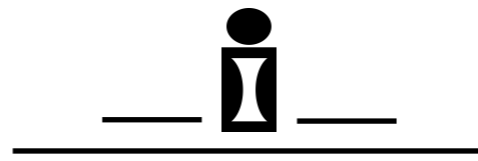
R. Tapphorn, H. Gabel, K. Hashimoto, and T. Crowe



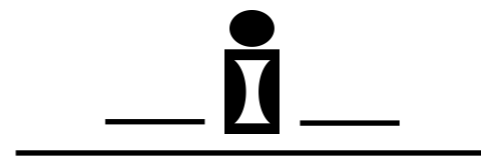


Overview

- ❖ Kinetic Metallization (KM) Process and Equipment
- ❖ KM ID Coating Applications
 - ❖ Dimensional Restoration of Aluminum Landing Gear Bores
 - ❖ WC-Co for Actuator Sleeves or Cylinders

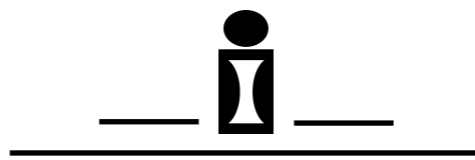


Kinetic Metallization Process & Equipment



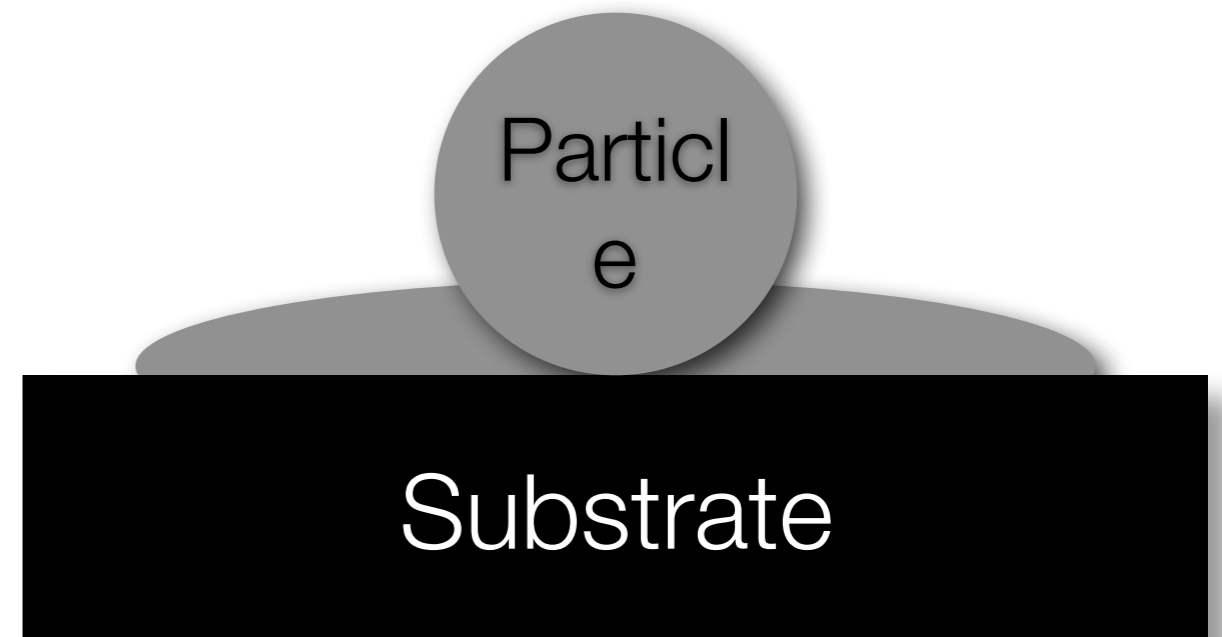
Introduction to Kinetic Metallization

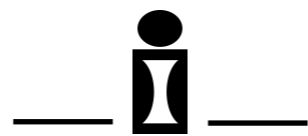
- ❖ Metal deposition through particle impact
- ❖ Low-temperature \ll melting point
- ❖ Low noise < 75 dBa @ 1 m
- ❖ Highest quality — Lowest cost



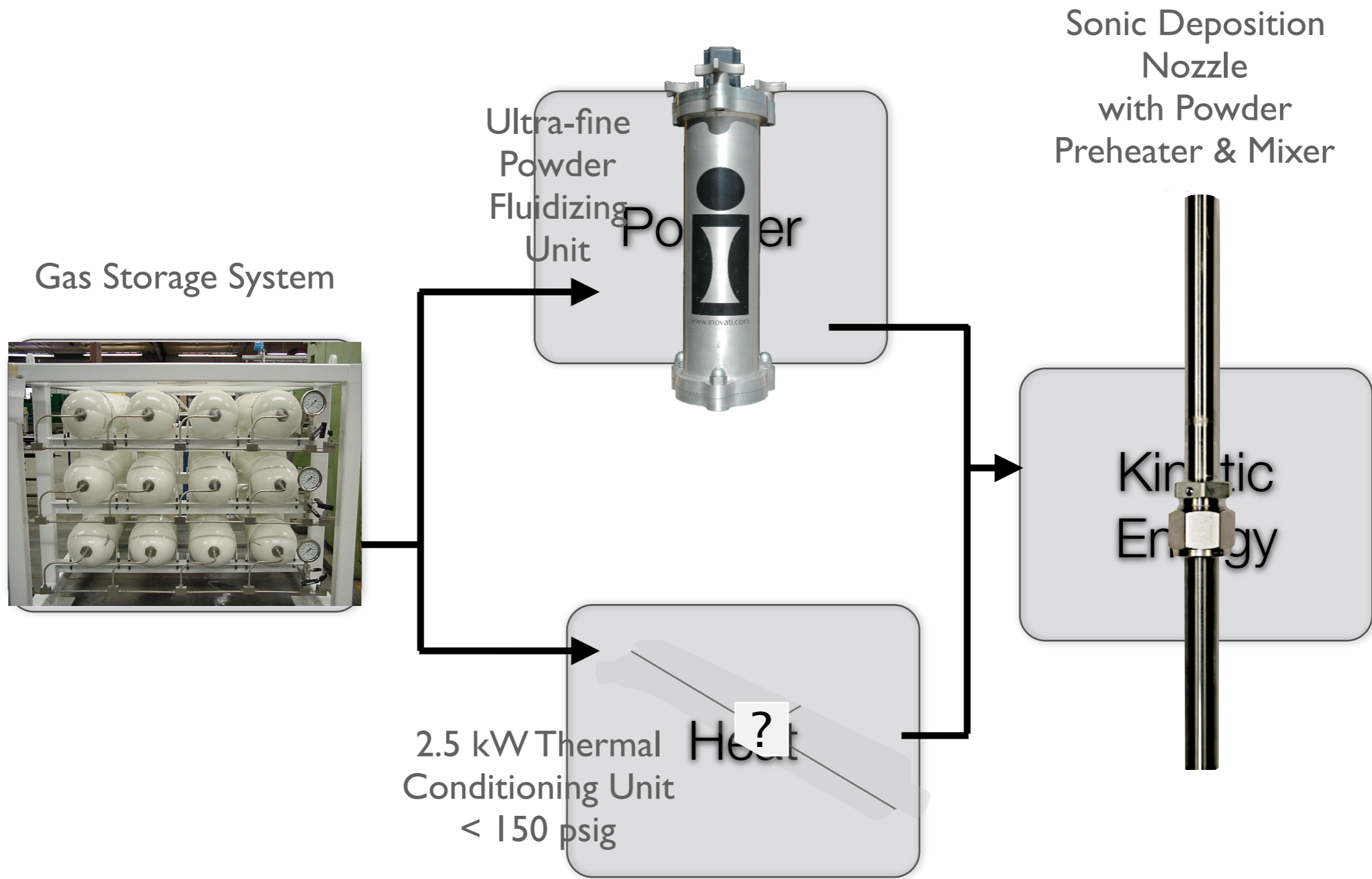
Sonic Mach 1 Nozzle

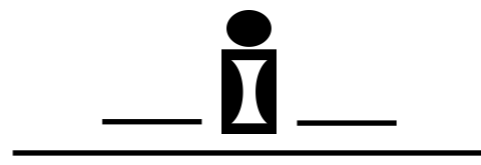
- ❖ High particle velocity
> 750 m/s
- ❖ Powder injection at
nozzle inlet
- ❖ Pressure < 1 MPa
(150 psig)
- ❖ Temperatures to
1100C
- ❖ Powder preheater &
mixer





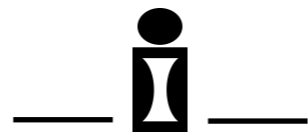
Kinetic Metallization™ Process





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)

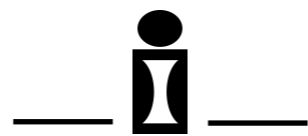
❖ Applicable Coatings

- ❖ 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

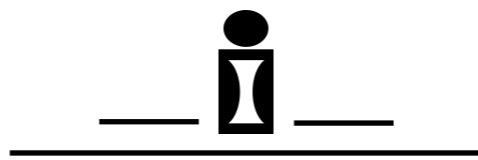




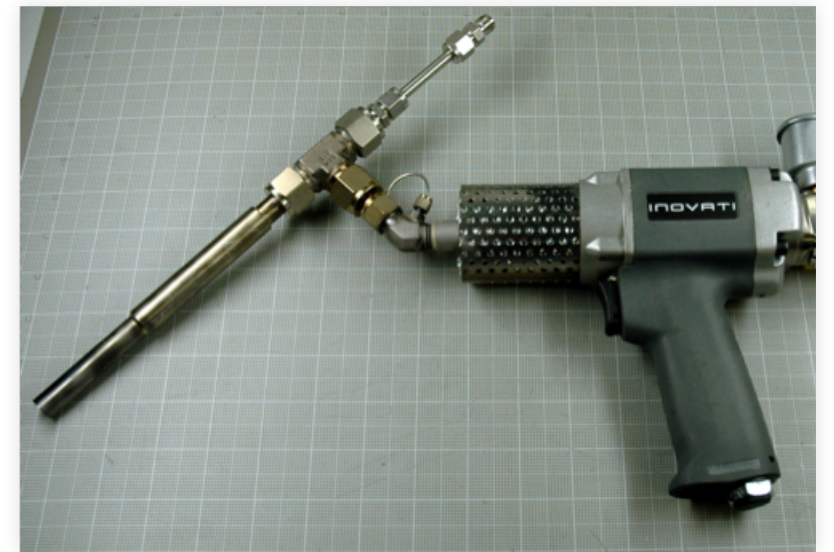
KM-Mobile Coating System (KM-MCS)

- ❖ **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 Guns

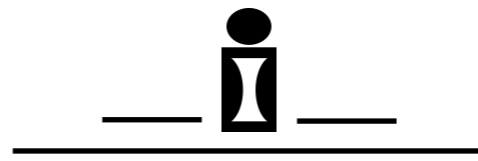




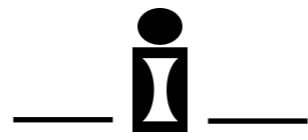
KM ID Gun

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



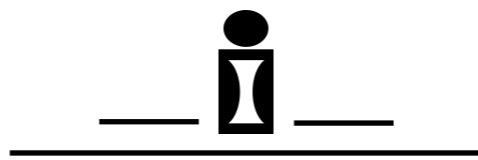


Dimensional Restoration of Aluminum Landing Gear Bores

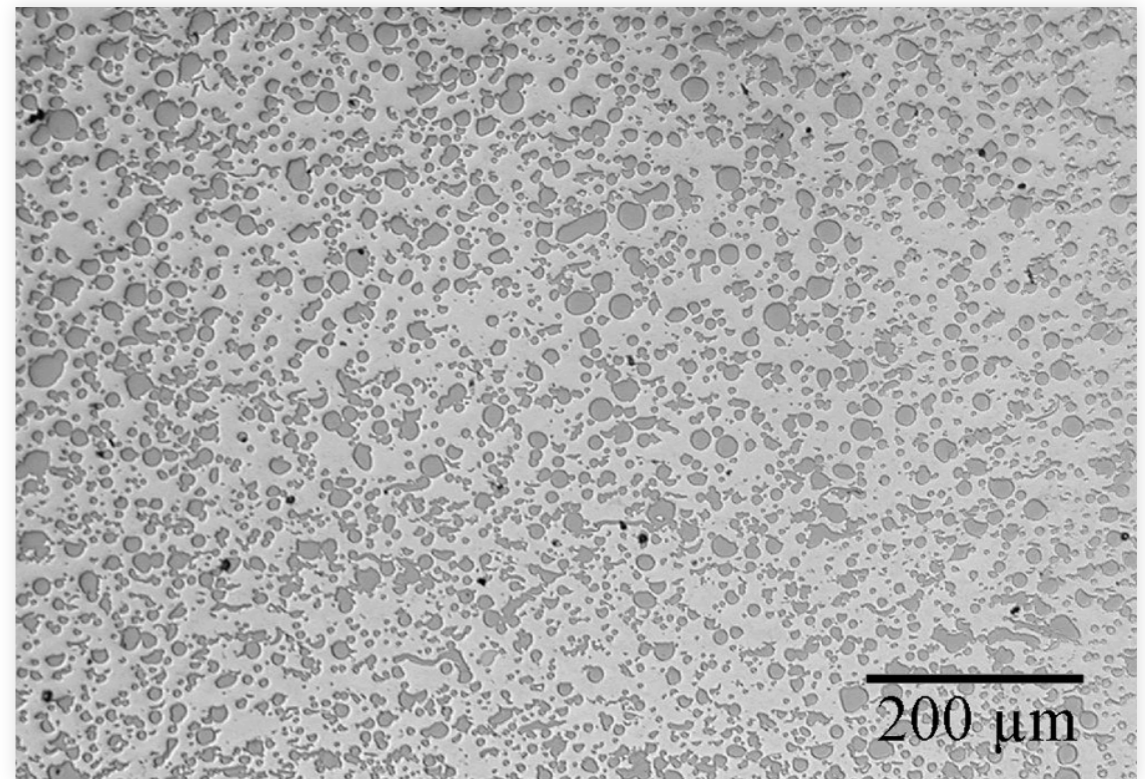
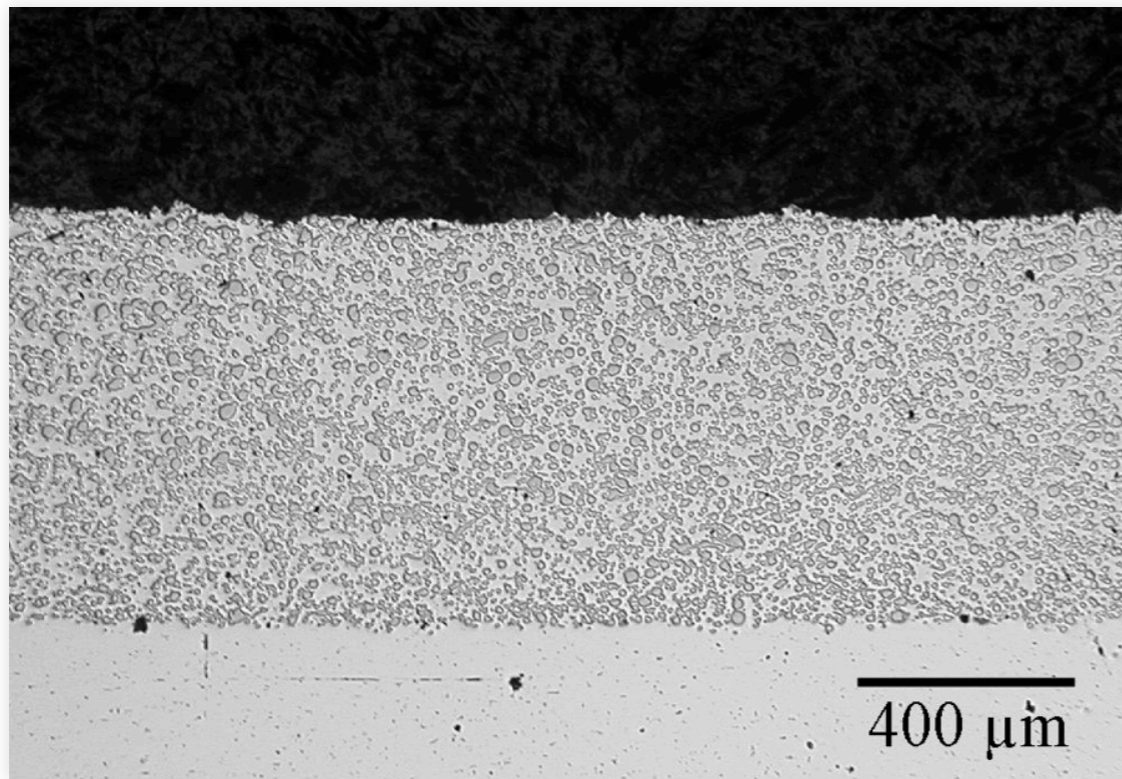


Material & Process Requirements for LG Dimensional Restoration

- ❖ 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®

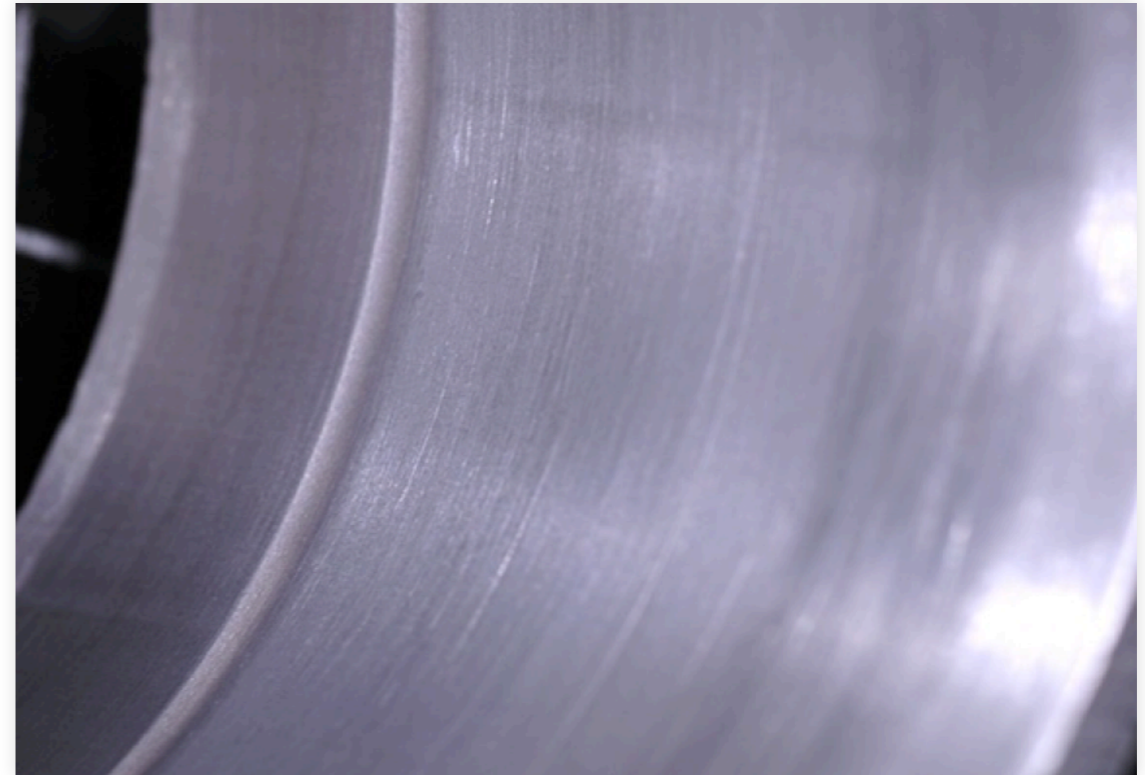


KM Coating Hardness

Coating Formulation	Measured Rockwell F (HRF)	Calculated Brinell Hardness (HB)
6061	78	72
6061 Al-Trans®/Cr	95	106
6061 Al-Trans®/Ni Alloy	94	102
7075	105	133
7075 Al-Trans®/Cr	107	142
7075 Al-Trans®/Ni Alloy	110	154



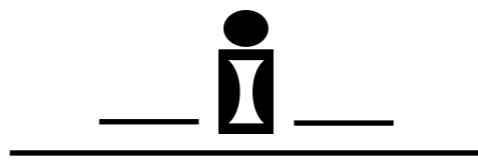
KM Coated ID Machinability



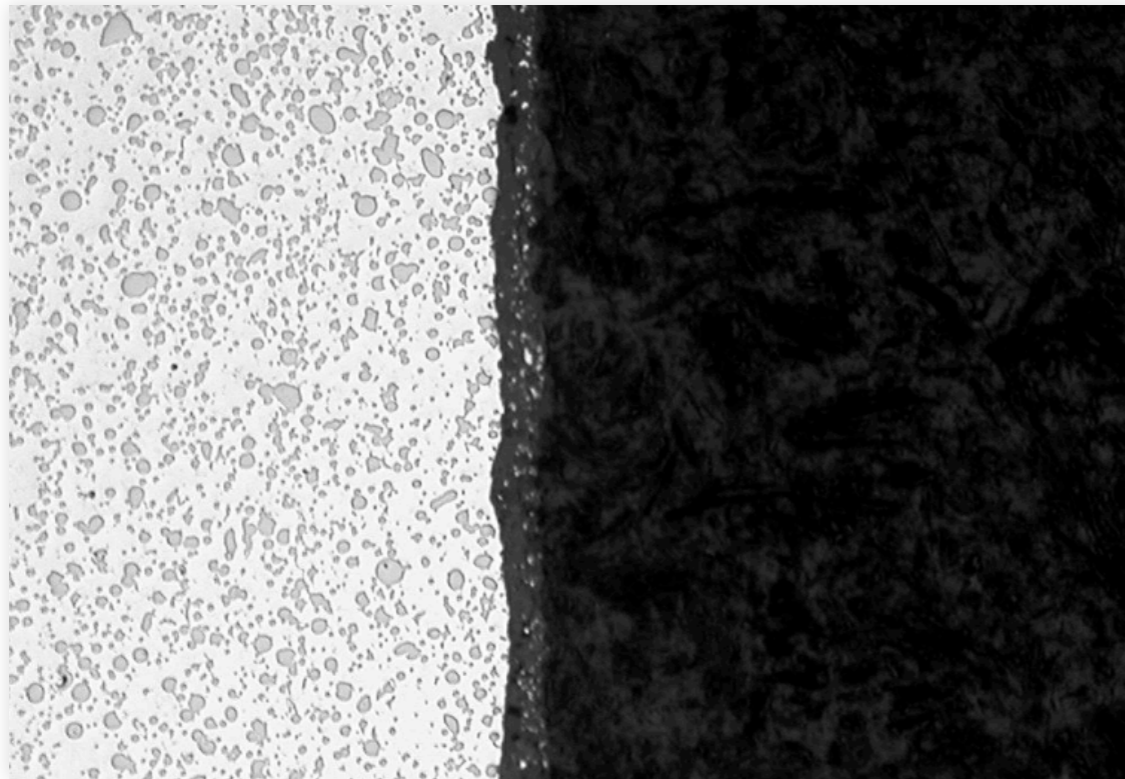
- ❖ No Chipping or Spalling



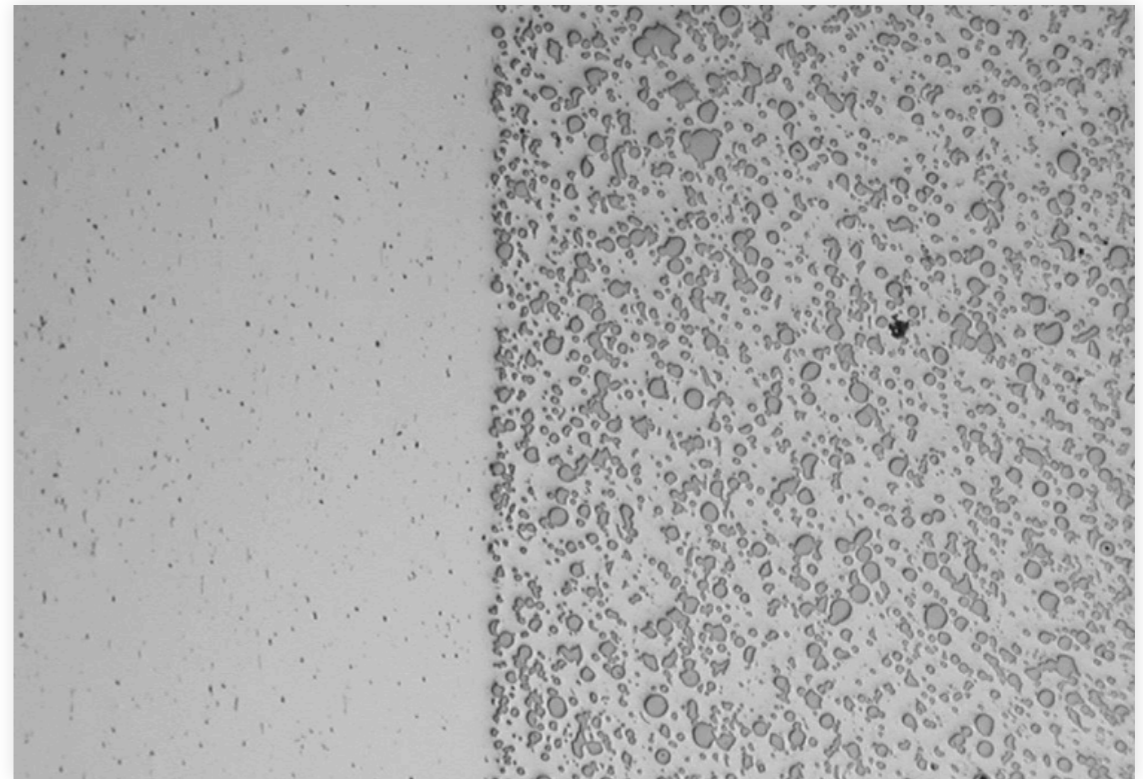
INOVATI



KM Coating After Anodizing

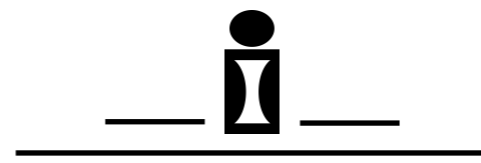


0.002" Nominal Anodized Thickness

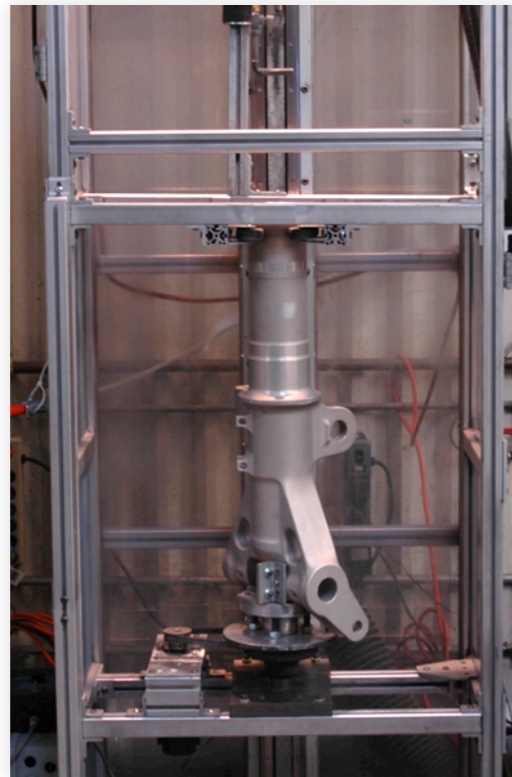


Fully Dense (>99%)

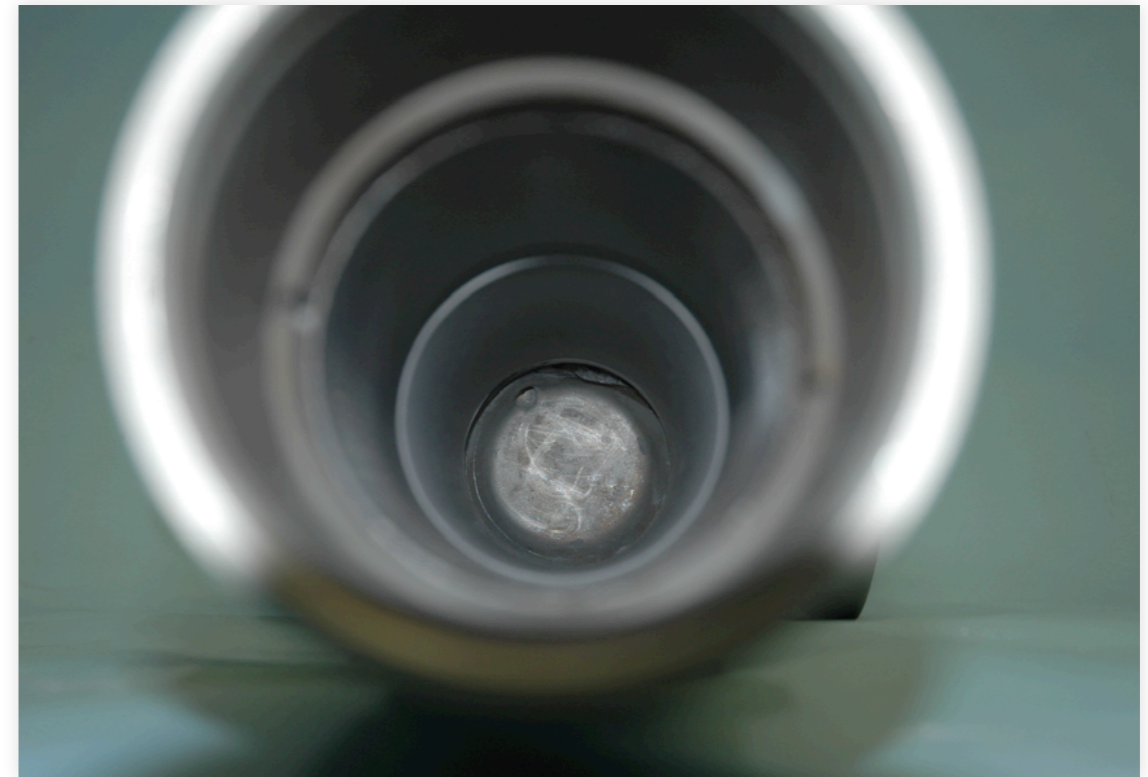
- ❖ Coating Compatible Type III Anodizing



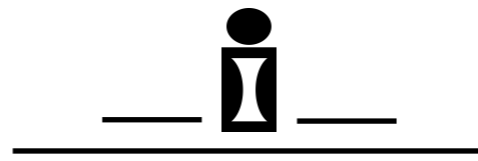
OEM Landing Gear



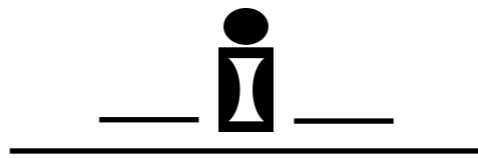
❖ Rotation of LG



❖ KM Gun
Axially Translated



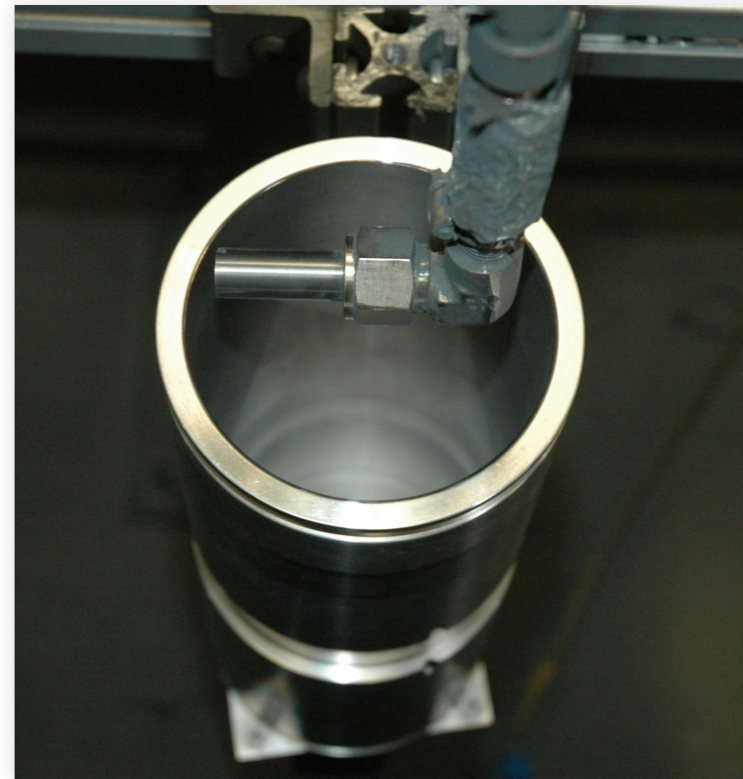
WC-Co for Actuator Sleeves & Cylinders



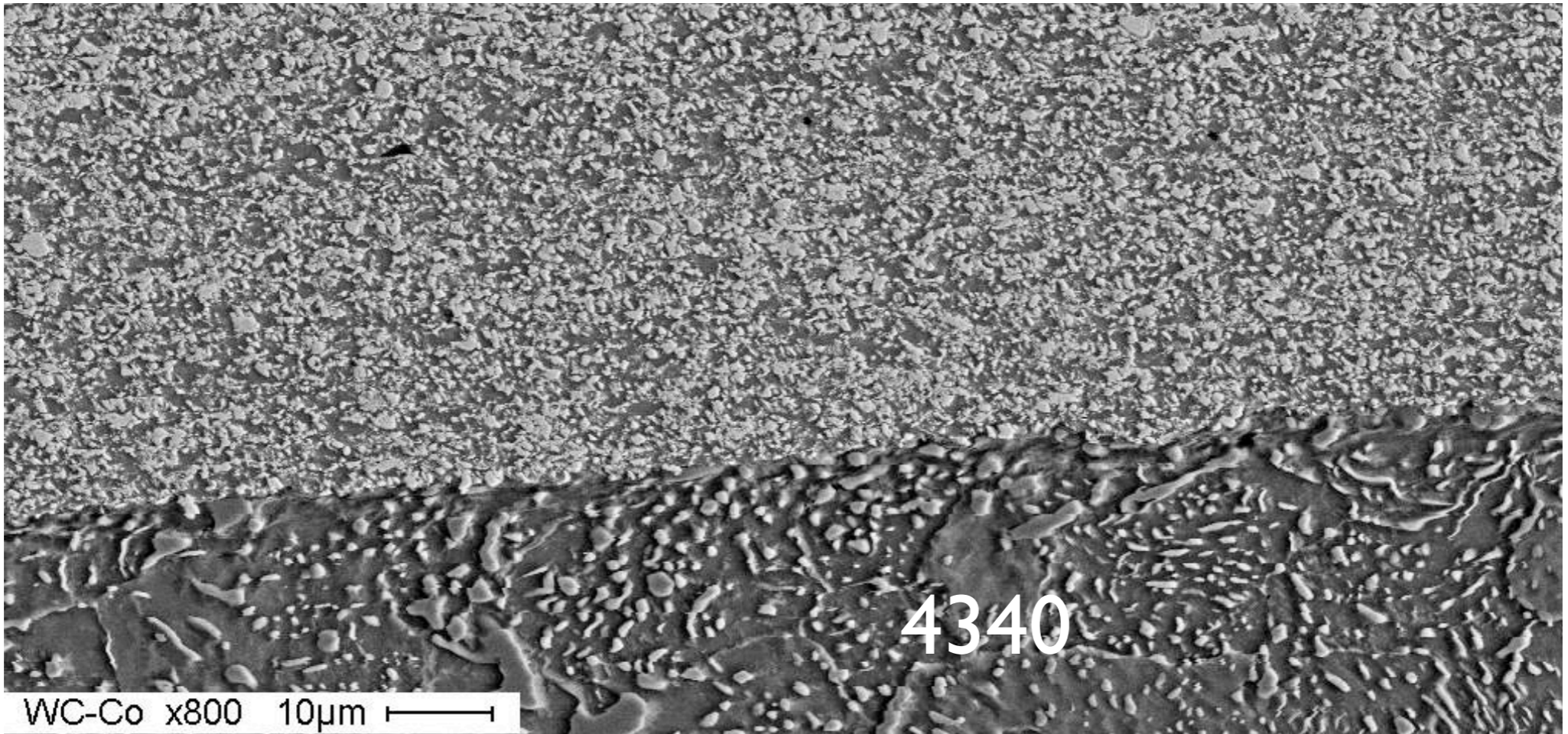
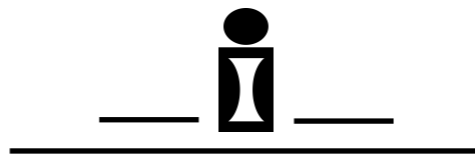
KM WC-Co Coating



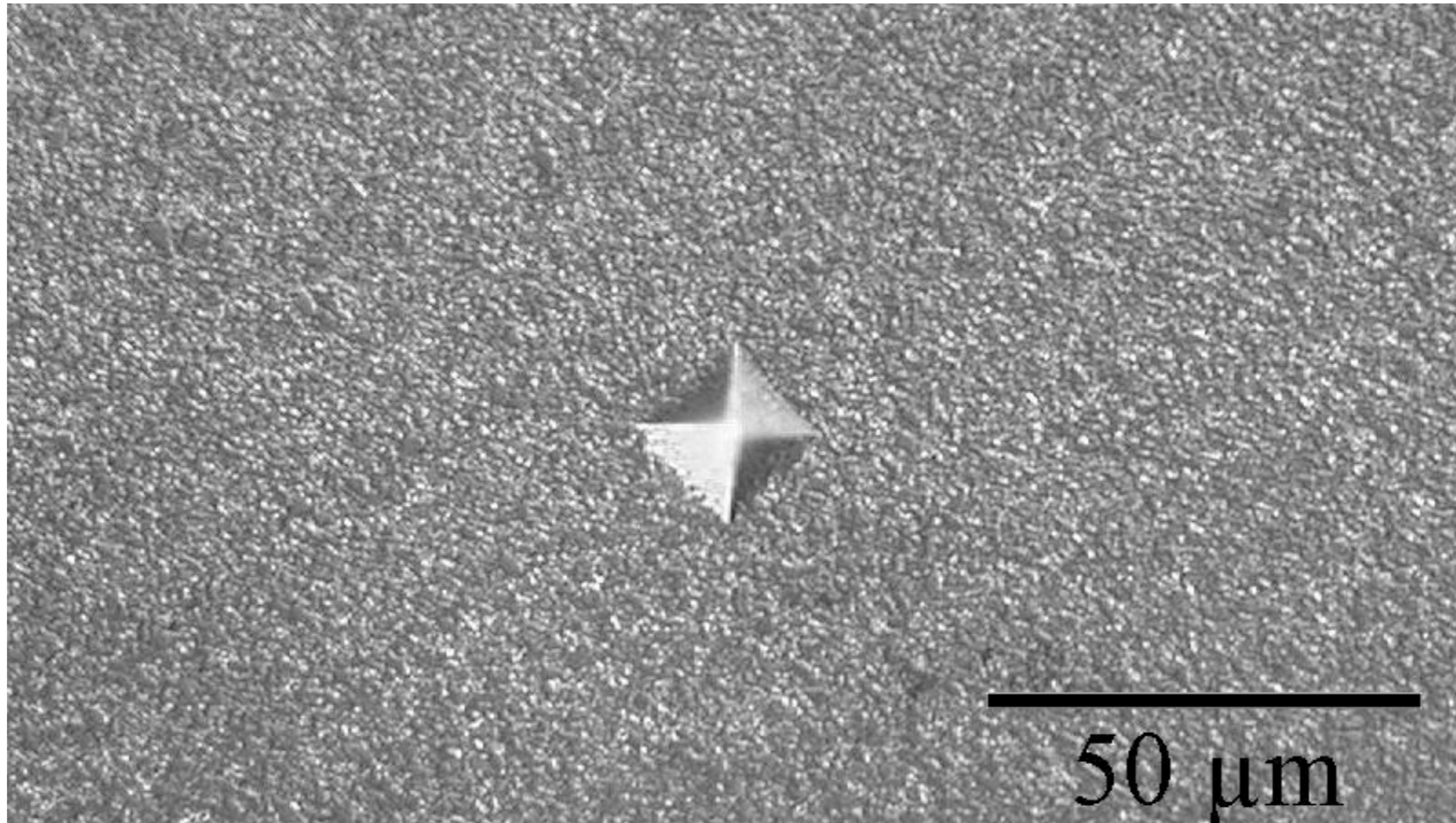
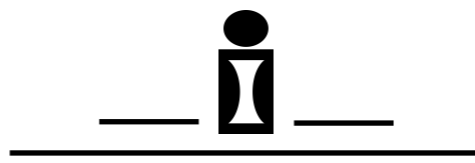
❖ 16" deep bore



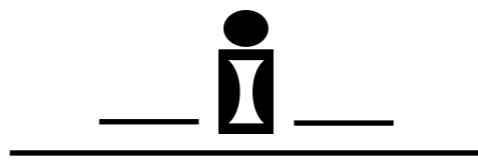
❖ 3.75" ID



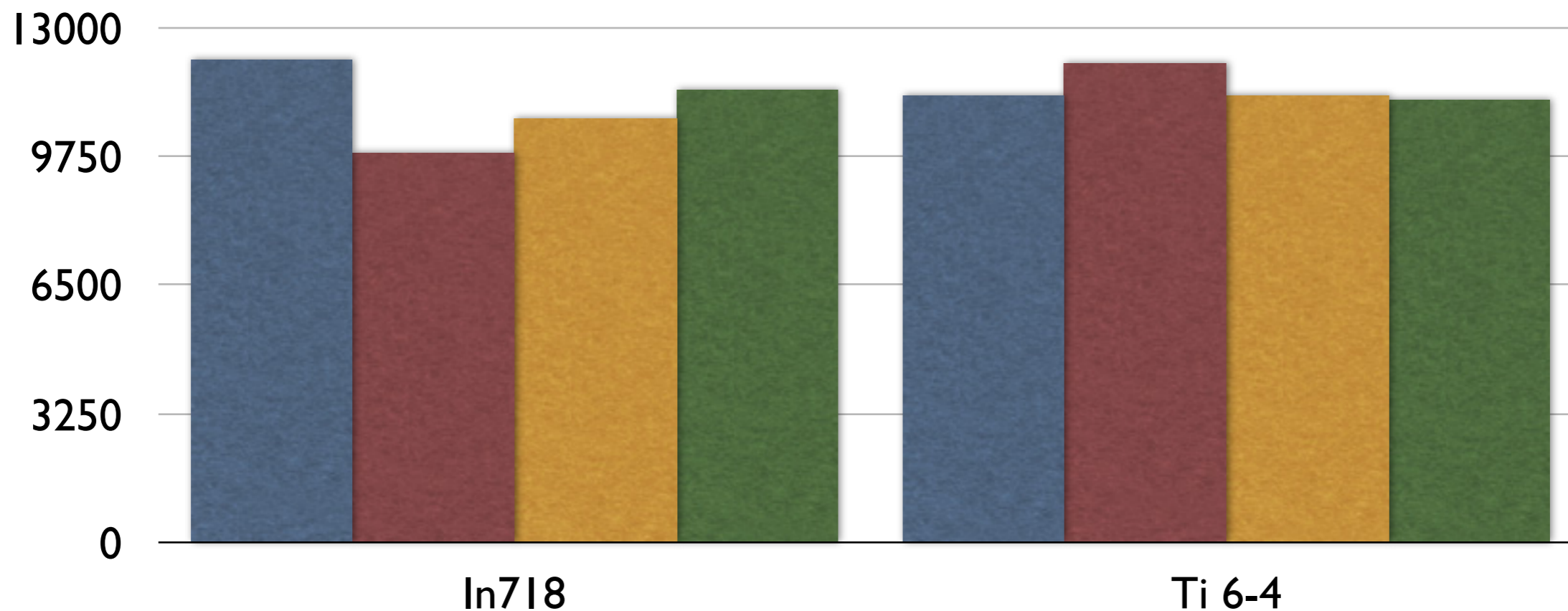
WC-Co Microstructure



1200 Hv_{300g}

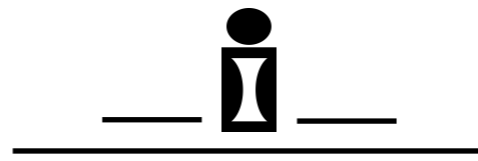


Adhesion Strength (psi)



KM WC-Co 4 Samples





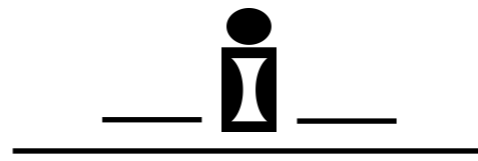
Summary



KM ID Coatings

LG Dimensional Restoration

- ❖ 7075 Al-Trans®
 - ❖ Coating hardness \approx 7075-T6
 - ❖ PASS – Coating hardness $>150\text{HB}$
 - ❖ 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