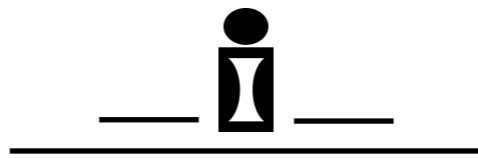


# Kinetic Metallization™ Naval Weapon System Repairs

Presented to: NAVAIR Fleet Readiness Center  
East

Presented by: Howard Gabel  
[www.inovati.com](http://www.inovati.com)





# Deposition Processes

Gas

Vapor Deposition

Liquid

Thermal Spray

Solution

Electrochemical

Solid

Impact Consolidation

IVD

HVOF

Plating

KM

CVD

A/VPS

Anodize

CS

PVD

D-Gun

Chemical Conversion



# KM Basics

## ❖ Impact Consolidation Process

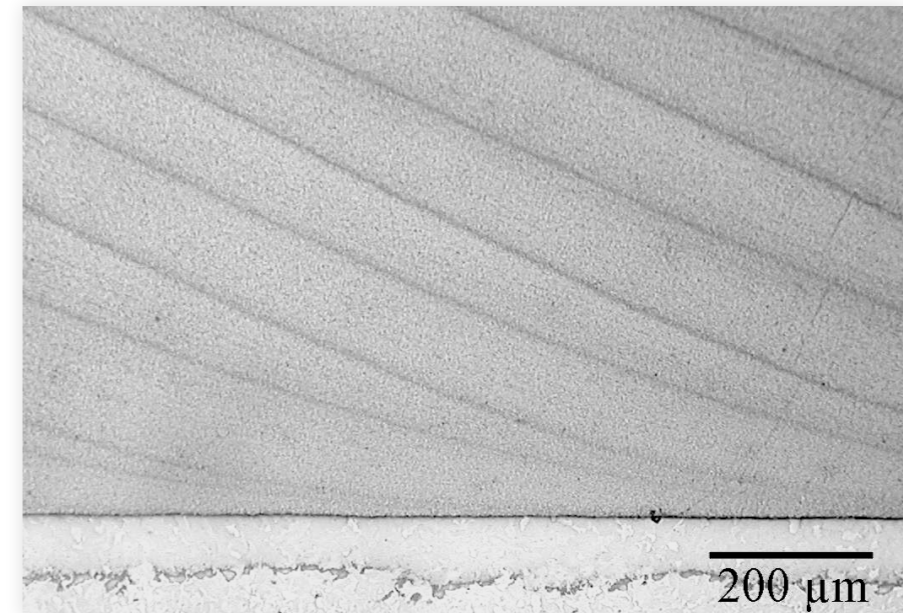
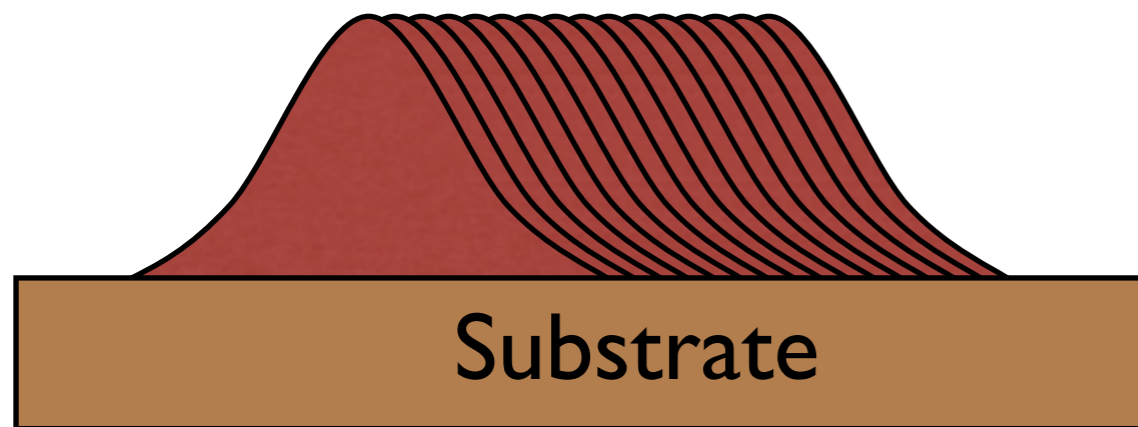
- ❖ Feed-stock: fine powder,
- ❖ Accelerant: inert light gas

## ❖ Solid-state Consolidation

- ❖ No Melting
- ❖ No Liquid Chemicals

## ❖ Environmentally Innocuous

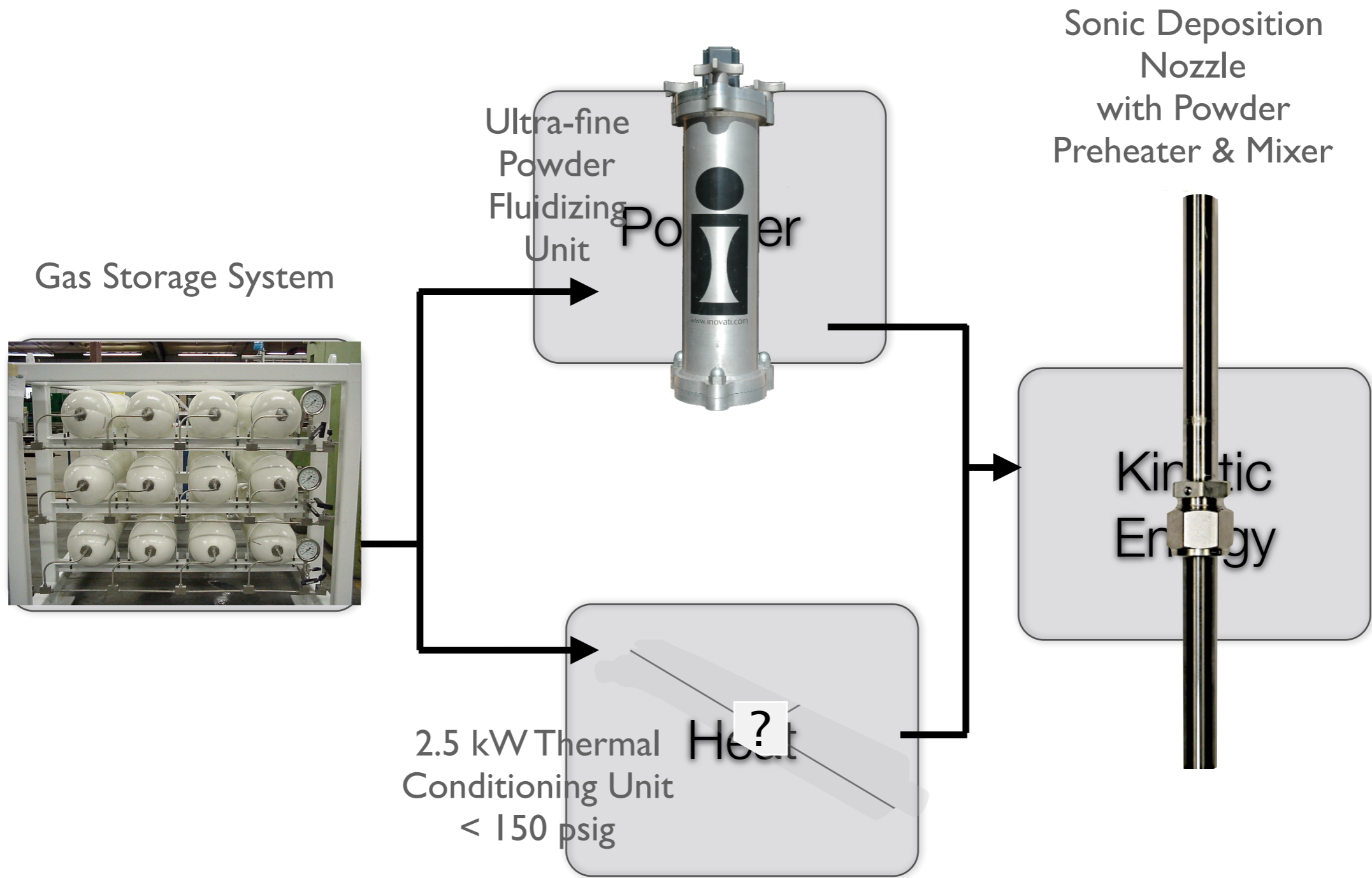
- ❖ No Particle release
- ❖ No Chromate formation
- ❖ No Hazardous Gas Emission
- ❖ Enhanced worker safety



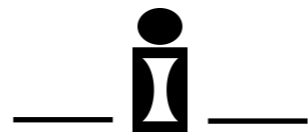
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# Kinetic Metallization™ Process



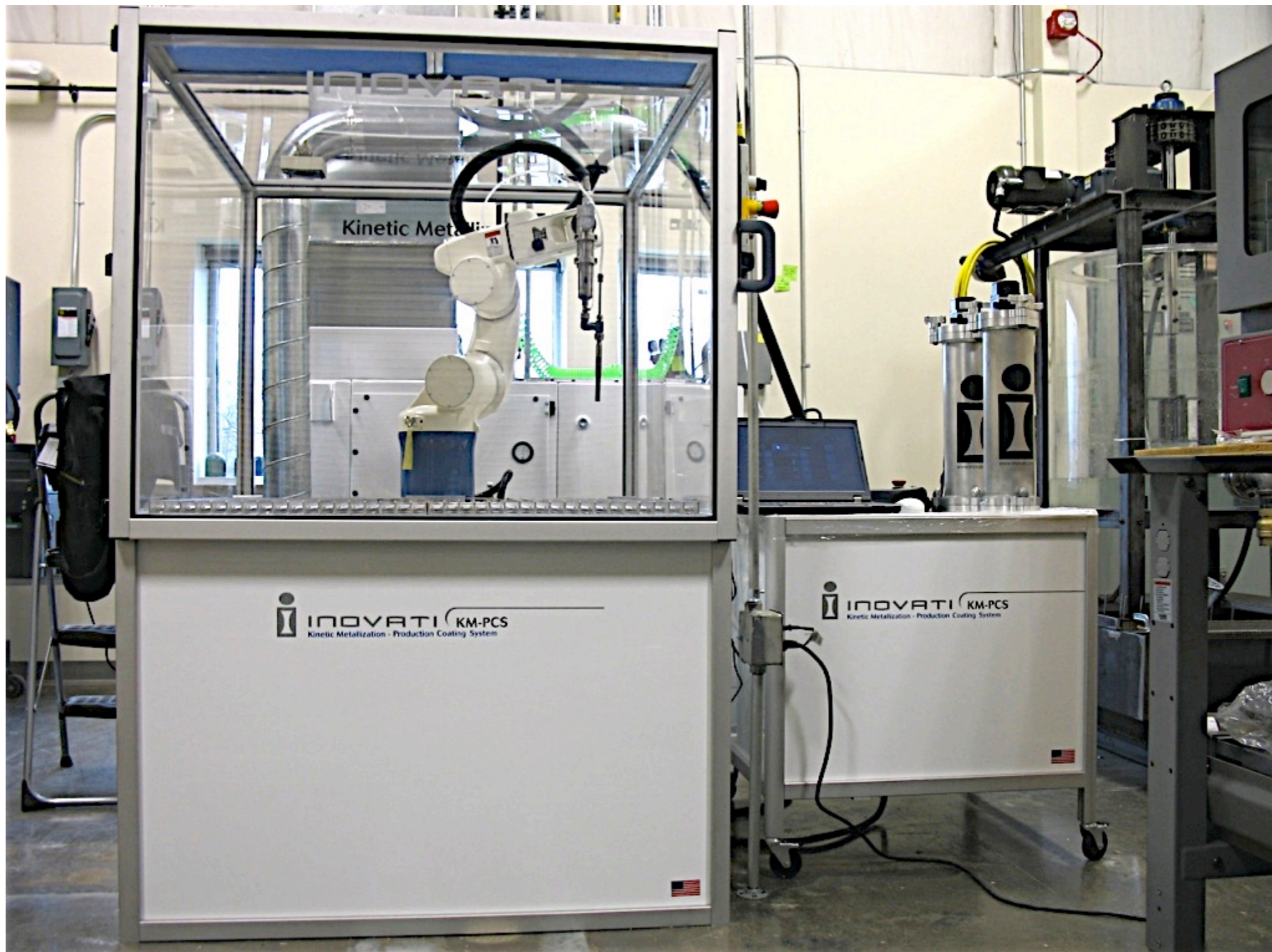




# KM Systems







  
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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



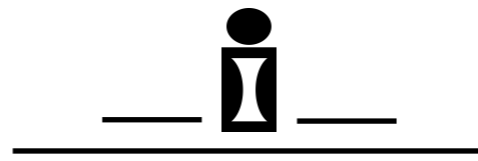




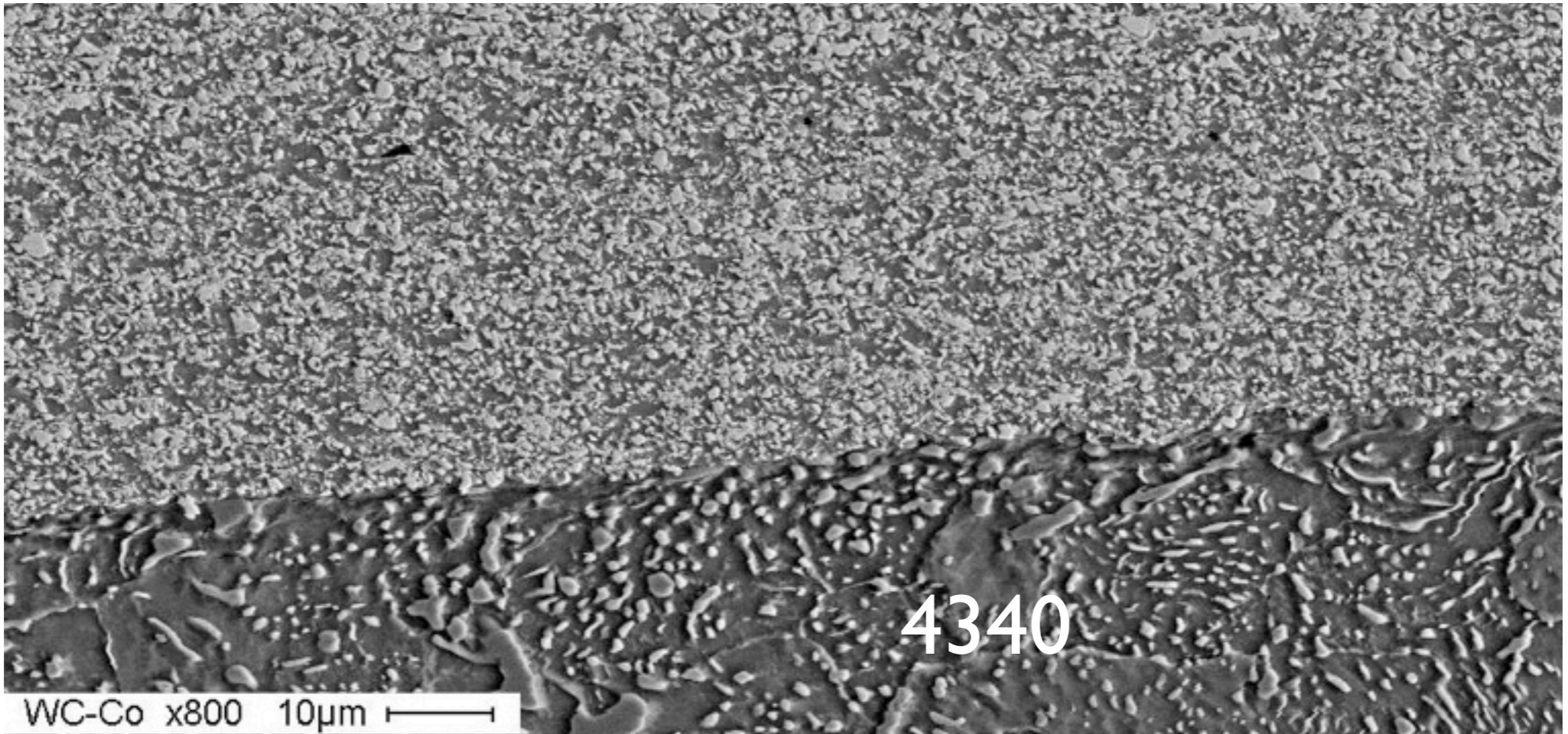
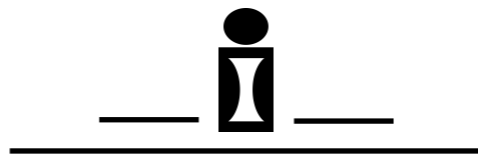
# KM ID Gun

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



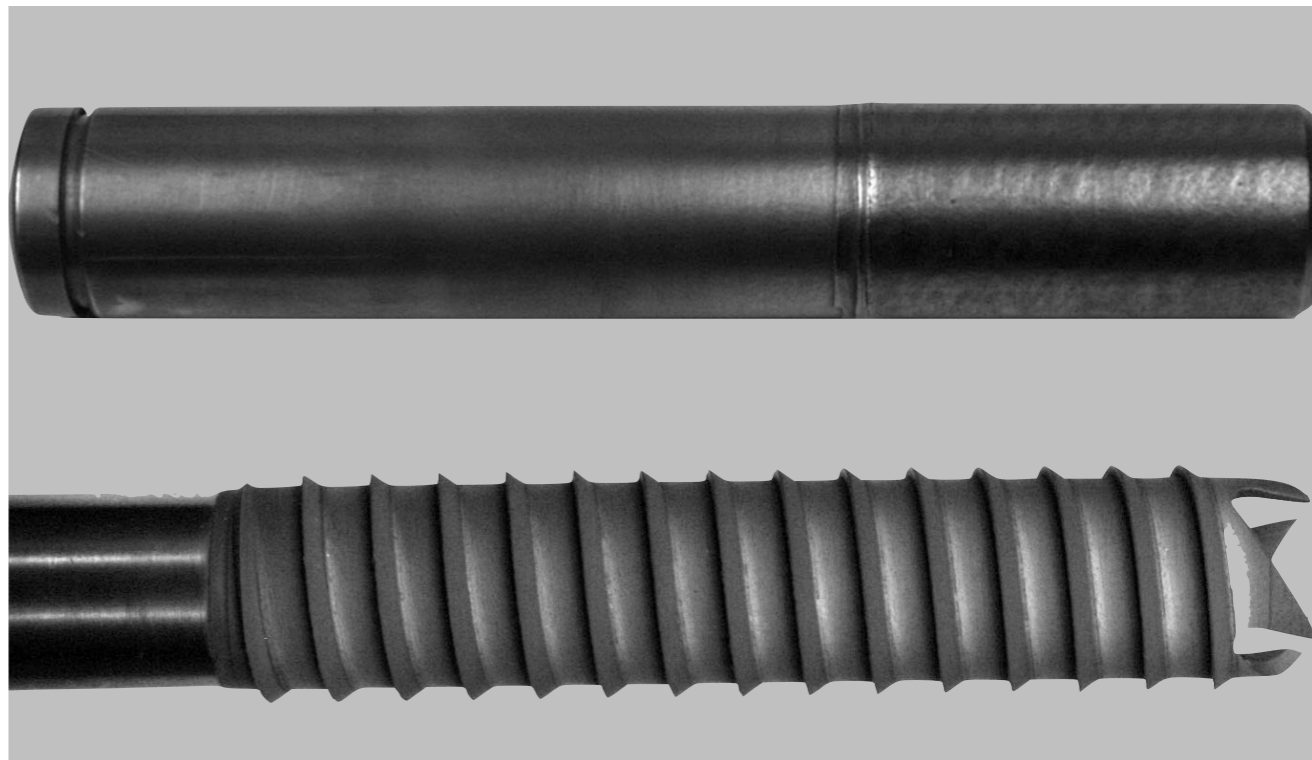


# Low Temperature WC-Co



# WC-Co Microstructure

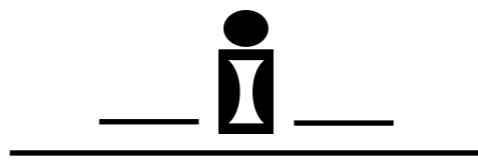




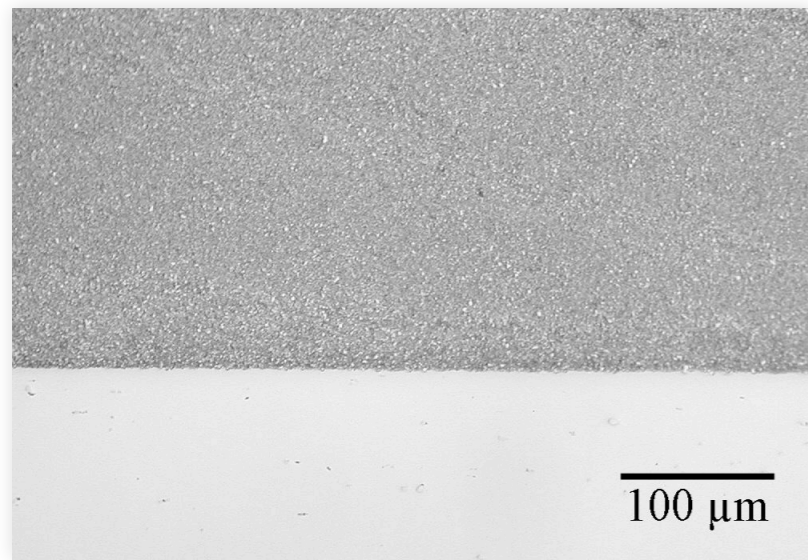
KM1000  
WC-Co Coatings



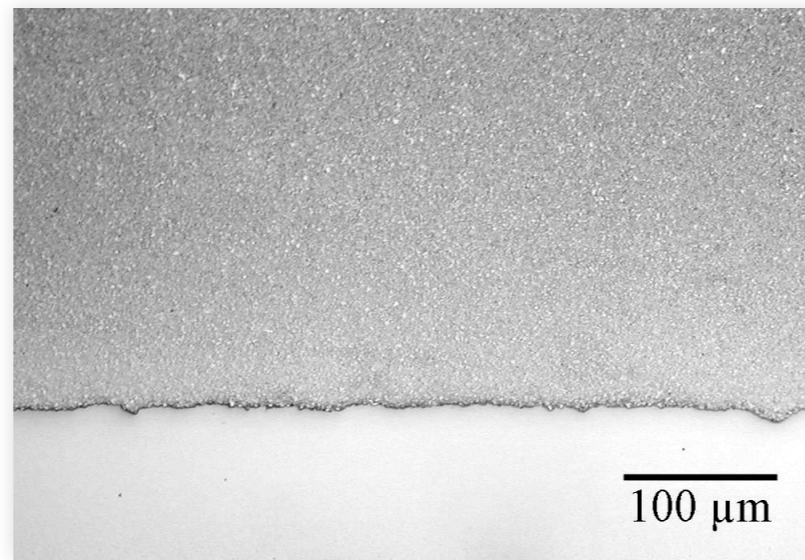
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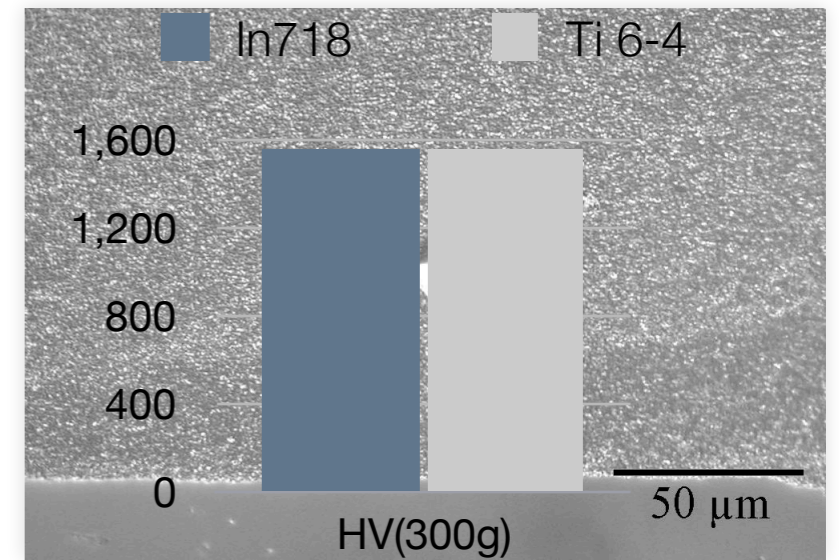
# WC-Co on Aero Alloys



❖ Inconel 718

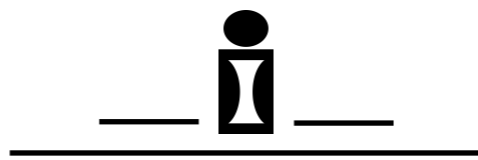


❖ Ti-6-4

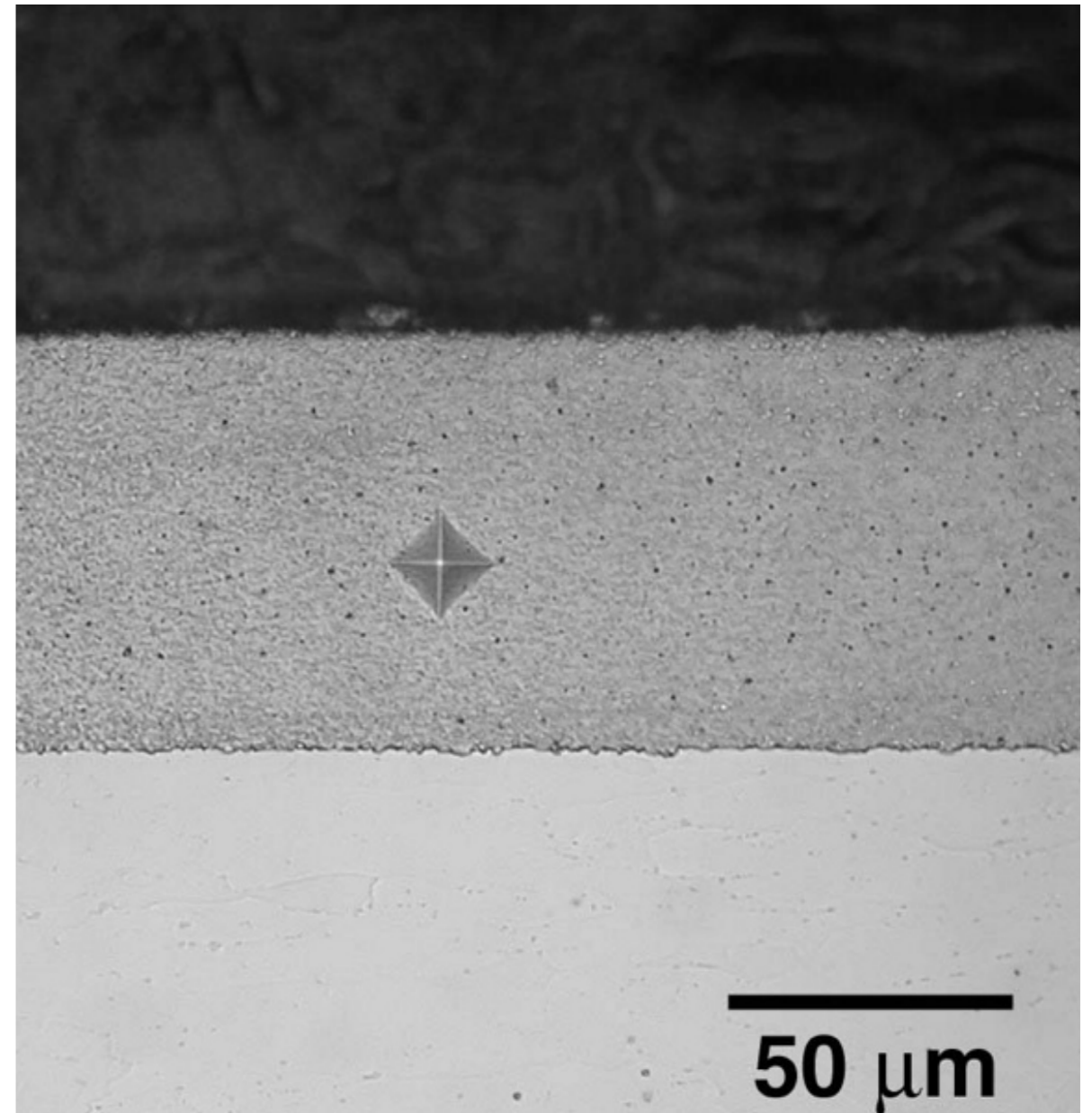
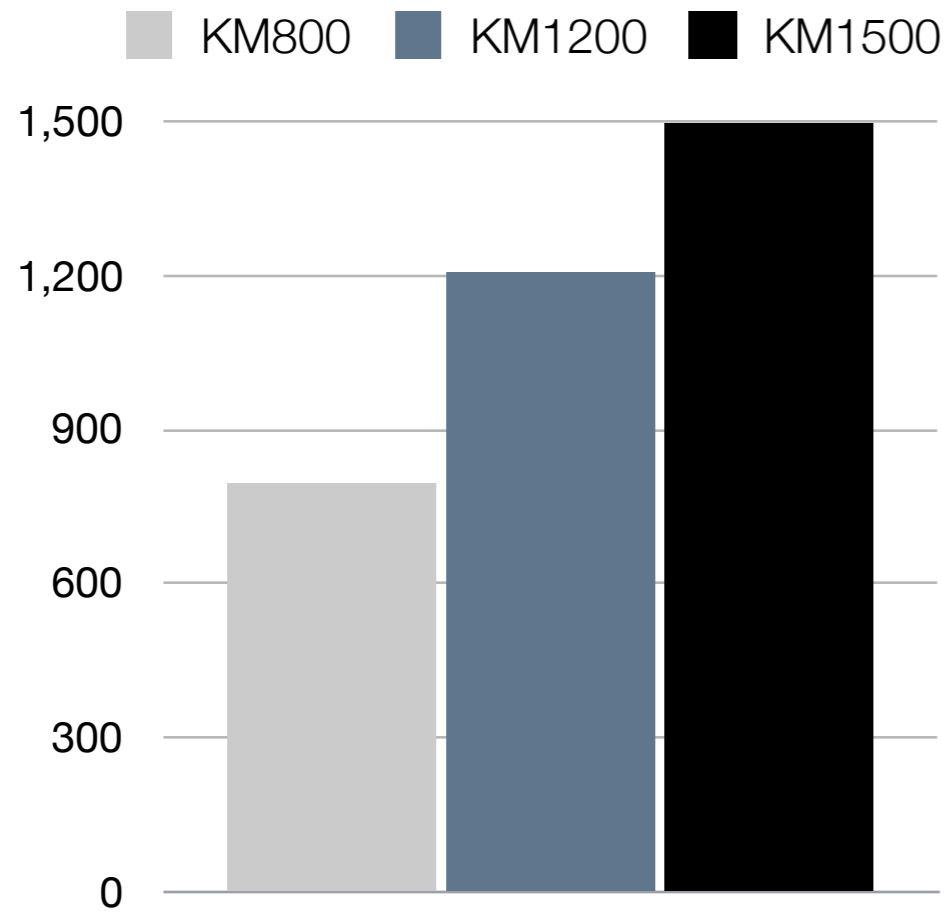


❖ Hardness

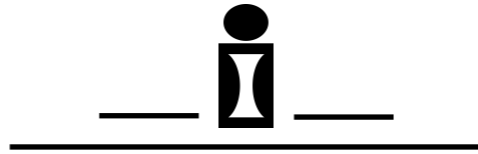




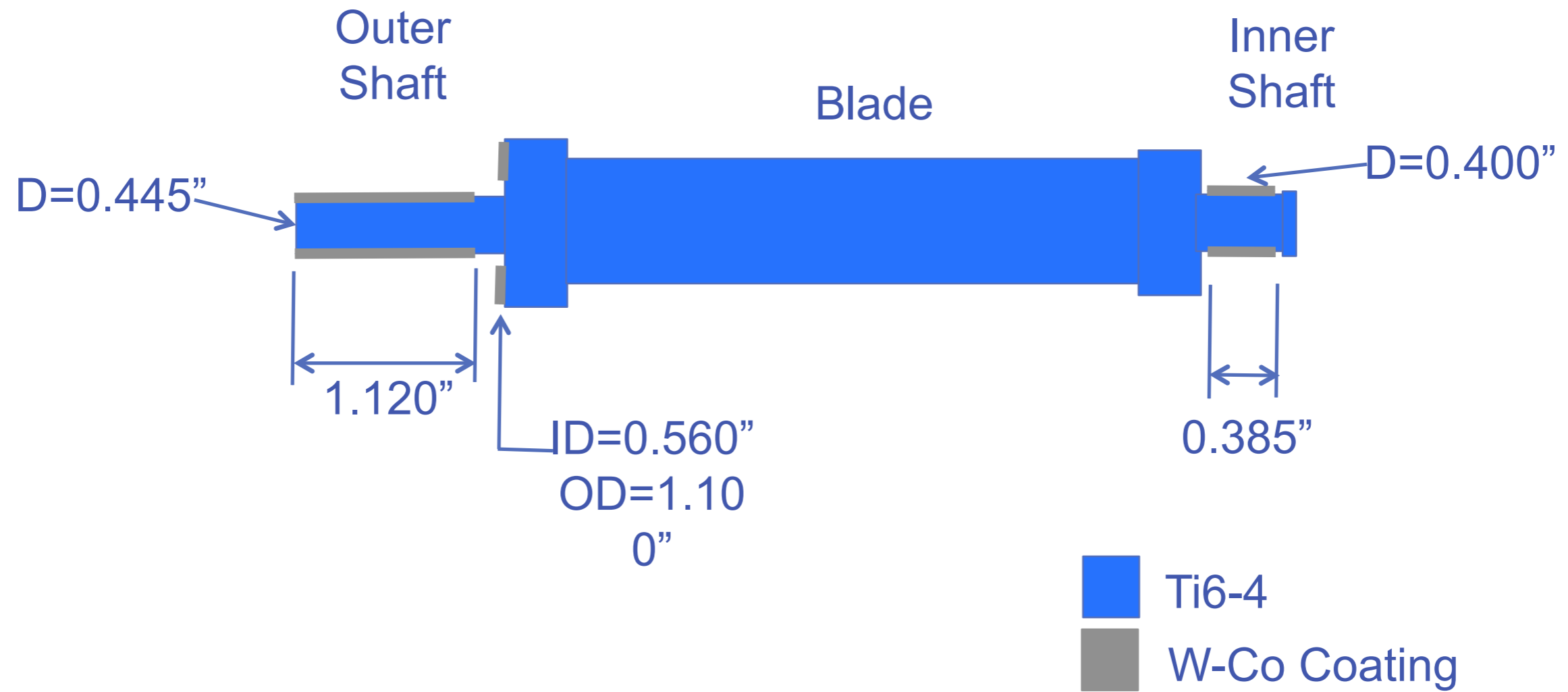
# Tunable Hardness KM WC-Co



HV (300g) = 1495 kg/mm<sup>2</sup>



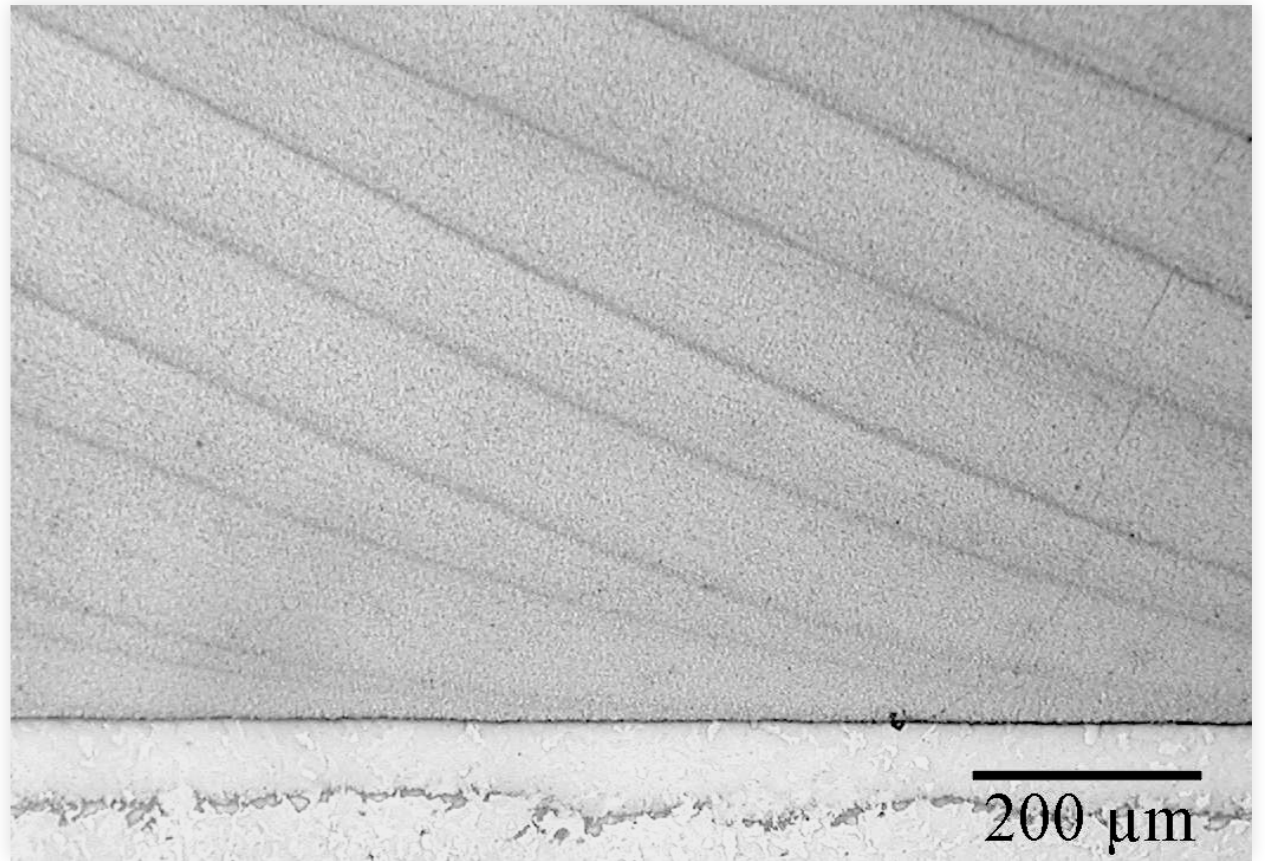
# Stator Coated Surfaces

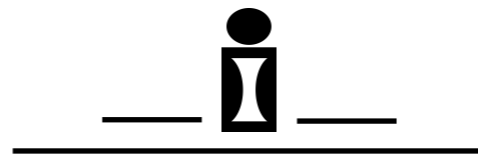




# Next generation KM Coating

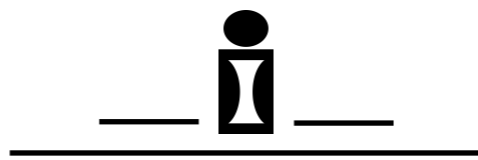
- ❖ Corrosion resistant matrix
- ❖ Corrosion/Wear resistant carbide
- ❖ Layered structure
- ❖ Increased ductility
- ❖ Patent Pending





# F18 Hydraulic Gear Repair

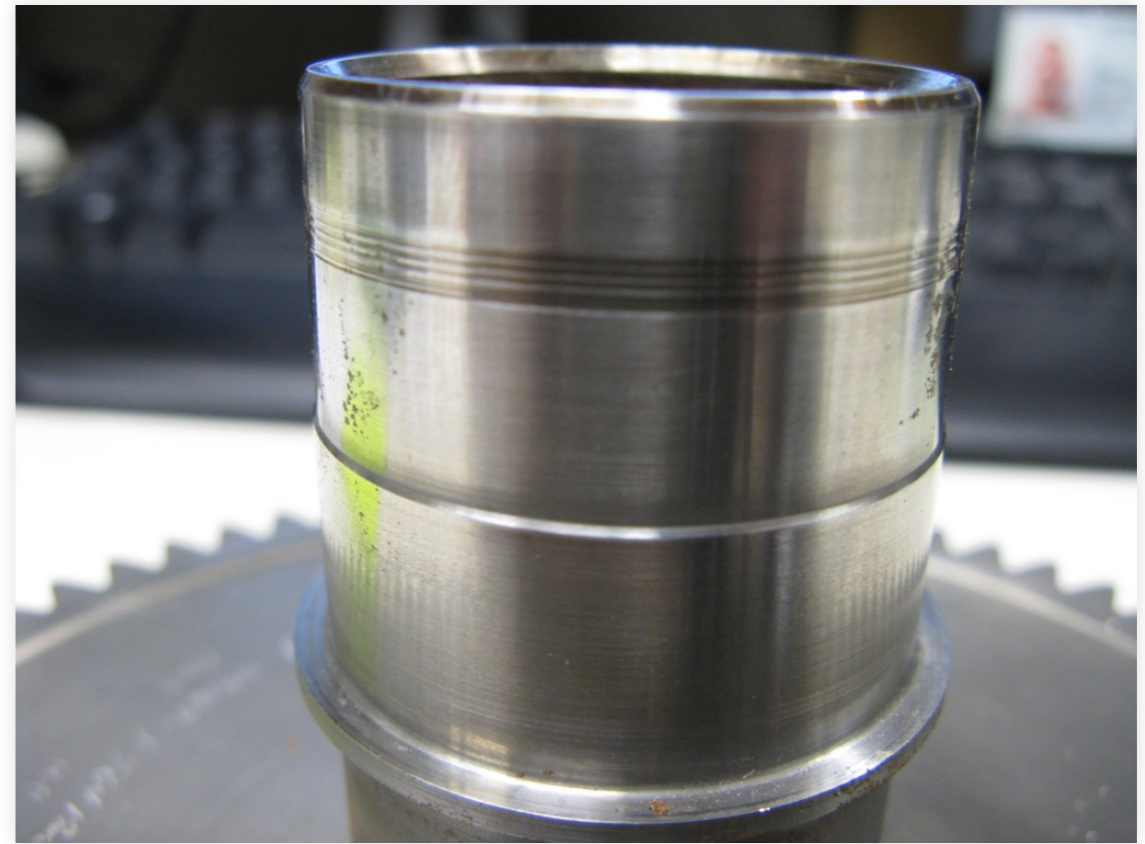




# Wear Groove



❖ 0.005" deep

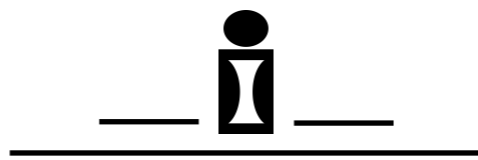


❖ Detail



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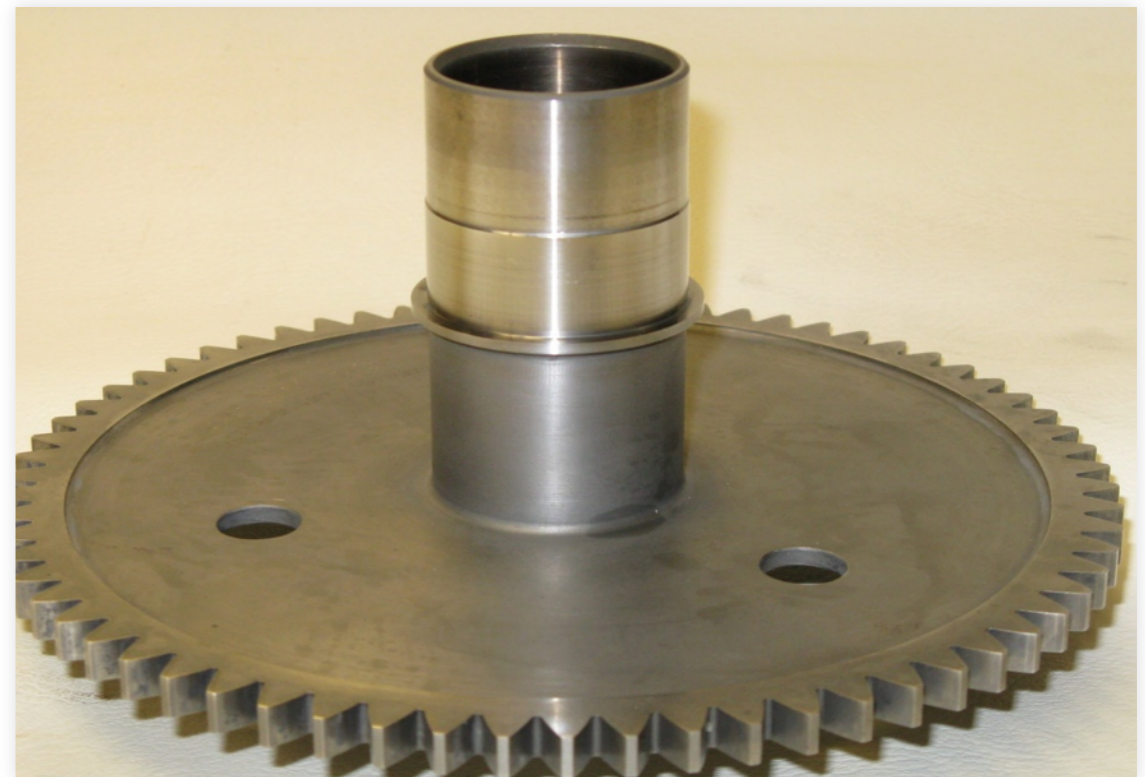




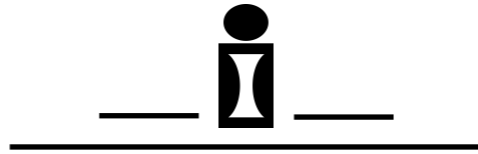
# Better Than New



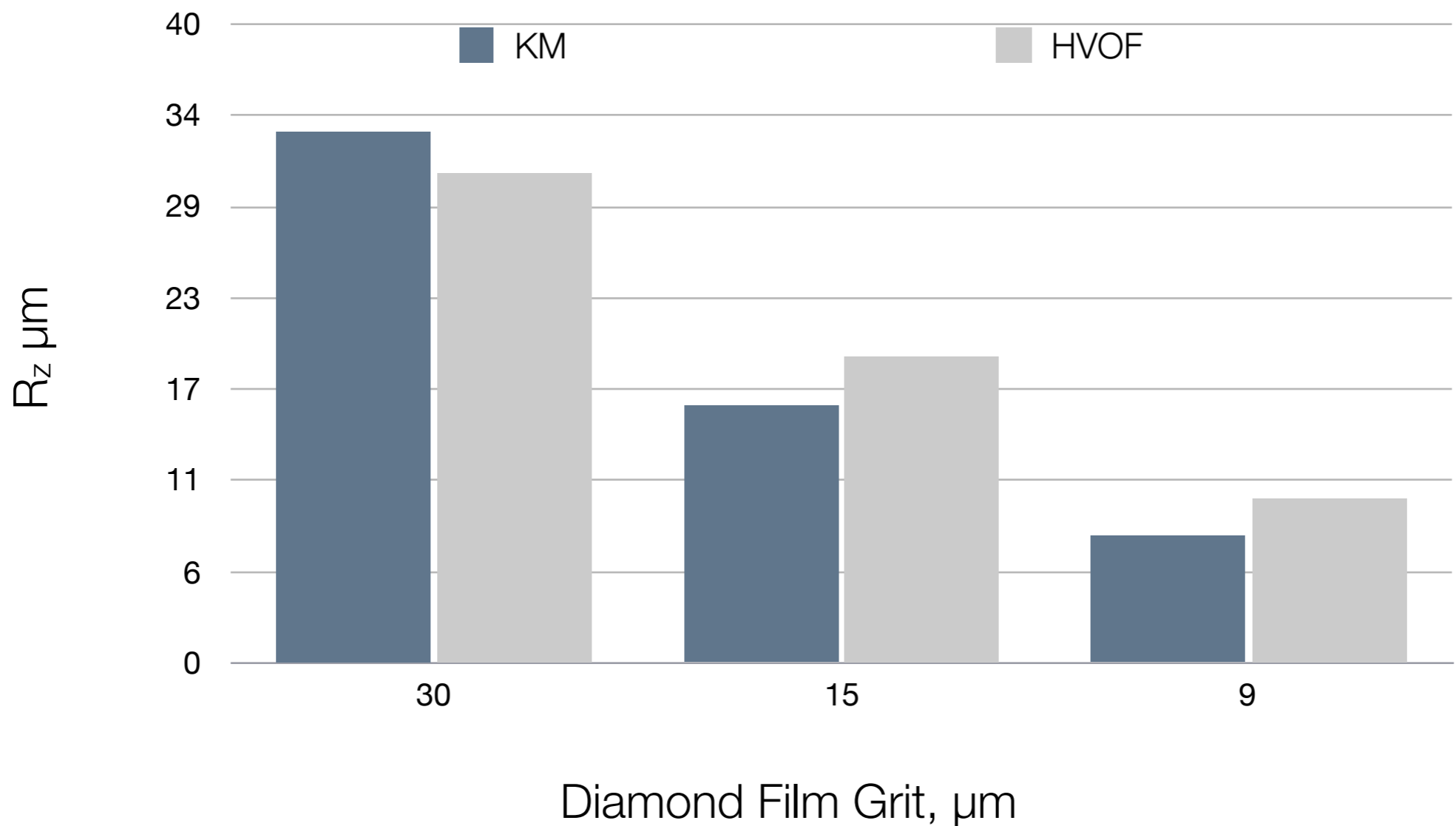
- ❖ 0.05" removed
- ❖ 0.10" sprayed

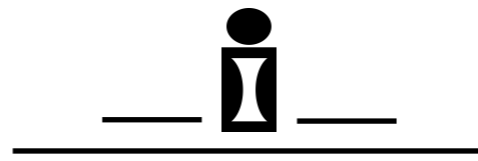


- ❖ WC-Co, Hv = 1,000
- ❖ Rz = 2  $\mu$ m



# 3M Surface Finish Study



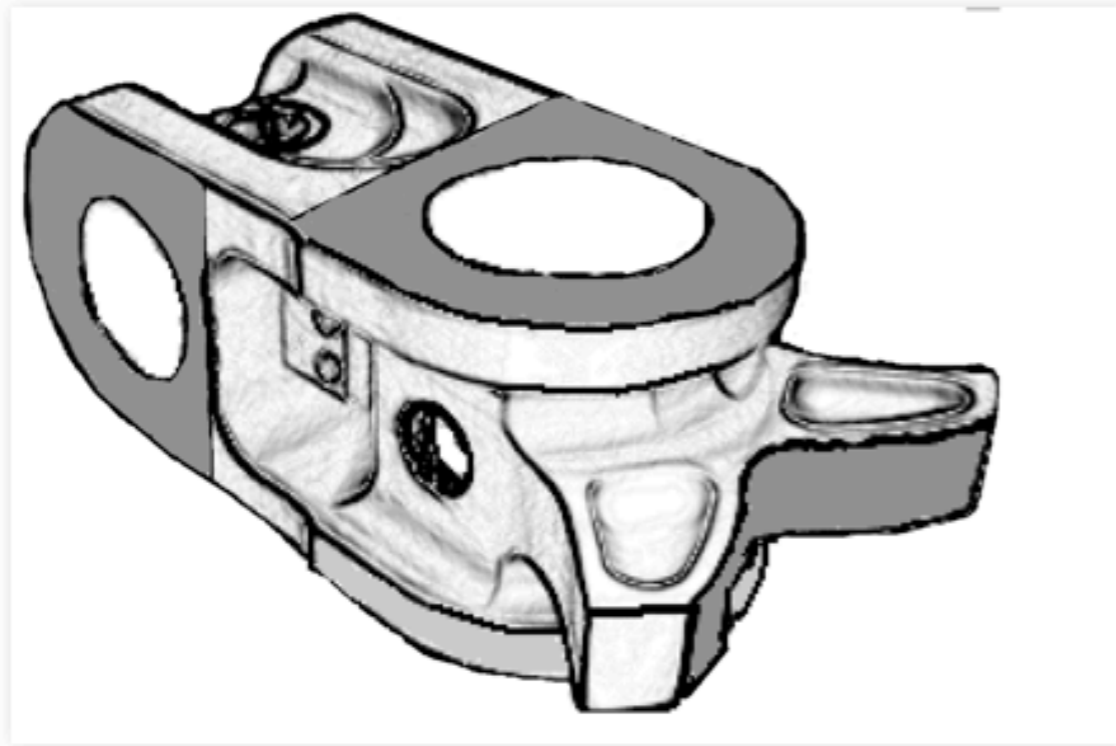


# Tailhook





# F-18 Tailhook Arresting Gear Pivot



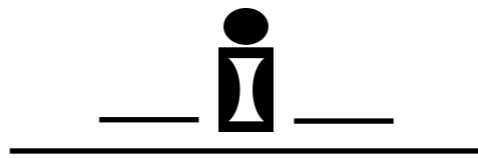
- ❖ WC-Co Coating (shaded)



- ❖ Photo of Arresting Gear Pivot

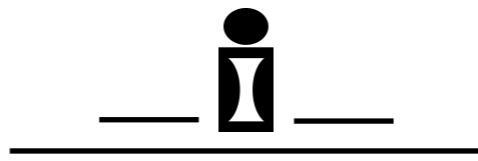




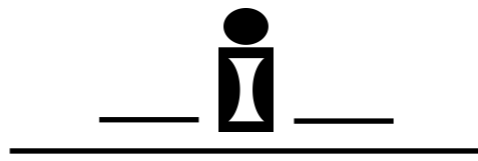


# Trident Trim Pump



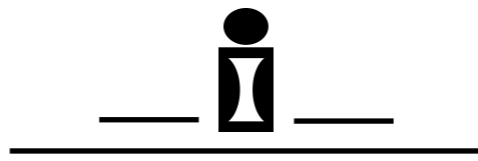


# Rotor



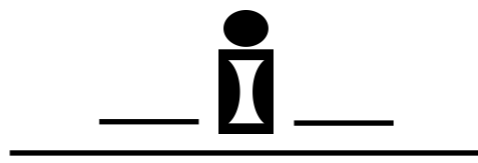
# Cover



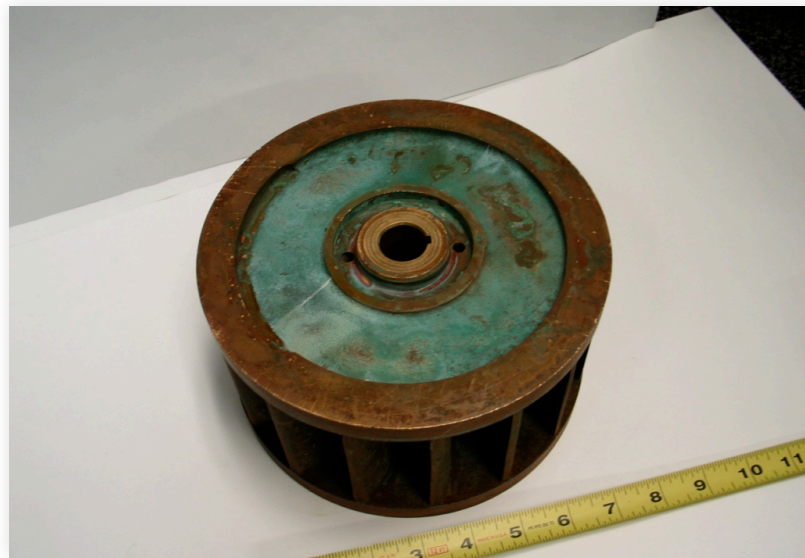


# Case





# Problem

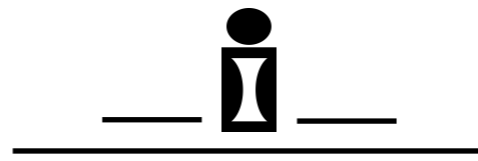


❖ Corrosion

❖ Erosion

❖ Wear

❖ Unobtainable



# F18 E/F

# Generator Shaft

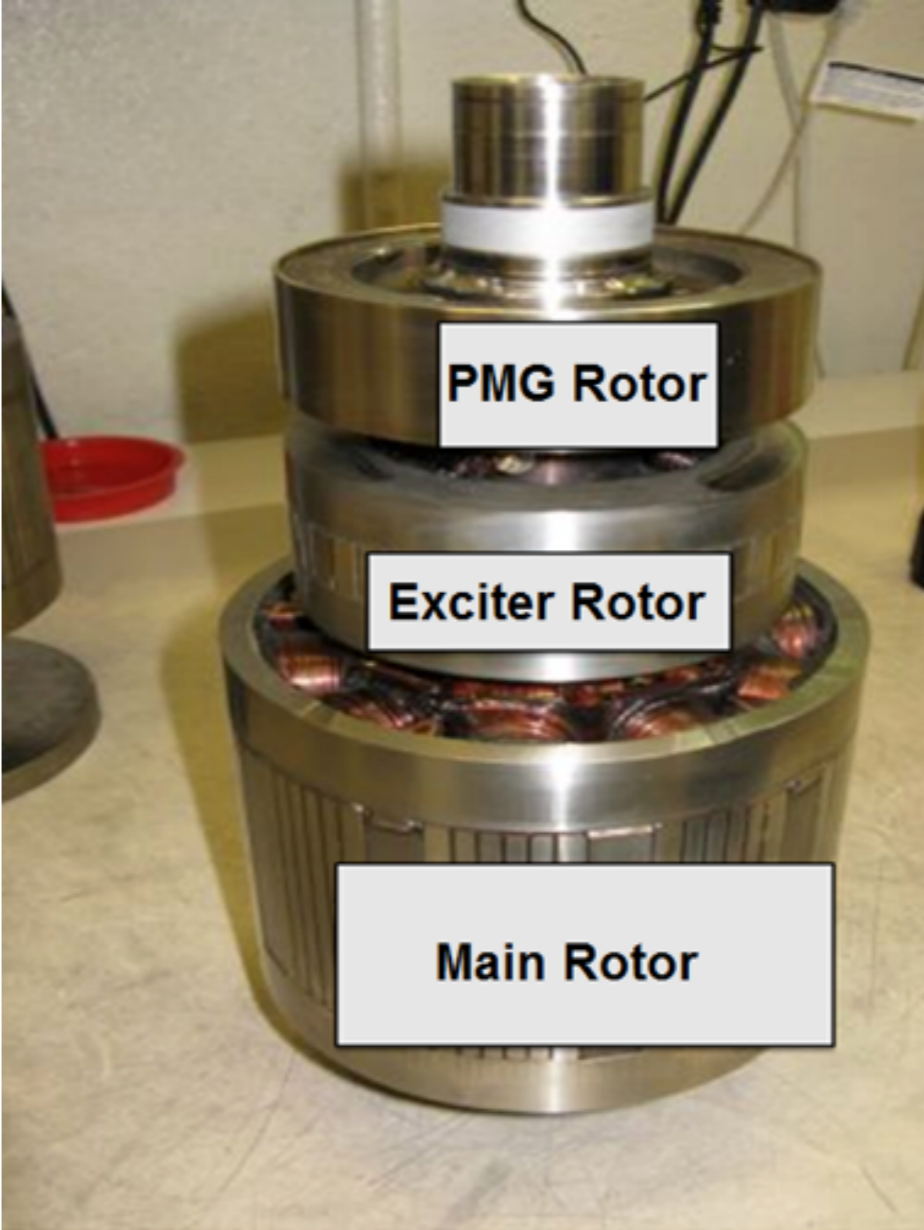


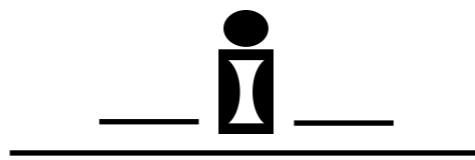


# Damage Areas

- ❖ Top
- ❖ Beneath Permanent Magnetic Group
- ❖ Bottom
- ❖ Journal Bearing Area





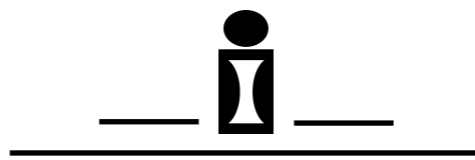


# Journal Damage

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



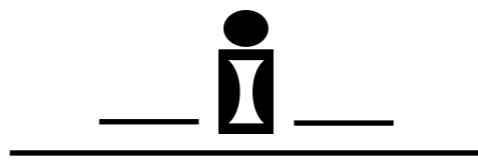




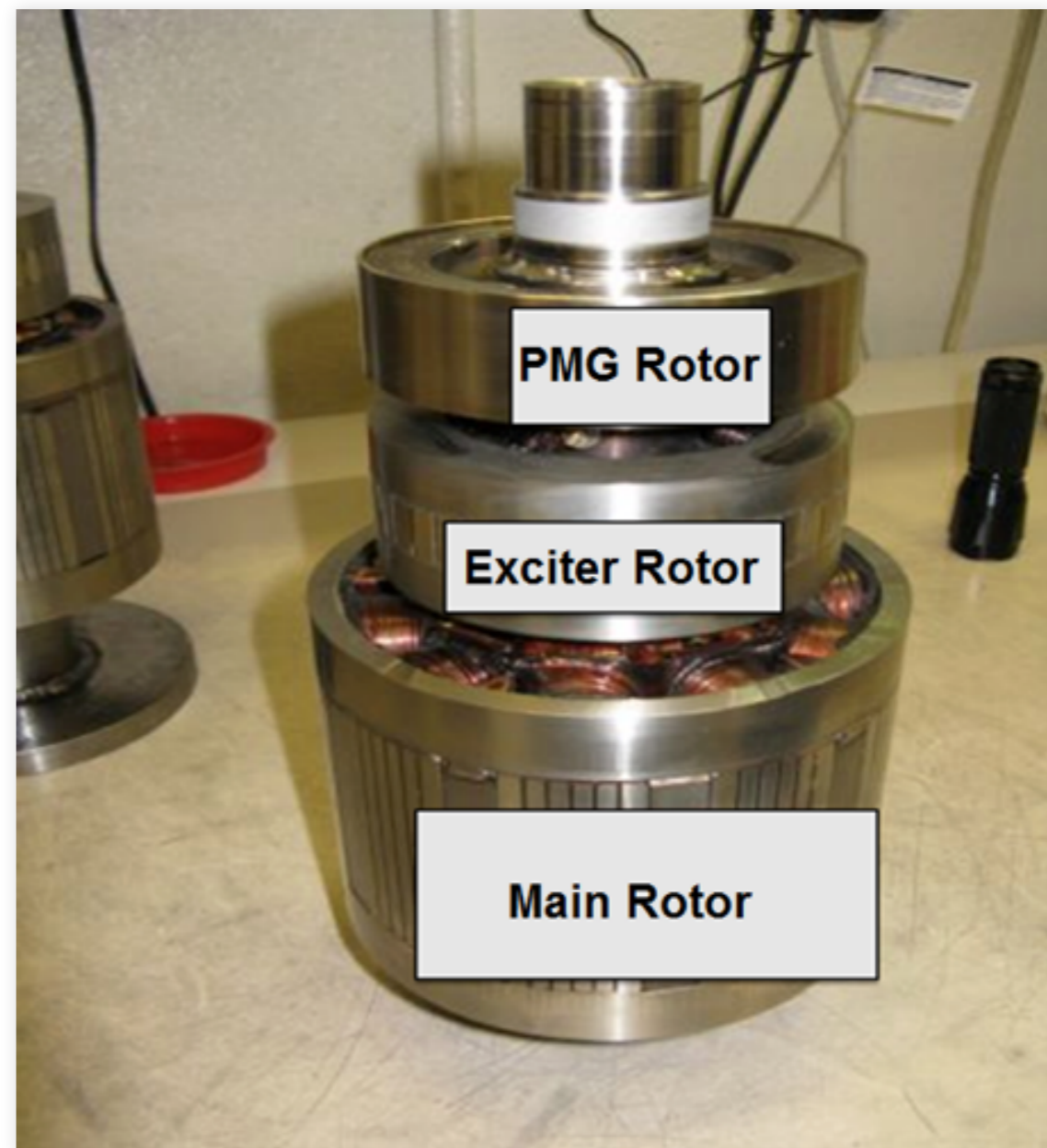
# Antidrive End

- ❖ PMG removal damage
- ❖ Diminutional restoration



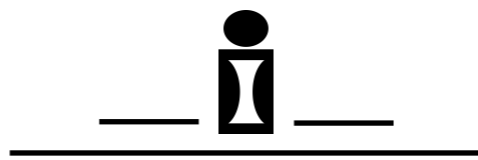


  
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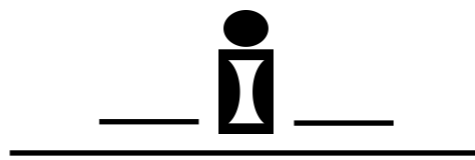
# Journal Bearing Area



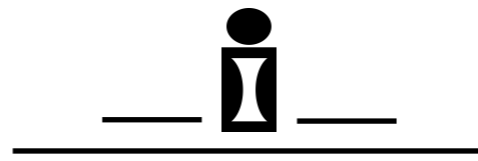
❖ Drive end detail



❖ Bearing



# Journal Damage



# AMAD Gearbox

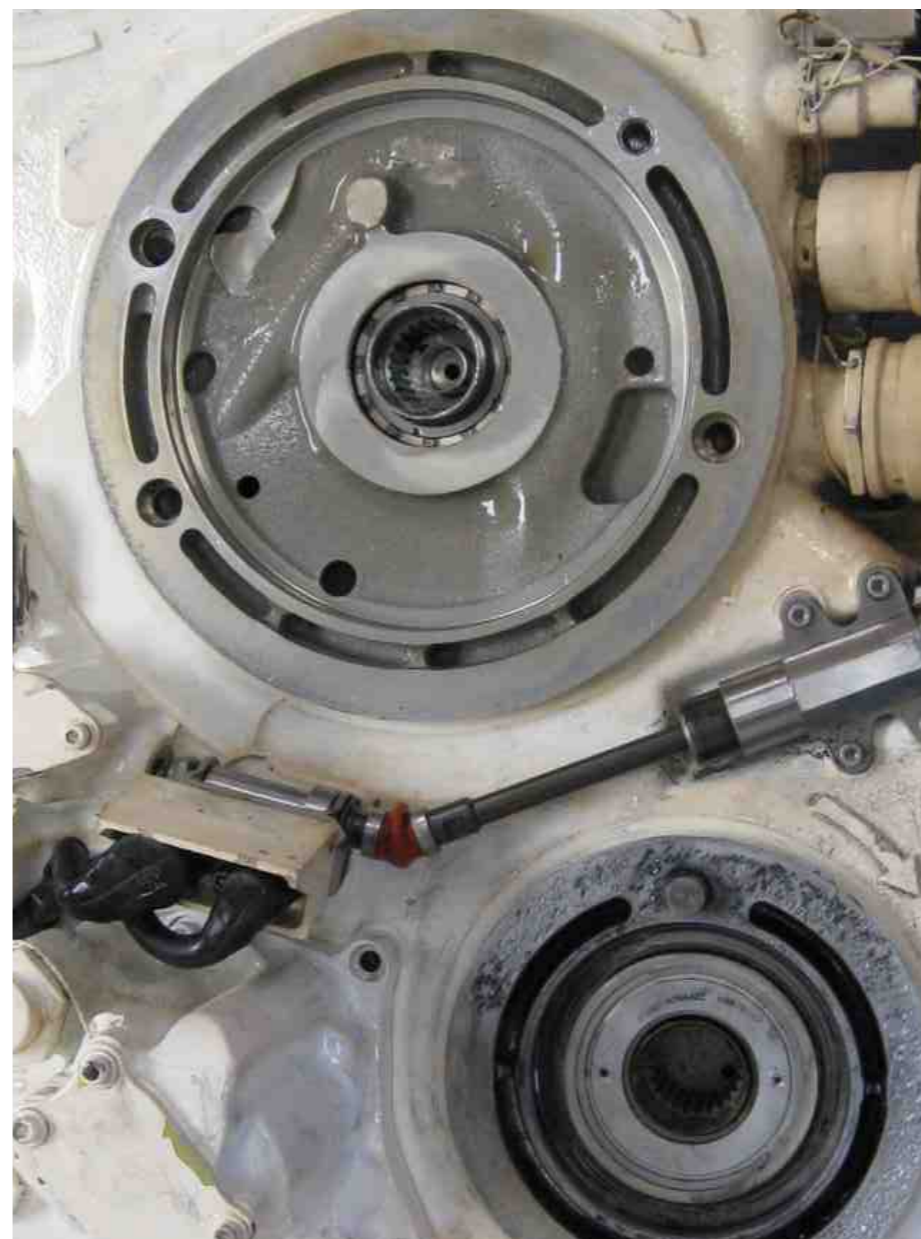




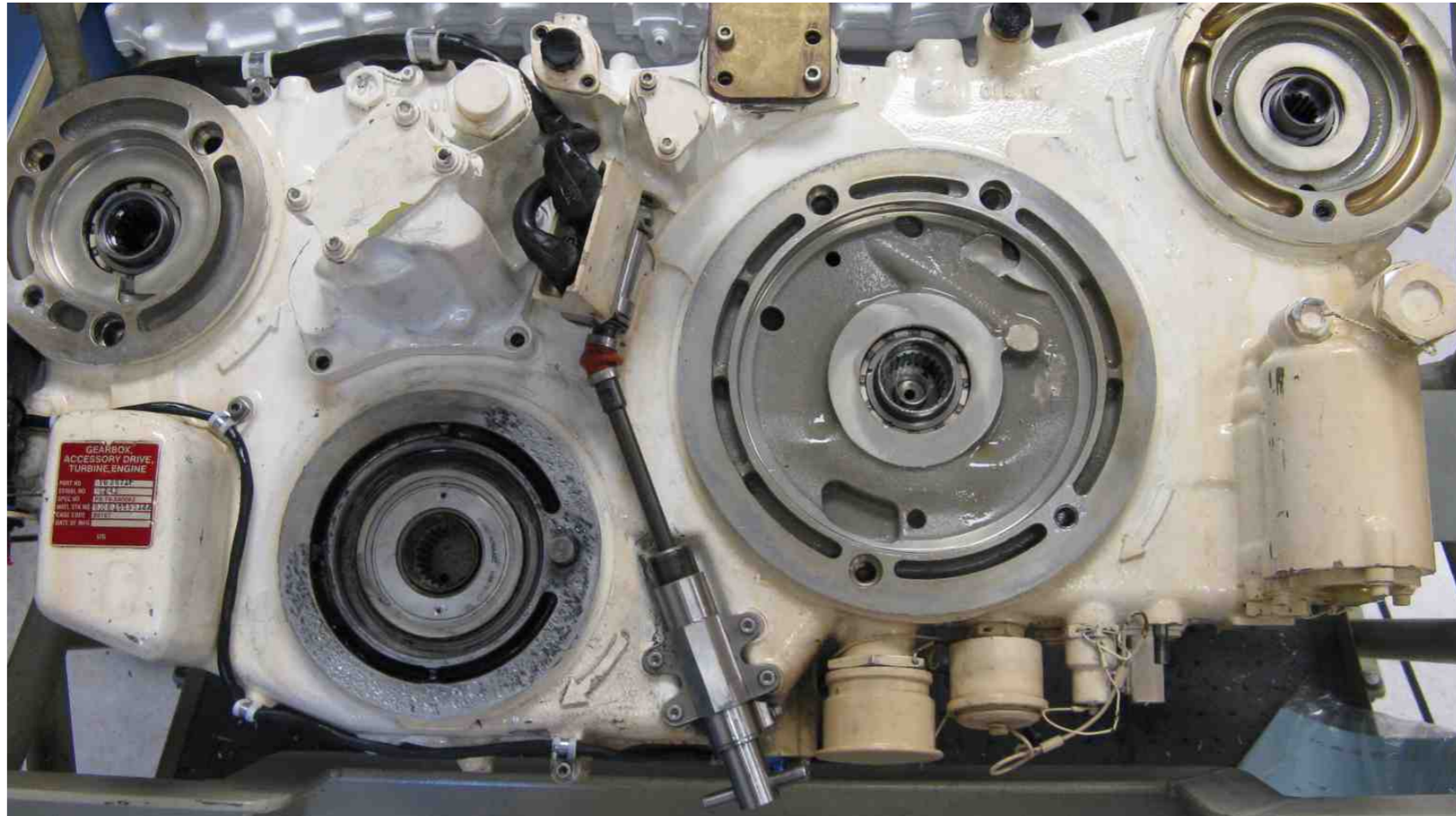


# High Value

❖ Damage Occures



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# Fretting Hydraulic Pad



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# Fretting Hydraulic Pad



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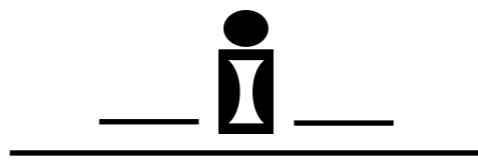




# KM Repair



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# Machined



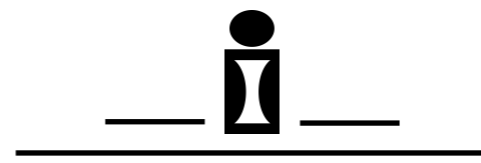


# Finished



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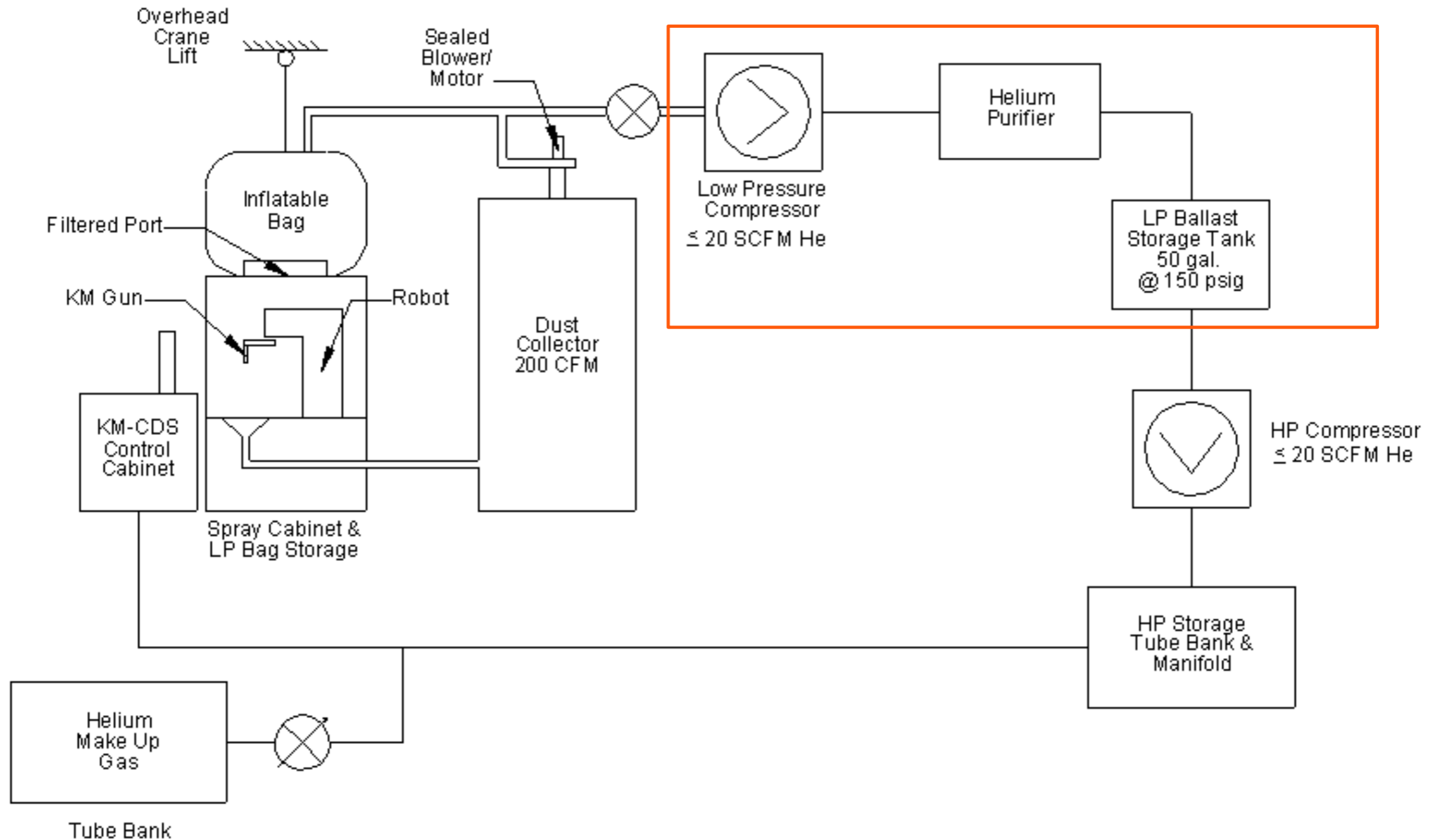


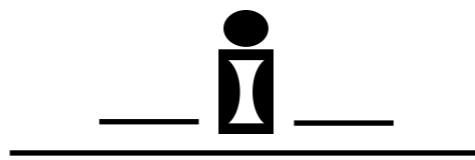
# KM Carbide Coatings

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



# Helium Recycle





# KM He Recycle

❖ Capital Cost

❖ \$250K

❖ Footprint

❖ 6' X 3'

❖ He Cost Reduction

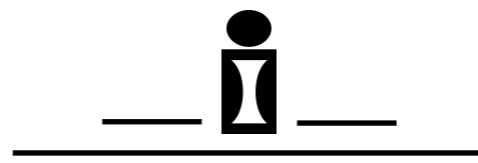
❖ at today's cost

❖ factor of 4

❖ Purity

❖ 99.9%





# Acquisition Cost

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