Kinetic Metallization

Joining and Repair of Titanium Aircraft Structures

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Overview

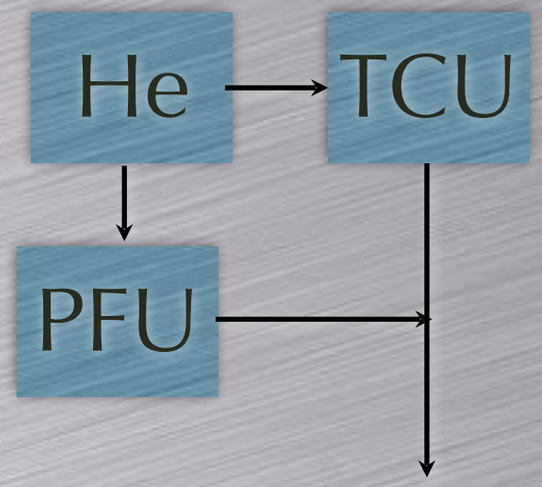
- Introduction to Kinetic Metallization
- Applications
- Powder Selection
- Coating Microstructure
  - CP Ti
  - Ti-6-4
- Coating Properties
  - Density
  - Oxygen content

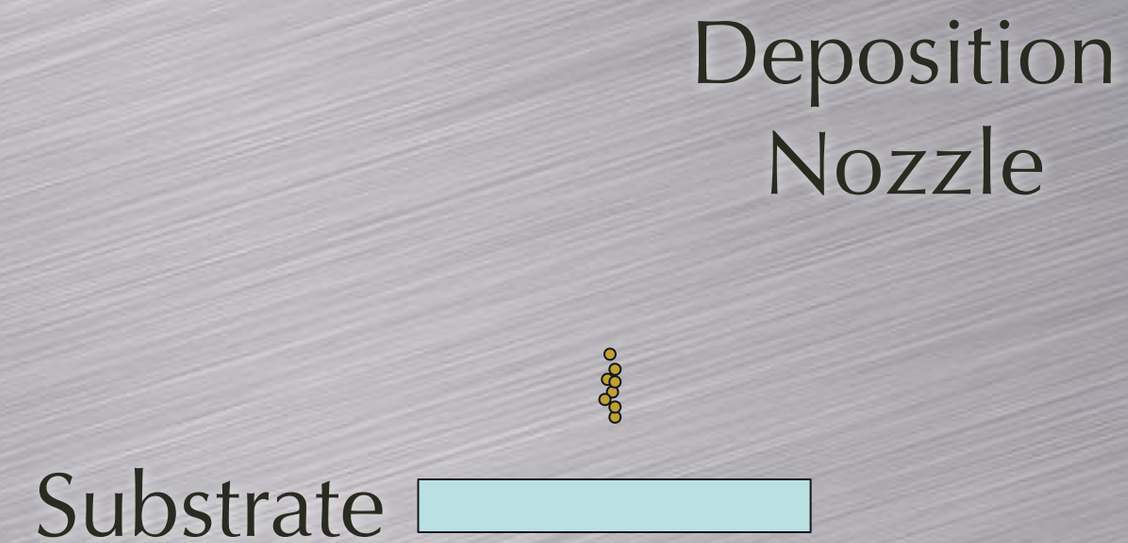
Kinetic Metallization

- Impact Consolidation Process
  - Feed-stock: fine powder
  - Accelerant: inert light gas
- Solid-state Consolidation
  - No Bulk Melting
  - No Liquid Chemicals
- Environmentally Innocuous
  - No Particle or Hazardous Gas Emission

KM Process Flow

- Powder fluidized using pressurized He gas (PFU)
- Powder/gas mix thermally conditioned to improve deposition efficiency (TCU)
- Deposition nozzle produces highly collimated spray pattern
  - Area coverage using X-Y rastering of nozzle and/or rotation of substrate





KM–CDS

First KM-CDS Shipped!!
Buyer: US Naval Academy
Located: NAVSEA-Carderock

- Coating Development System
- Desk sized
- Production unit
  - Same footprint
  - Remove spray enclosure

KM Applications

- Aerospace
  - Repair of titanium aircraft structures
  - Repair of titanium airfoil blades
  - Near-net shape structural reinforcements
- Medical
  - Biocompatible coatings
- Corrosion resistant coatings
- Energetic materials

KM Advantages

- KM vs. Weld Repairs
  - Eliminates:
    - Thermal distortion
    - Heat affected zone
    - Degradation of parent material processes
- KM vs. Thermal Spray
  - Eliminates:
    - Thermal distortion
    - Grit blasting surface preparation
    - Oxide inclusions and oxygen pickup
    - Explosive gases

Repairs & Joining Process

- Spray Forming
  - Fillet repairs
    - Dings & scratches
    - Fill small holes and crack grooves
    - Plug insert with perimeter fill
    - Thin backing plate
  - Joining techniques
    - Add gussets with fillet joining
    - Spray form small structures
    - Replace welding techniques

CP Ti Powders

- Titanium sponge fines (Hunter process)

-100 mesh
(-150 microns)

-325 mesh
(-45 microns)

-500 mesh
(-25 microns)

KM CP Ti Coatings

- Titanium sponge fines (Hunter process)

-100 mesh
(-150 microns)

-325 mesh
(-45 microns)

-500 mesh
(-25 microns)

KM CP Ti Coatings

- Significant deformation of CP Ti particles observed during particle impact

-500 mesh (-25 micron)

KM Coating Density

- KM CP Ti coating density increases with decreasing particle size
  - Oxygen content has secondary effect

Ti-6-4 Powder

- Spherical Ti-6-4 (Inert gas atomized)

-500 mesh
(-25 micron)

KM Ti-6-4 Coatings

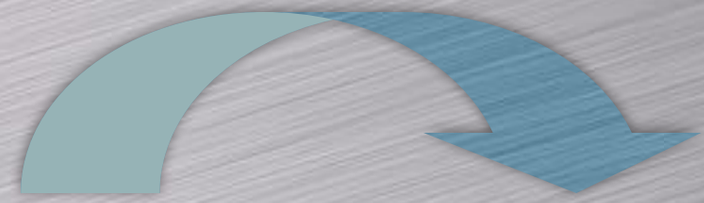
- Spherical Ti-6-4 powder (Inert gas atomized)

Increasing Gas Temperature

Increasing Gas Temperature

+

Reduced Particle Size



Summary

- **Kinetic Metallization** can achieve >99% dense CP Ti and Ti-6-4 coatings
  - Coating density is determined primarily by particle size and particle velocity
- **Kinetic Metallization** is the only powder spray process that can produce high density coatings without increasing oxygen content

Future Work

- Measure mechanical properties of KM CP Ti and Ti-6-4 coatings
  - Tensile
  - Fatigue
- Measure joint strength between KM CP Ti and Ti-6-4 coatings and substrate