WC/10Co/4Cr Thermal Spray Powder...Beyond the chemistry

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2nd Advanced Coating Symposium “Oil and Gas”
The Woodlands, TX 9-11 October 2018
Part of the Fisher Barton Group

• Ten manufacturers developing and delivering innovative products
• 1,000+ employees
• Technology and innovation driven
• Group-wide Technology Center driving innovation and product development
• Manufacturing thermal spray powders in Houston since 1969
• ISO 9001: 2015 & AS 9100D: 2016 certified
• Several aero certified powders
• Ability to make small batches
• Powder development
- Blenders
- High temperature sintering furnace
- Crushing equipment
- Screening equipment
- Air classification
- Quality control lab
- ASTM B822 (Microtrac S3500)
- ASTM B212 (Apparent density)
- ASTM B213 (Flow rate)
- ASTM B214 (Sieve analysis)
- Chemistry → Outside labs.
Tungsten and chrome carbide powders

- Sintered and crushed
- Agglomerated & sintered
- Blended powders
  - 88 WC / 12 Co
  - 88 (W$_2$C/WC) / 12 Co
  - 83 WC / 17 Co
  - 86 WC / 10 Co / 4 Cr
  - 86 (W$_2$C/WC) / 10 Co / 4 Cr
  - 90 (W$_2$C/WC) / 10 Ni
  - 75 Cr3C2 / 25 NiCr
  - 80 Cr3C2 / 20 NiCr
  - WC / 20 Cr3C2 / 7Ni
Ni/Fe - Aluminum Powders

- Buildup / Bond Coat
- Al clad powders

- Ni 5Al
- Ni 8Cr 7Al 5Mo 5Fe
- Ni 18.5Cr 6Al
- Fe 35Ni 6Al
- Fe 30Ni 6Al 6Mo
WC/10Co/4Cr Thermal Spray Powder...Beyond the chemistry

- Coating with D-Gun then HVOF
- Hard Chrome Alternative Team (HCAT)

- Aerospace (motor components, landing gear)
- Mining (Hyd. Cyl. Struts and lifting)
- Paper (rolls, blades)
- Oil and Gas (valves, seats, compressors, down hole motors...
Coating Properties
Application Process
Process Parameters
Materials
Component life cycle
Qualification
QC

**HCAT**: Extensive Coating study

- Hardness, Adhesion, corrosion, microstructure, residual stress, mechanical fatigue, impact, H embrittlement, substrate Temp
- DJ 2600, JP-5000 original equipment tested due to commercial availability. Also APS
- Combustion gas flow, stoichiometry, Carrier gas, deposit rate, travel speed, spray distance, nozzle...
- Chemistry, powder size...
- OEM (Boeing, PWA, GE, Bombardier, Goodrich...)
- SAE (AMS 2447, 2448, 7879, 7880, 7881, 7882)
- microstructure, hardness, Almen, substrate temperature, deposit rate.
WC/10Co/4Cr Thermal Spray Powder…Beyond the chemistry

• HCAT and following specification were the beginning...
• Process and applications have increased tremendously
  - Equipment manufacturers, models, performances, fuel-gas
  - “newer” processes, HVAF, ID coating,
  - Coating thickness, corrosion media, erosion, abrasion, recycling

• Powder specifications very “loose” vs coating spec.
  - Spec mostly address chemistry and sizing, sometimes morphology
  - Specification qualifies coating + powder and sometimes component.
Agglomerated Sintered Powder

RM Blending
Slurry
Spray Drying
Sintering
Deagglomeration
Size classification

Powder Particle Size

WC Grain

d1
d2
d3
d
Crushed Sintered Powder

- RM Blending
- Sintering
- Crushing
- Fine crushing
- Size classification

Powder Particle Size

WC Grain
Beyond the Chemistry

SEM + Cr EDS map
Segregation and Seeding
WC/10Co/4Cr - PSD and Apparent Density

Bimodal PSD

monomodal PSD

AD powder
Smaller powder size + smaller WC particles HVAF

- HVAF, HVAF ID, HVOF ID
- Need powders with small PSD (5-25µm, 5-15µm, 5-10µm)
- Crushed sintered powder
- Smaller WC (1 µm av)
- Remain economic
- Repeatable quality
Smaller powder size + smaller WC particles HVAF

LA-3387F Crushed  Aggl Sintered

ASTM G65 (proc A / 6,000 rev)

<table>
<thead>
<tr>
<th>Method</th>
<th>AVL, mm³</th>
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<tbody>
<tr>
<td>LA-3387F</td>
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<tr>
<td>Aggl Sintered</td>
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Smaller powder size + smaller WC particles HVAF

<table>
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<tr>
<th>Microhardness</th>
<th>LA-3387-F HVAF (crushed Sintered) 5-15 µm</th>
<th>Agglomerated Sintered HVAF (5-25 µm)</th>
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Smaller powder size + smaller WC particles HVAF

LA-3387F Crushed

Aggl Sintered
Smaller powder size + smaller WC particles

WC RM <1µm as received

WC RM <1µm after furnace run
• WC/Co/Cr popularity for HCR is increasing
• New equipment and application are opening additional opportunities for those alloys (HVAF, Internal coating, SPS...)
• One spec fits all not possible (coating or powder)
• Powder manufacturer to establish specification
• Large database of testing and field application

• Cost stability of raw material can be a deterrent (Co, W)
• Toxicity of Co