HVAF Flash Carbide As Economical Alternative To Electroplated Hard Chrome

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Problem description:

- During 30 years of development, thermal spray coatings (mainly HVOF) replaced only 5% of Electroplated Hard Chrome (EHC)
- Main reason of EHC still remains in the market is its COST, which is dramatically lower that developed alternatives
- The cost of direct materials used in HVOF coatings is 7 times higher then the cost of chromium in EHC.
- Main developments of EHC alternative were focused on using lower-cost materials and increase of deposition efficiency DE

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Problem description (cont.)

The most economical coating is not the one sprayed with the low-cost material and the highest DE.

It’s the thinnest coating.

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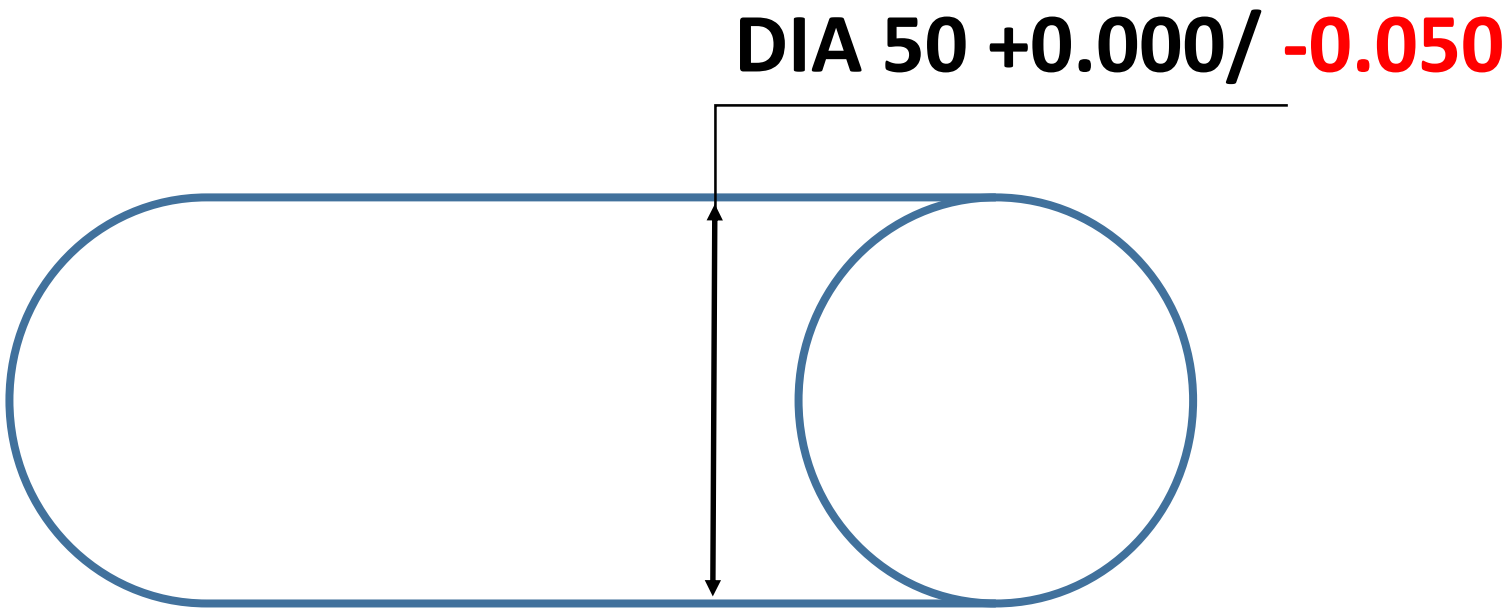
Problem description (cont.)

EHC market is dominated by a very thin coating, known as “Flash Chrome” (15…20 micron)



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Flash Carbide Principles

The WC-10C04Cr HVAF Flash Carbide coating technology is based on the similar to Flash Chrome principles:

- **The part is ground to the lowest tolerance dimension**
- **The coating thickness is comparable to tolerances, set for the final coated part (i.e., 20-25 micron or less)**
- **The coating roughness is low – “ground-like” Ra 1.5-1.7 micron**
- **Such coating does not require dimensional grinding**
- **Polishing to Ra 0.2-0.3 micron removes only 5 micron of “as-sprayed” thickness**

The final cost of Flash Carbide is 1/10 of conventional WC-coating

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Requirements for Flash Carbide:

- Thin WC-10C-4Cr coating (20-25 micron after polishing) must be dense to provide adequate corrosion resistance
- As-sprayed coating roughness must be low enough to avoid the need for grinding (Ra less than 2.0 micron)
- The coating material must not degrade during application (= should not become brittle)
- The technology should be reproducible

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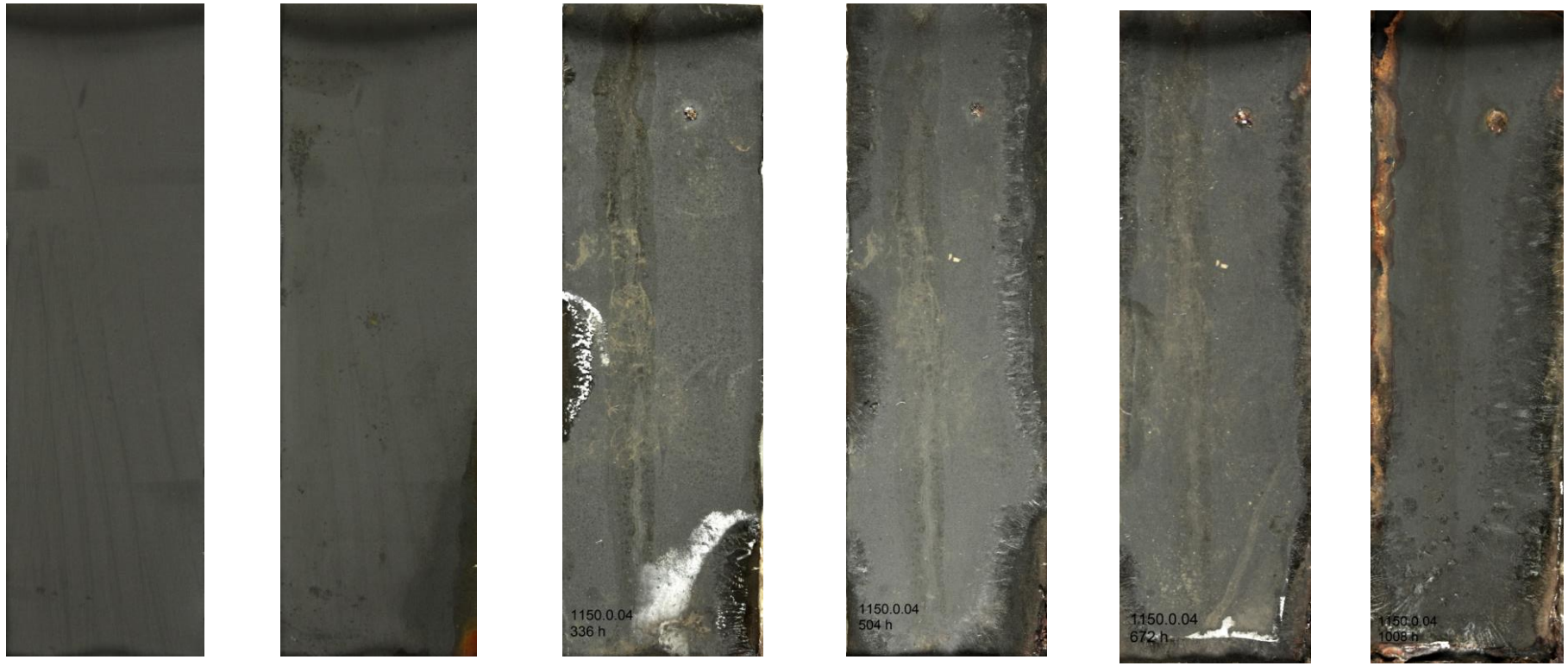
Flash Carbide: ASTM B117 Salt Spray Corrosion Test

AK06 HVAF WC-10Co4Cr: 15 µm (0.0006“) thickness as-sprayed

0 h | 168 h | 336 h | 504 h | 672 h | 1008 h



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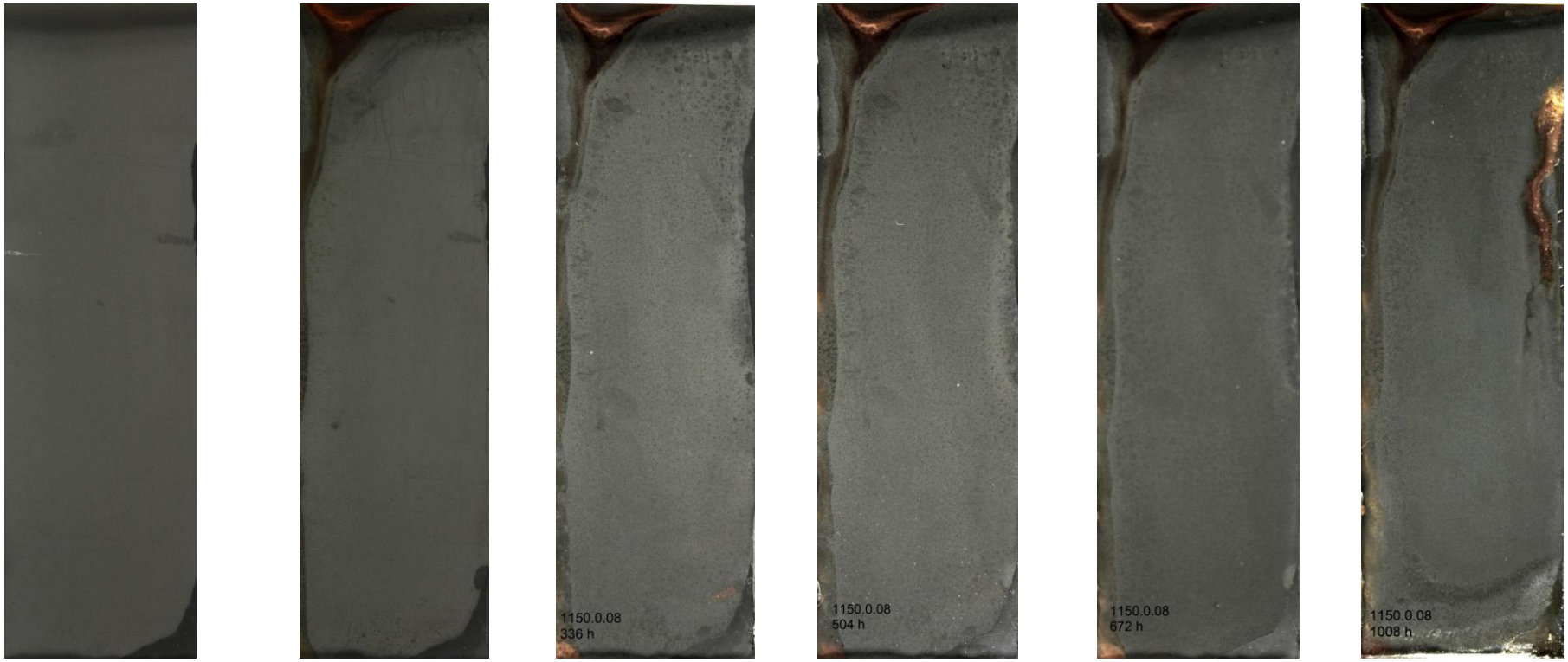
Flash Carbide: ASTM B117 Salt Spray Corrosion Test

AK06 HVAF WC-10Co4Cr: 25 µm (0.0010“) thickness as-sprayed

0 h | 168 h | 336 h | 504 h | 672 h | 1008 h



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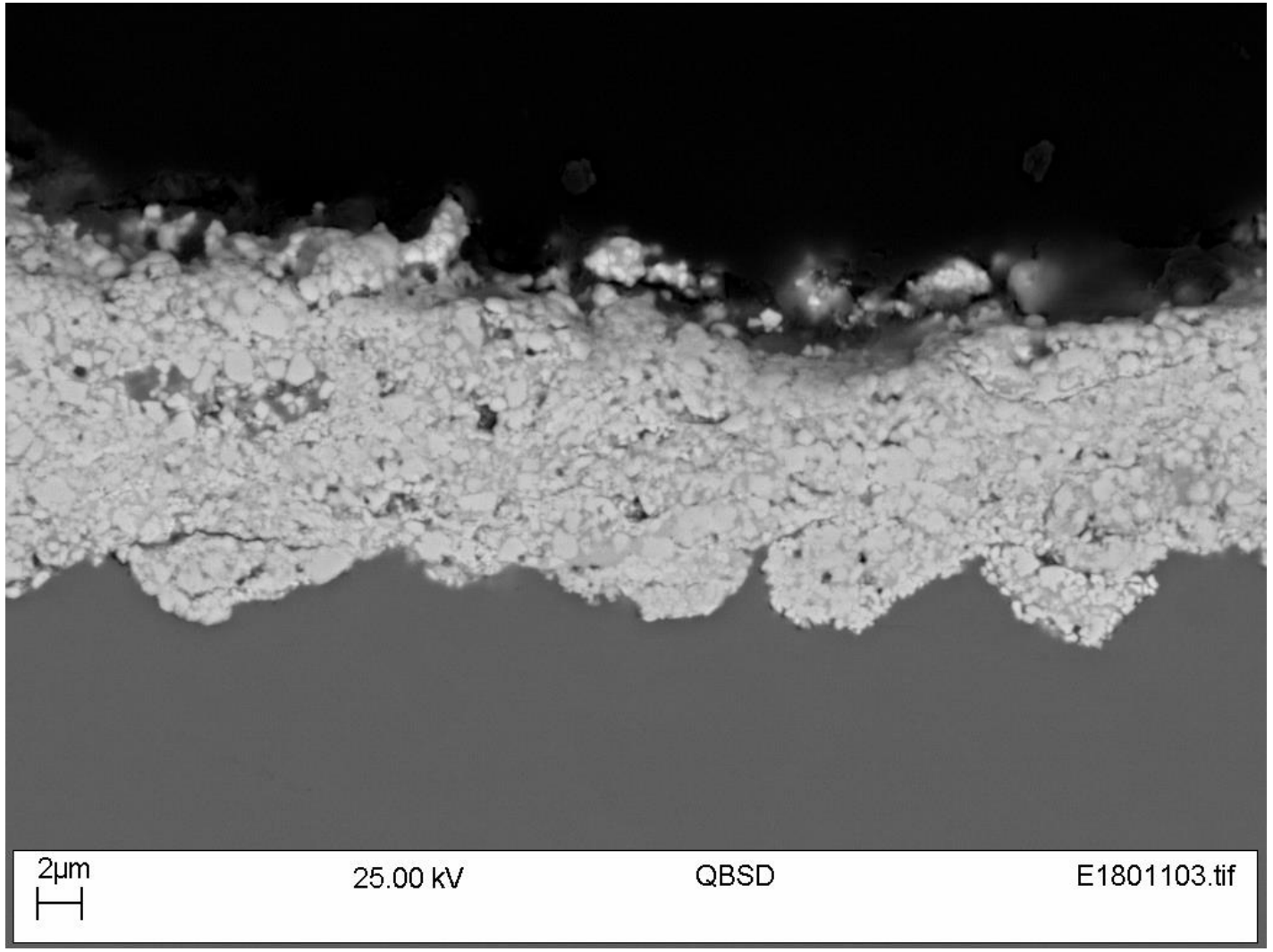
Flash Carbide: ASTM B117 Salt Spray Corrosion Test

AK06 HVAF WC-10Co4Cr: 15-μm Coating micrograph after 1008 hours of test



Mechanical Properties of (Thick) HVAF and HVOF WC-10Co-4Cr Coatings

	HVAF (AK06)	HVOF (JP)	HVOF (JP)
Powder Size (µm)	- 15	25/5	45/15
Spray System	AK06	JP-5000®	JP-5000®
Porosity (%)	<0.5	0.9	0.8
HV_{300}	1444	1250	1180
ASTM G65 m.B (mg)	14	21	18
E-Modulus (GPa)	325	n.d.	n.d.
Cavitation Wear (mg)	1.4	2.8	4.7
Metallic Co (%)	ca. 5.5	(zero)	ca. 4
Ra (µm)	1.5 – 1.8	2.9	5

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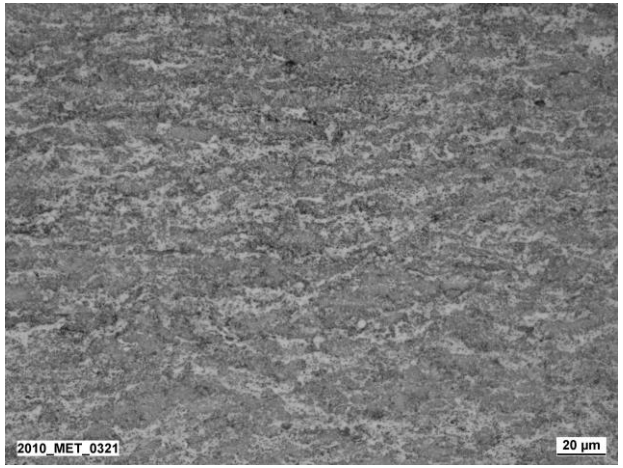
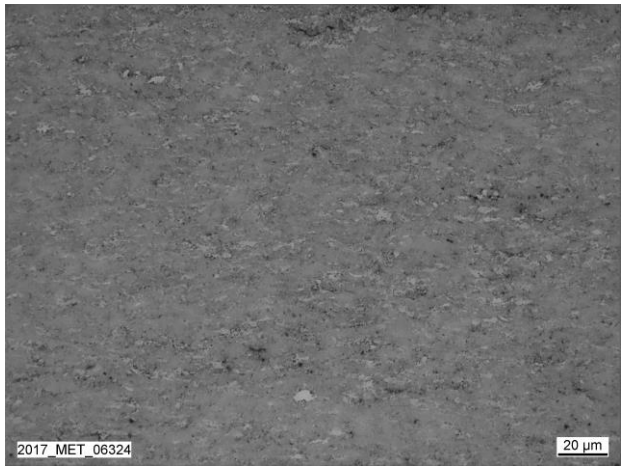
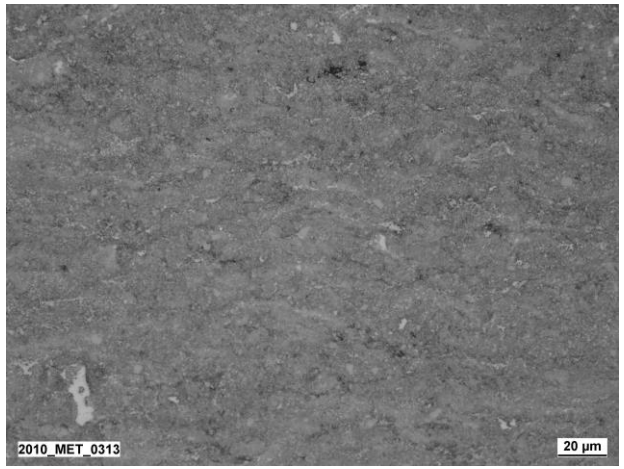
Structure of HVAF and HVOF WC-10Co-4Cr coatings



HVOF, 25/5µm. Bright: eta phase



HVAF. Cermet structure with few eta phase



HVOF, 45/15µm. Less eta phase, cermet structure still visible

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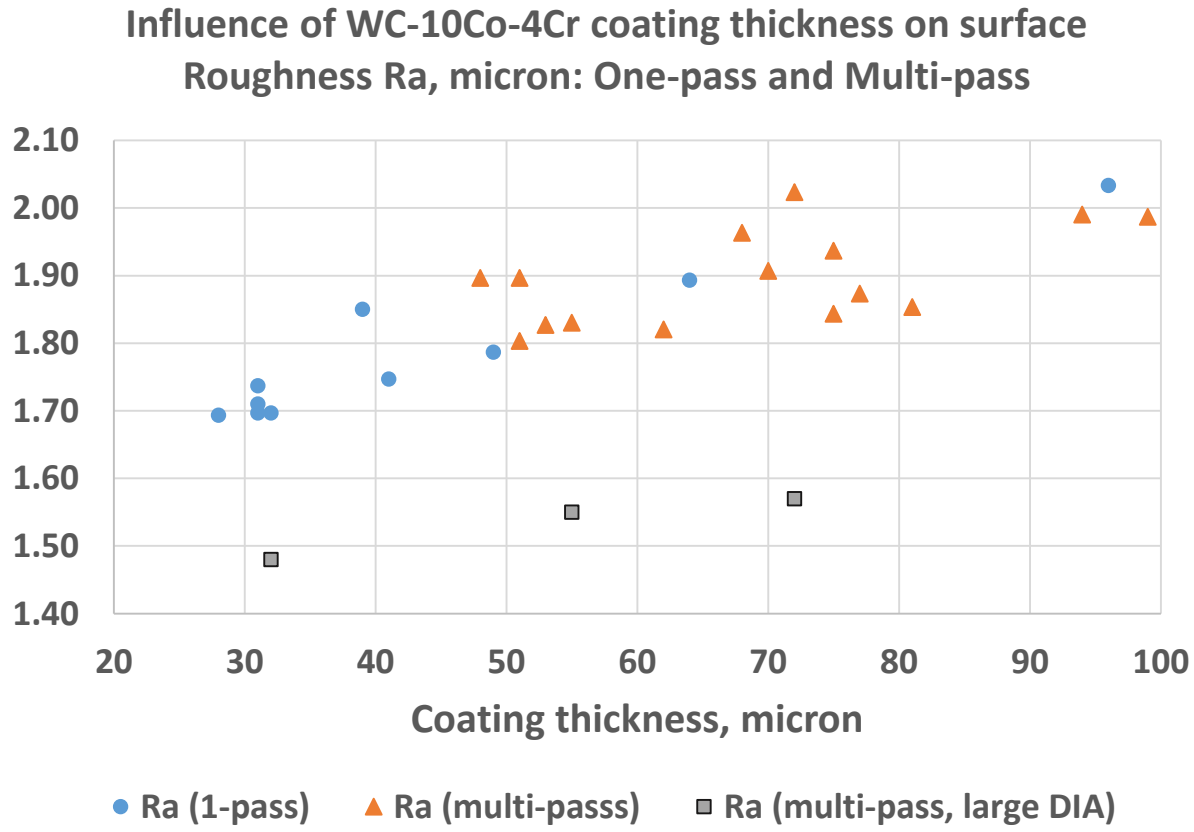
Flash Carbide:
Factor affecting surface roughness



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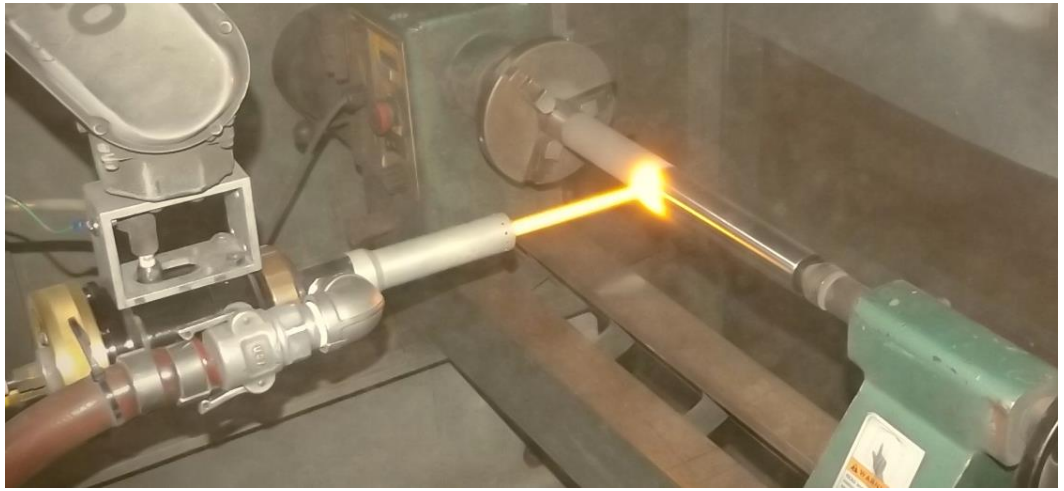
Flash Carbide Process

- Dimension-grind the part to lowest tolerance, Ra 0.5 micron
- One pre-heating/cleaning pass with the gun flame
- Pass(es) of coating, HVAF fine/dense WC-10Co-4Cr powder (30 micron)



- Polish surface to needed roughness (remaining 22-25 micron of coating)
- **Total cost of coating to 38 mm OD x 300 mm L rod, Ra 0.2 μm finish: <15 USD**

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Summary

The concept of “Flash Carbide” coating is developed, targeting deposition of high-quality WC-10Co-4Cr coatings at extremely low cost due to reduction of coating thickness and elimination of the need for dimensional grinding in the process.

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