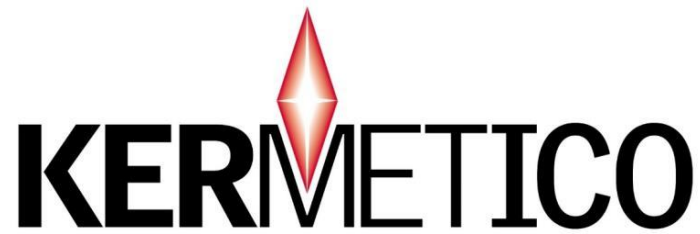


# **HVAF Flash-Carbide: An Economic Alternative to Electroplated Hard Chrome and solution for high-load applications**

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# Flash-Carbide:

Flash-Carbide is hard (over 1400 HV<sub>300</sub>) and very dense coating of WC-10Co-4Cr composite material, applied with Kermetico High-Velocity Air-Fuel (HVOF) spray method onto various metallic parts and structures to improve their surface resistance to severe wear and corrosion.

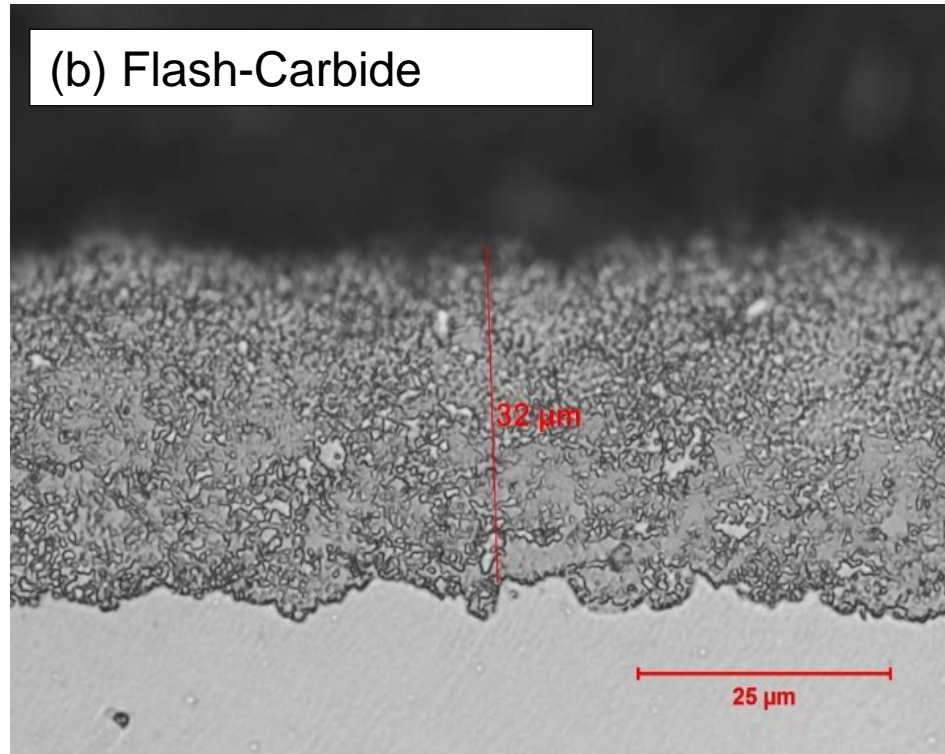
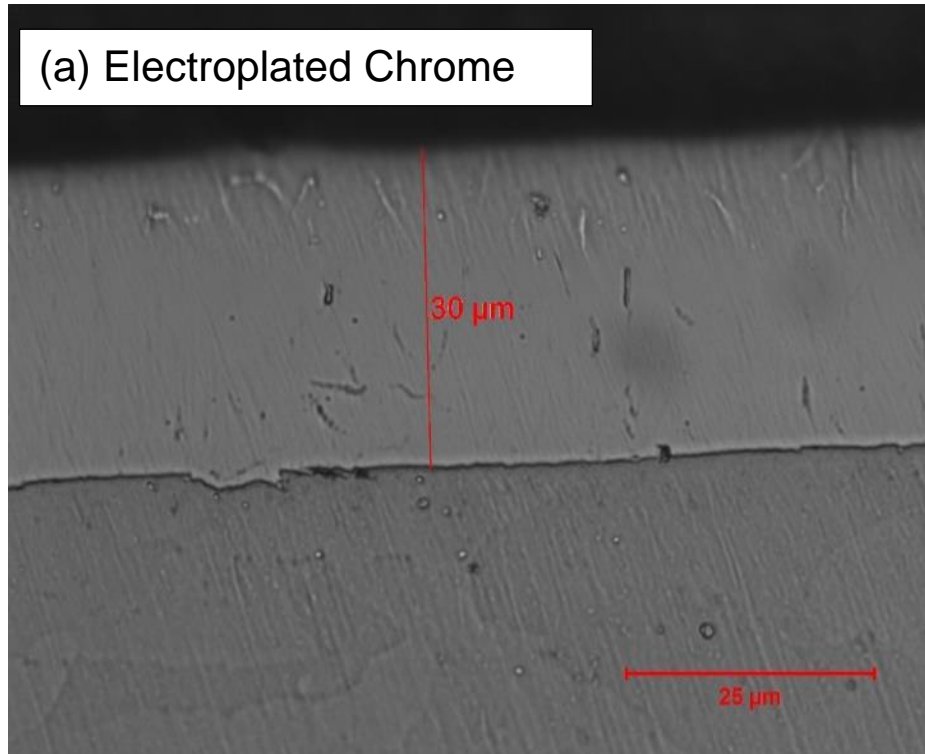
The Flash-Carbide coating:

- thickness is comparable to dimensional tolerances of the treated parts (10-30 micron)
- small thickness deviation, about 1 micron,
- as-sprayed surface roughness is similar to ground surface, typically  $R_a = 1.0 - 1.5$  micron.

Thus, the Flash-Carbide surface does not require dimensional grinding. Final surface roughness is achieved with a simple polishing.

# Cross-sectional micrographs of Electroplated Hard Chrome EHC (a) and Flash-Carbide (b) coatings

Micrograph images is a courtesy of GE Global Research, Niskayuna NY USA



# Flash-Carbide (cont.)



- Coating is dense to meet industry specifications for corrosion resistance.
- Mechanical properties, such as fatigue resistance, wear and erosion resistance, impact resistance, etc. exceed existing values for Electroplated Hard Chrome and other carbide coatings.

**When coating cylindrical parts, such as hydraulic rods, pump plungers and shafts, the sprayed-and-finished Flash-Carbide cost drops below 0.04 USD per sq.cm (under 37 USD per sq. foot), which is 10...20 -times lower than typical HVOF carbide coating.**

## **Flash-Carbide:**

Survives over 1000-hr  
salt spray corrosion  
test at thickness as  
low as 15 microns



# Flash Carbide: NSS test report summary

Plant / Sub contractor Details	Kinetic Surface (Kermetico)	Part No/Ident No.	Carbide coating
Part No	HVAF Flash carbide coating	Plating thickness:	-
Evaluated by:	Kiran M	Surface finish (after plate):	-
Evaluation Date:	08-02-2021	Rust started at :	NO RUST
Hardness:800HV min	---	Corrosion Test Conducted:	NSS
Adhesion Test results:	---	Test Hours : 1500 hrs	1512 hrs
Microcracks,spec-400/cm :	---	Intermittent/ Continuous :	Continuous
Reason for testing	Trials	Diameter	54 mm

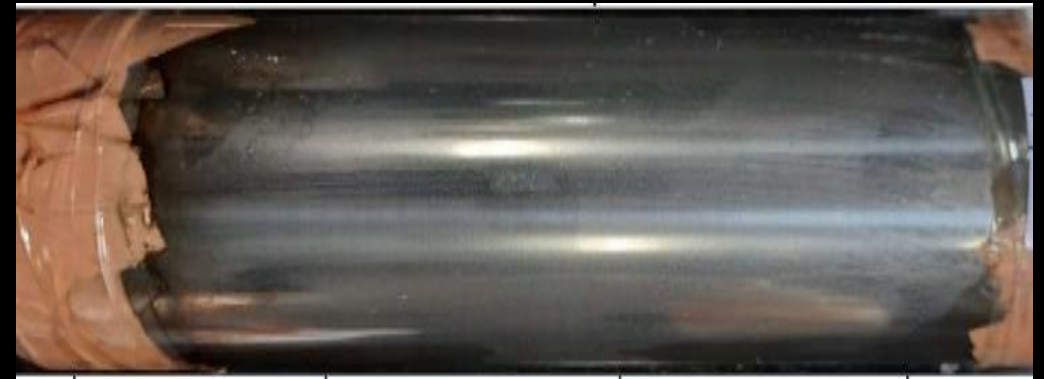
		Type of Test	Test start date	Test end date
		NSS	07-12-2020	08-02-2021
Salt Spary Test as per ISO 9227				
Sl.No.		Parameters	Specification	Actual
1	Air Pressure	Setting Pressure in bar	1.0 - 2.0	1.0
2	Prepared Salt Solution	pH	6.5 to 7.0	6.8
		Concentration NaCl(%)	5	5
3	Collected Salt Solution	pH	6.5 to 7.2	6.6
		Density	1.025 / 1.040	1.032
		Fog Collection	1 - 2 ml/hr	1.56
4	Test Chamber	Temp	35 ± 2 °C	35.0
		Saturatory Temp Temp	45 ± 2 °C	45.0
		Air Agitater	ON	ON
5	Specimen Angle	Angle	20° ± 5°	25°

# Flash Carbide: NSS test report summary

Before testing



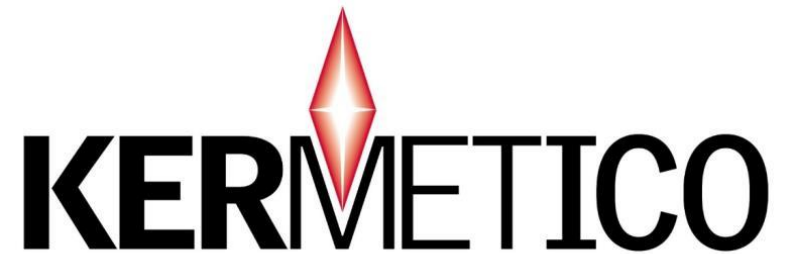
After 1000 hours – no rust spots



After 1500 hours – no rust spots

## **Flash-Carbide:**

Meets  
electrochemical  
corrosion  
requirements  
specified for  
protective coatings in  
marine applications  
during 1000-hr test

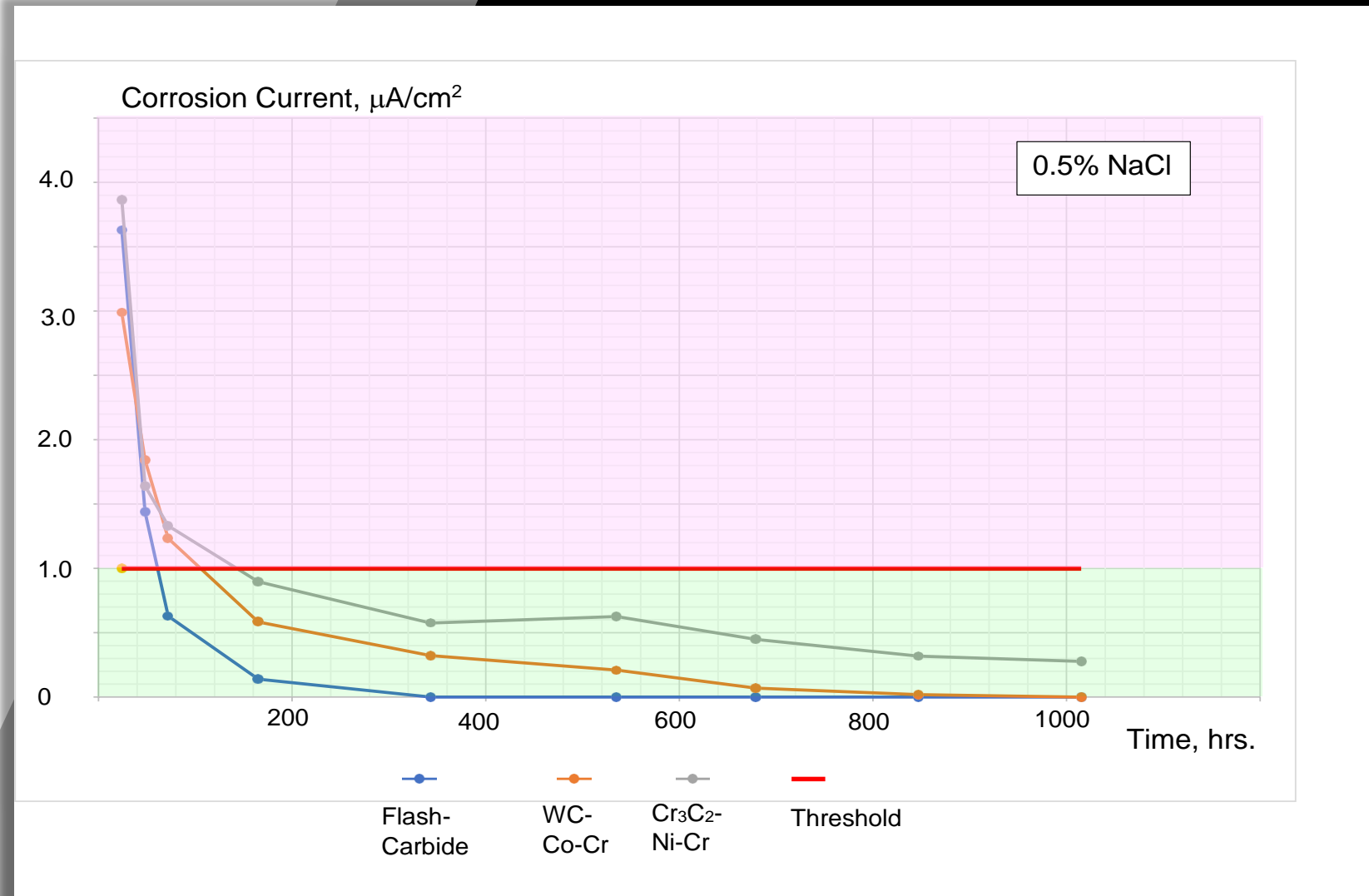




# Electrochemical Corrosion Data for AK-HVAF Coatings

Flash-Carbide (22  $\mu\text{m}$ ), WC-10Co4Cr (300  $\mu\text{m}$ ), Cr<sub>3</sub>C<sub>2</sub>-25NiCr (300  $\mu\text{m}$ )

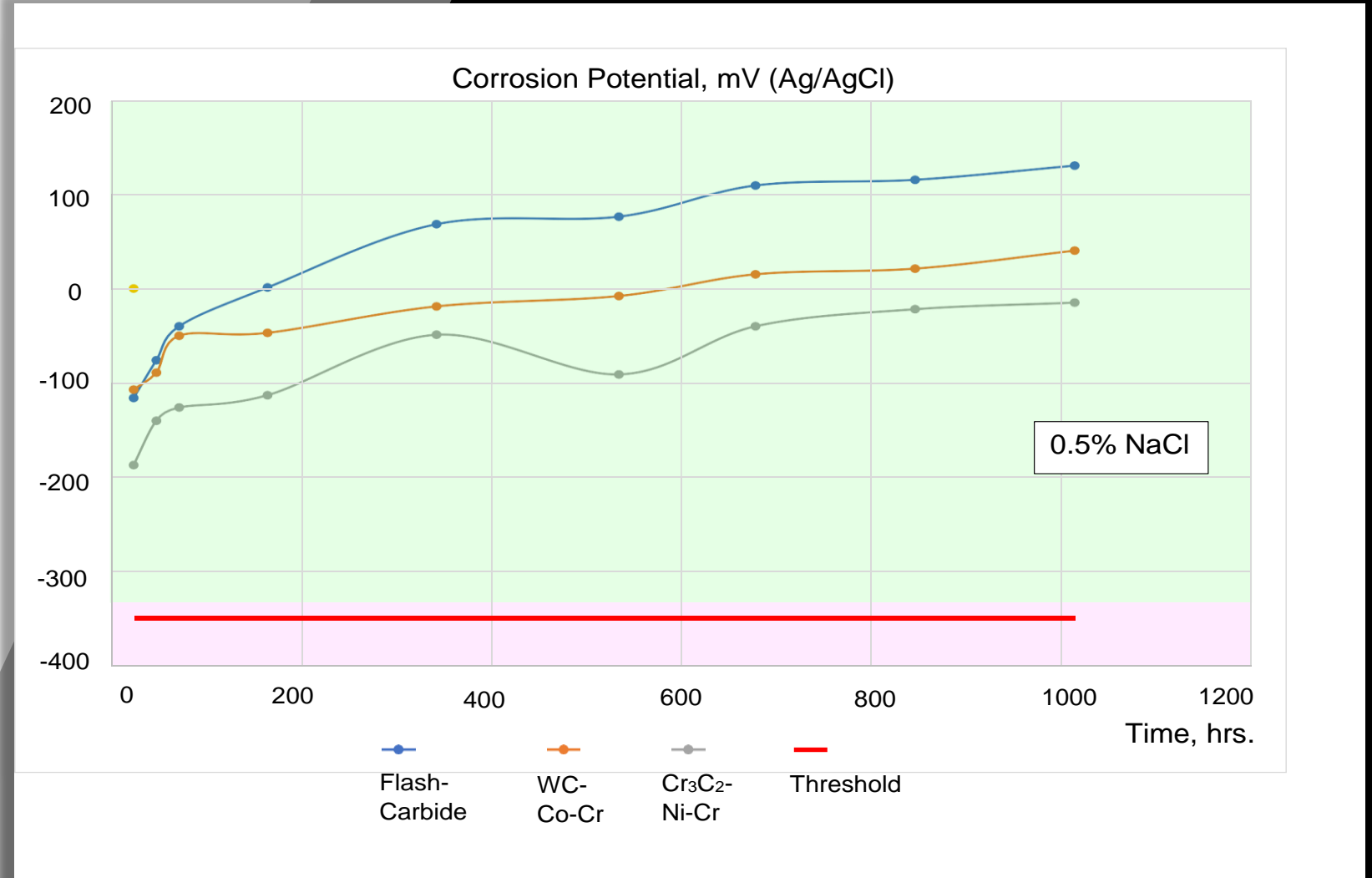
Courtesy of Metaltop B.V.,  
The Netherlands



# Electrochemical Corrosion Data for AK-HVAF Coatings

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Courtesy of Metaltop B.V.,  
The Netherlands

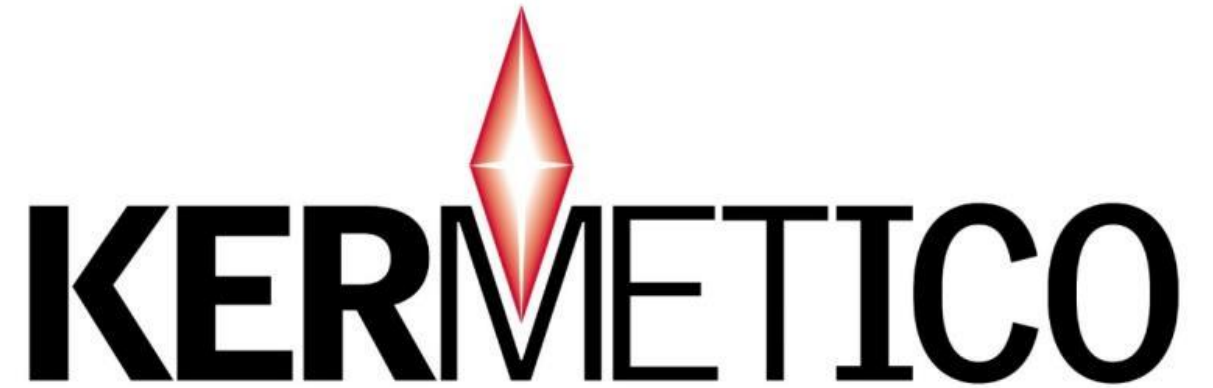


## **Flash-Carbide:**

Survives 30-day modified  
Komatsu' salt spray  
corrosion test at thickness  
50 microns after polishing

Nov 2019

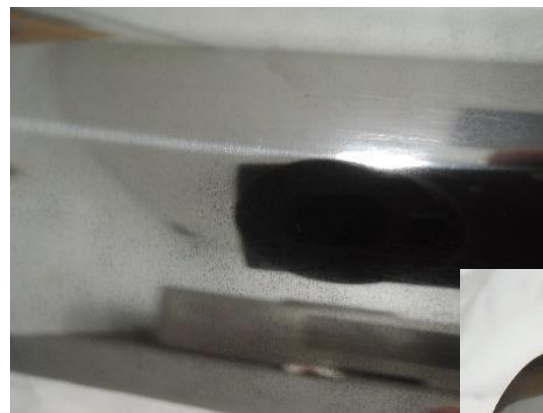
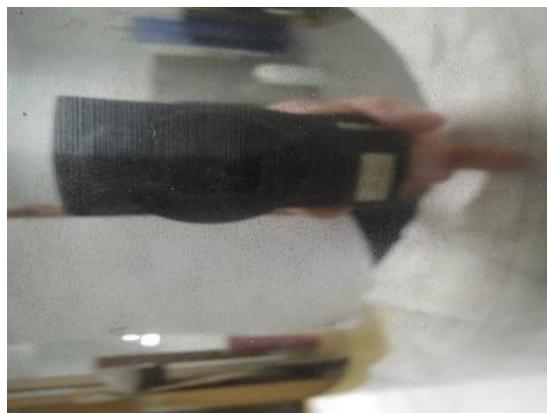
Komatsu Mining Corp.



## UK Sample 2 – Day 30

UK sample  
No.2

Flash Carbide (WC Co Cr) HVOF (high Velocity Air Fuel) coating. 0.002" (0.0508mm) thickness. Base steel = AISI 4140 grade steel (not hardened). 2 samples provide but only testing the one that is polished finished.

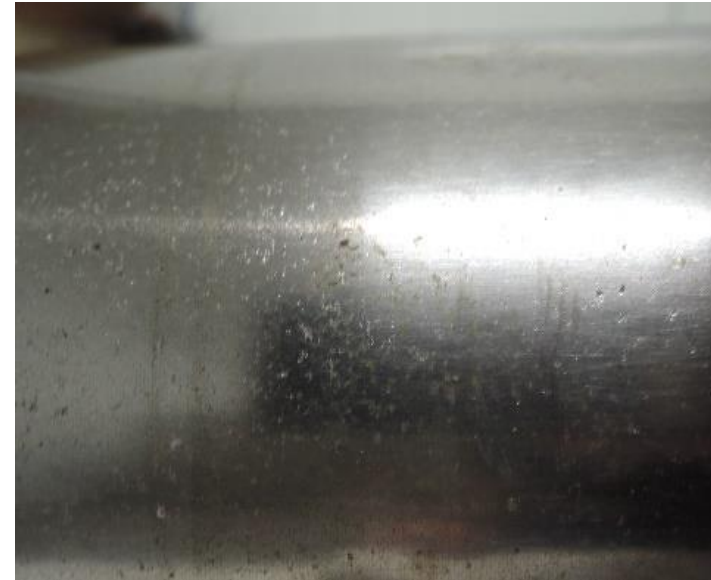


Condition of coating is very good after the 30 day test. Some very small pits in the surface but none appear to have breached through the coating thickness.

# UK Sample 3—day 30

UK sample  
No.3

EHLA (Extreme High LAser deposition) (60% In625 - 40% WC) Cladding. 0.005" thick and polished. Base steel = AISI 4140 grade steel (not hardened). 2 samples provide but only testing 1.



Condition of coating is reasonable after the 30 day test. Some very small pits in the surface but none appear to have breached through the coating thickness.

# Samples and testing - Summary

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UK  
sample  
No.2

Flash Carbide (WC Co Cr) HVOF (high Velocity Air Fuel) coating. 0.002" (0.0508mm) thickness. Base steel = AISI 4140 grade steel (not hardened). 2 samples provide but only testing the one that is polished finished.

A very good result.

Sample was in very good condition given the severity of the test. Some very minor pitting but not significant.

UK  
sample  
No.3

EHLA (Extreme High Laser deposition) (60% In625 - 40% WC) Cladding. 0.005" thick and polished. Base steel = AISI 4140 grade steel (not hardened). 2 samples provide but only testing 1.

A good result.

Sample was in good condition given the severity of the test. Some surface pitting widespread around the sample.

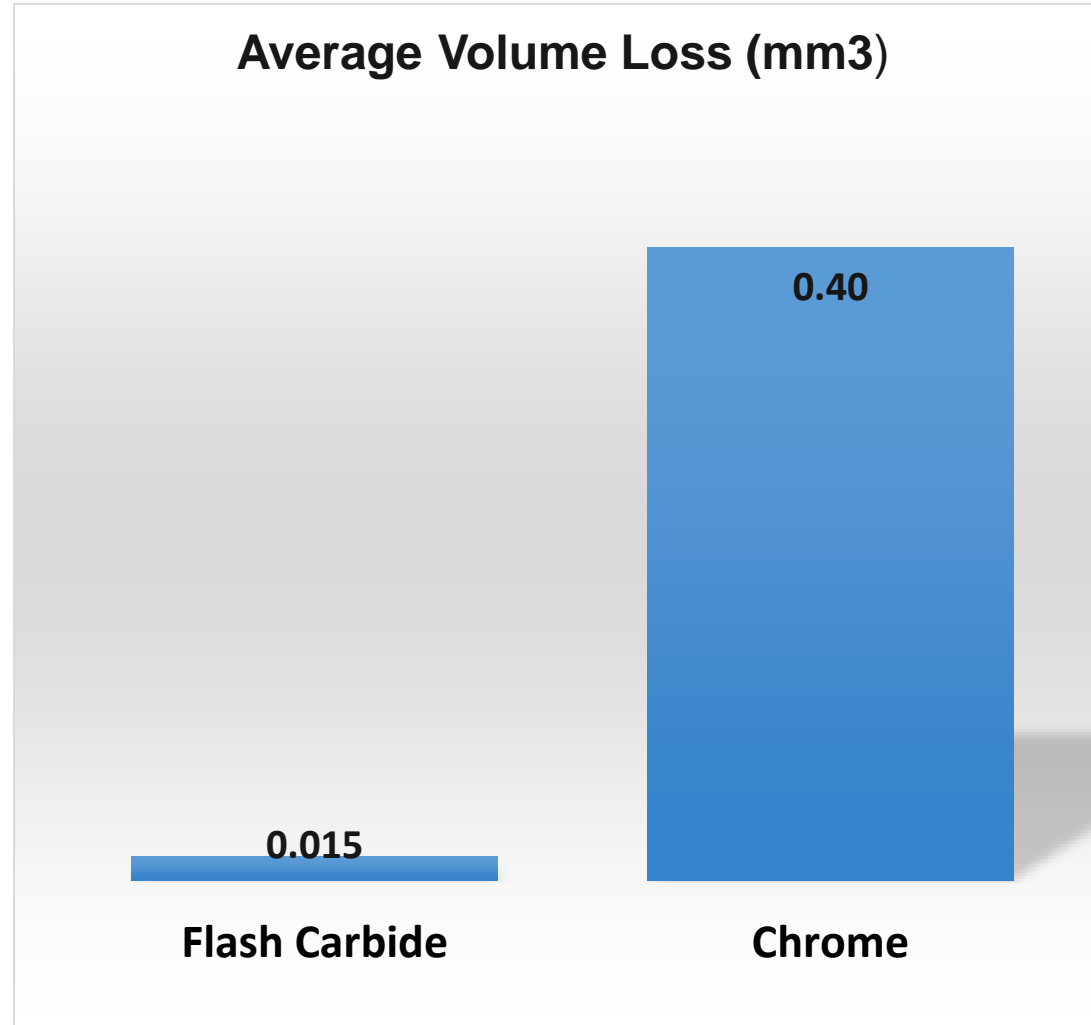
## **Flash-Carbide:**

Wear resistance  
exceeds  
electroplated  
chrome by 20+ fold



# **Flash-Carbide: ASTM G174 Loop Abrasion Test**

Test results is a courtesy of GE Global Research, Niskayuna NY USA

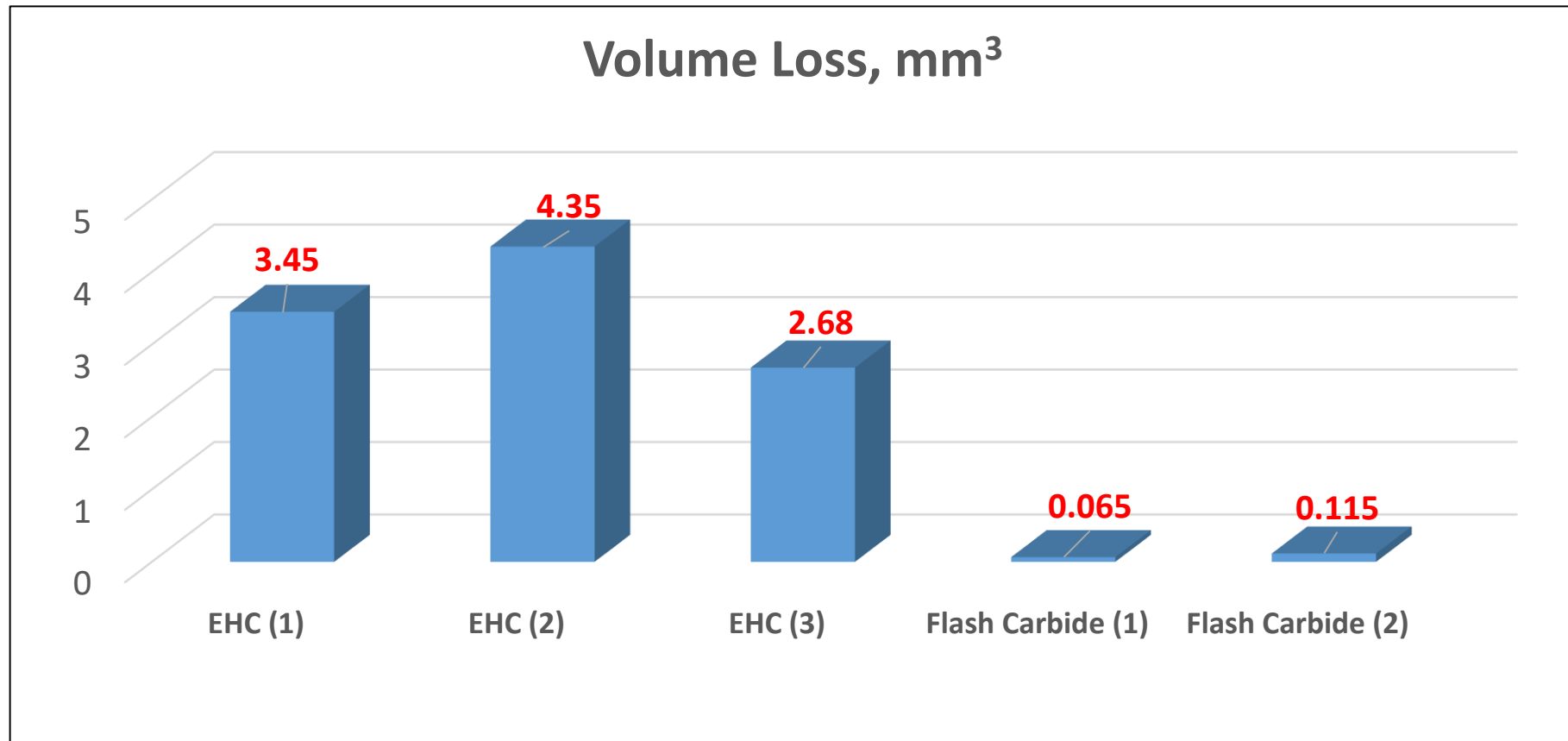




# Flash-Carbide: Abrasive Wear Test vs Electroplate Hard Chrome (EHC)

Test results is a courtesy of Prof. Li Changxin, Xian Jiatong University, China

Abrasive Wheel (400  $\mu\text{m}$   $\text{Al}_2\text{O}_3$ ) Diameter 210 mm, rotation 97 RPM, Load 25N, duration 1 min



# Flash-Carbide:

Mechanical  
properties beyond  
expectations



## **Flash-Carbide: Mechanical properties**

**4-point bend test at 100 kN load (95% Yield strength), 100 cycles**

**Rod is 38 mm diameter, 300 mm Long, 4140 carbon steel, Full Hard heat treated**



**Annealed rod is a subject to plastic deformation.  
No coating delamination**

Pictures by courtesy of  
Caterpillar Inc.

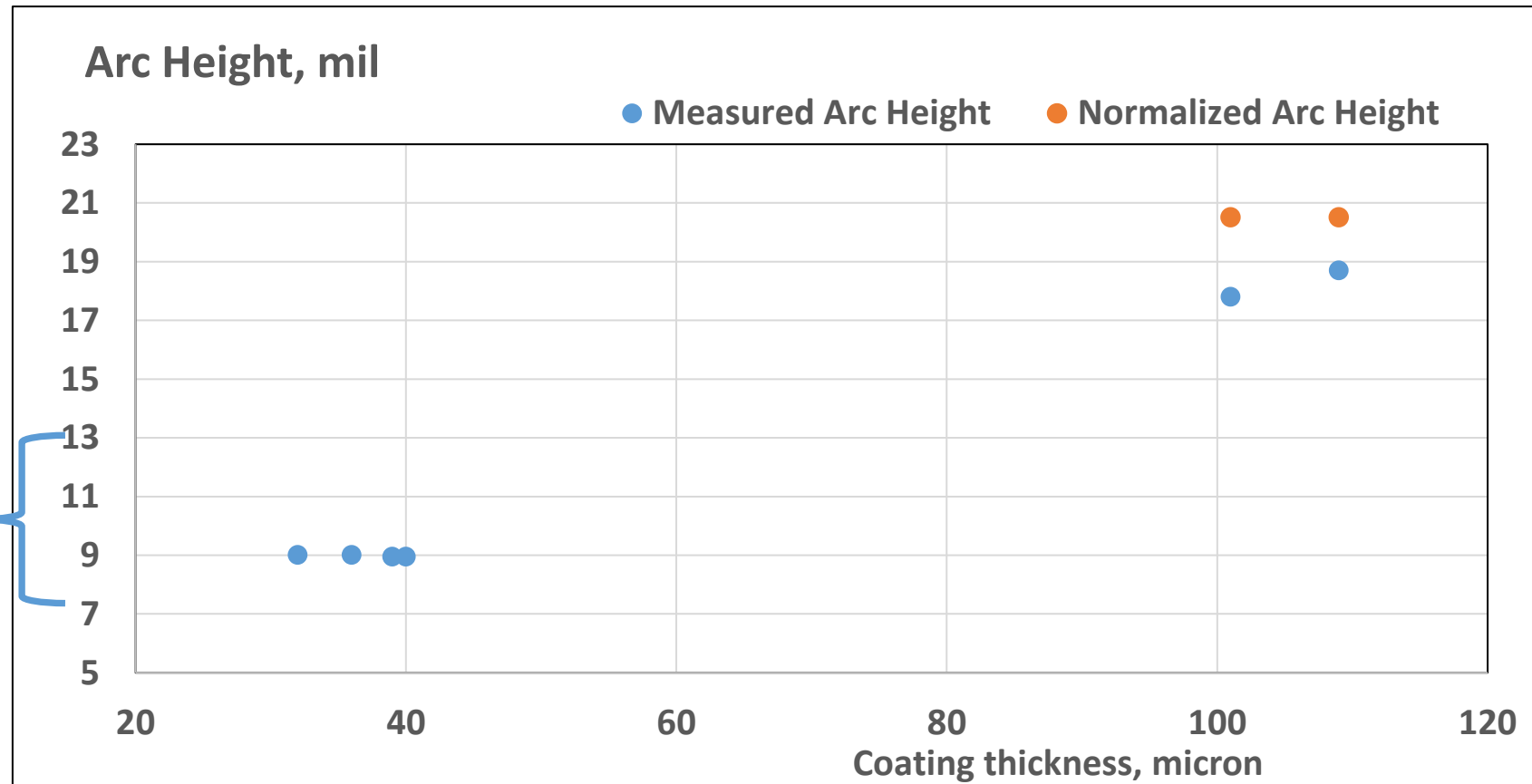
# Flash-Carbide: Residual stresses

ASTM 2447 Rev. D: Almen strip (Type N-1S), Arc height measurements

Flash-carbide thickness coating (20-40  $\mu\text{m}$ )  
matches the typical Almen strip requirements

Full-thickness coating (100-120  $\mu\text{m}$ )  
is over-stressed

Typical industry  
requirement:  
6-12 mils



# Flash-Carbide

**Cost Structure - Hydraulic rod, Diameter 38 mm x Length 550 mm (1.5" OD x 21.65" L)**

Spraying: **8.50 USD**



Polishing: **8.67 USD**



Handling: **2.20 USD**



**TOTAL: 19.37 USD**

As-received  
Ground to lower dimensional tolerance



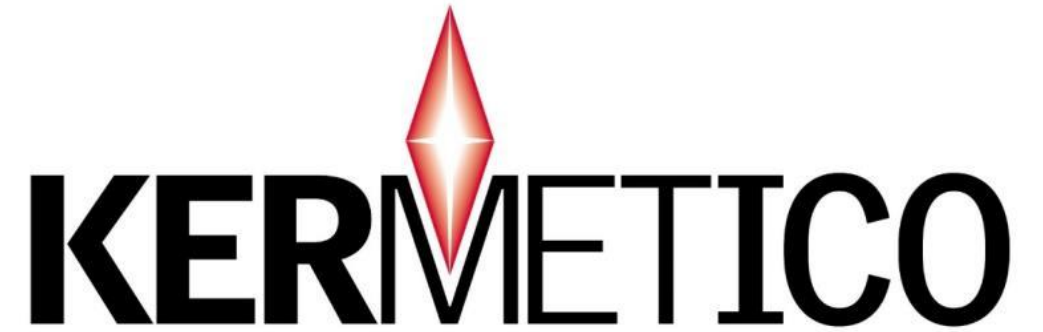
As-sprayed  
30 micron, Ra 1.50  $\mu\text{m}$



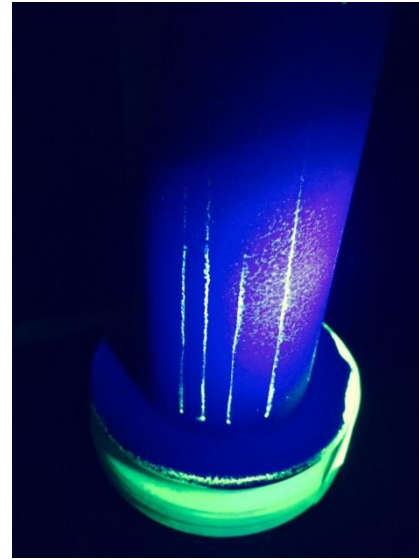
Polished  
21 micron, Ra 0.20  $\mu\text{m}$



# **Flash-Carbide:** **History and** **Applications**



# KERMETICO



Cracking of 200-micron thick coating at alternating peak loads of +/- 8,000 PSI



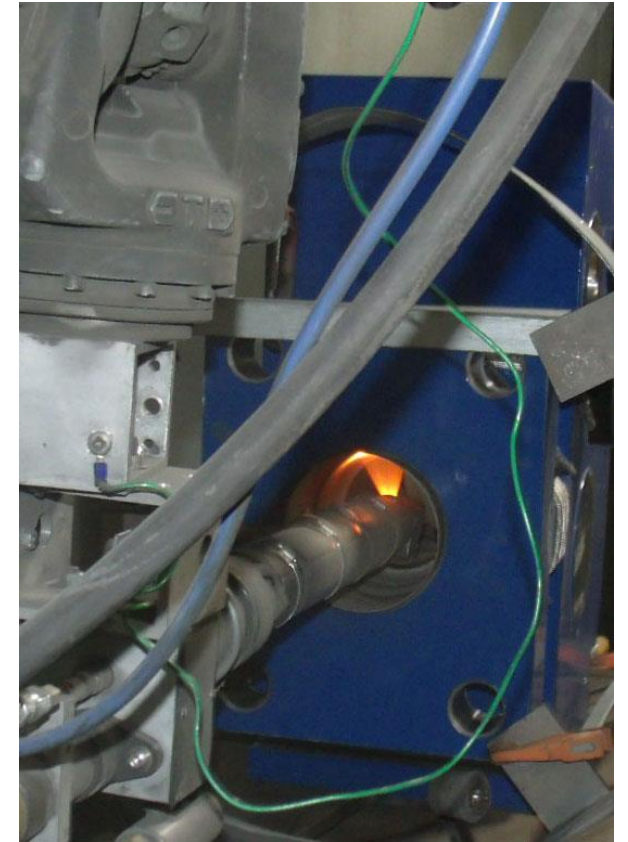
The 50-micron thick coating survives 100 cycles peak loads of +/- 11,000 PSI

**Flash-Carbide History: December 2016**  
Kermetico HVOF WC-Co-Cr Coating of 45 micron thickness is specified on Titanium pump pistons for underwater robots





**KERMETICO**



## **Flash-Carbide** History: April 2012

Kermetico started commercial applications of WC-Co-Cr Coatings in 100 mm+ internal diameters with AK04ID HVOF gun using -15+5 and -10+2 micron powders

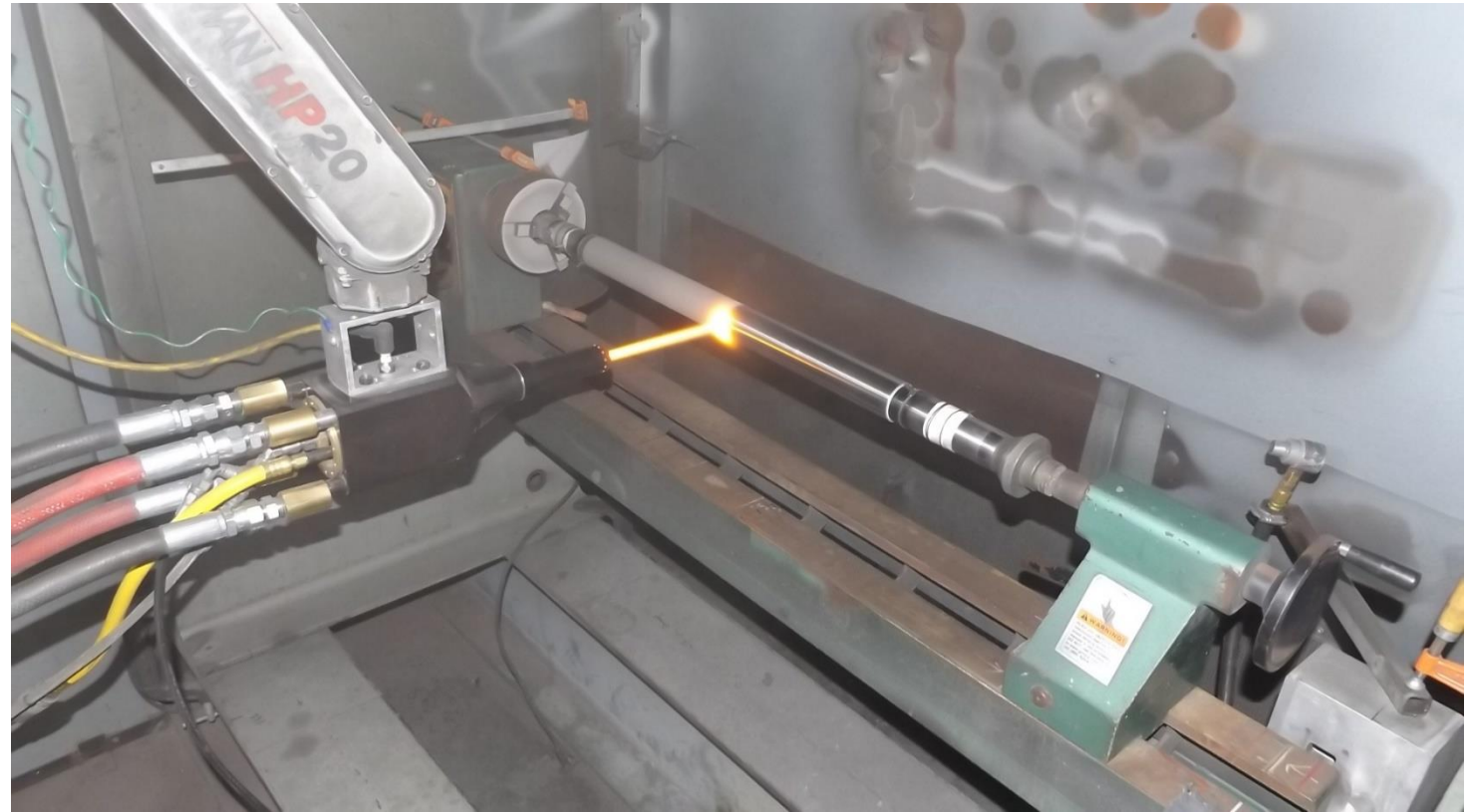



## Flash-Carbide

History: May 20, 2017

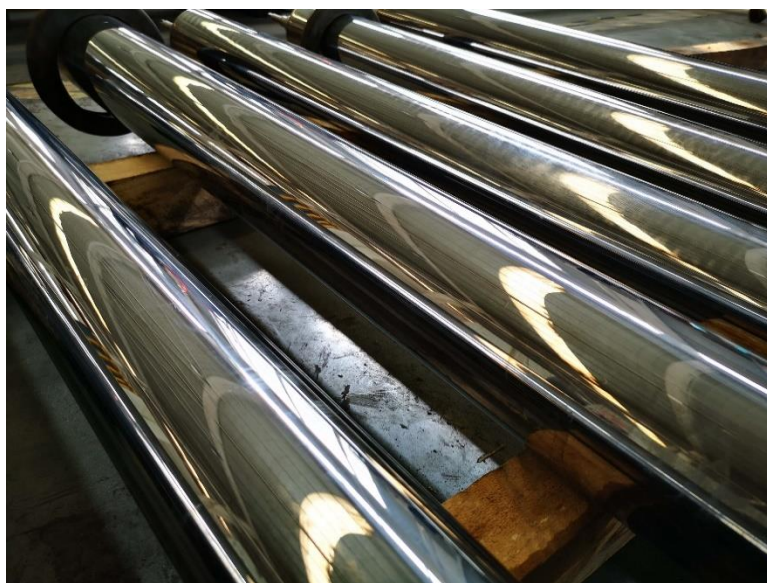
Flash-Carbide “date of birth”:

application of 25 micron thick coating, as-sprayed roughness  $R_a < 1.5$  micron, to guide roller in steel roofing manufacturing



  
**KERMETICO**

**Flash-Carbide:**  
Hydraulic  
rams for lifting  
platforms,  
piston rods  
RenCoat,  
China



  
**KERMETICO**

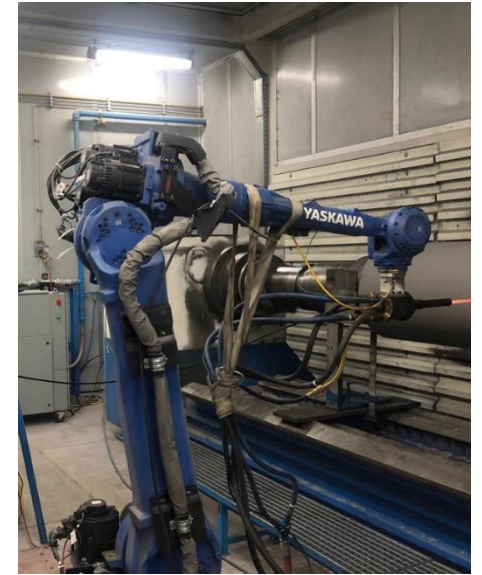





## Flash-Carbide:

Work rolls in cold rolling mills,  
MINDASA, Spain

- Load 2 tons/ linear mm.  
Sheet width 1,000 mm
- Continuous 5-stand rolling mill: Flash-Carbide outperforms Hard Chrome 3+ times
- Reversing cold rolling mill: Flash-Carbide outperforms Hard Chrome 5+ times
- Cost of Flash-Carbide is similar to Hard Chrome. Annual revenue: 3.6M €

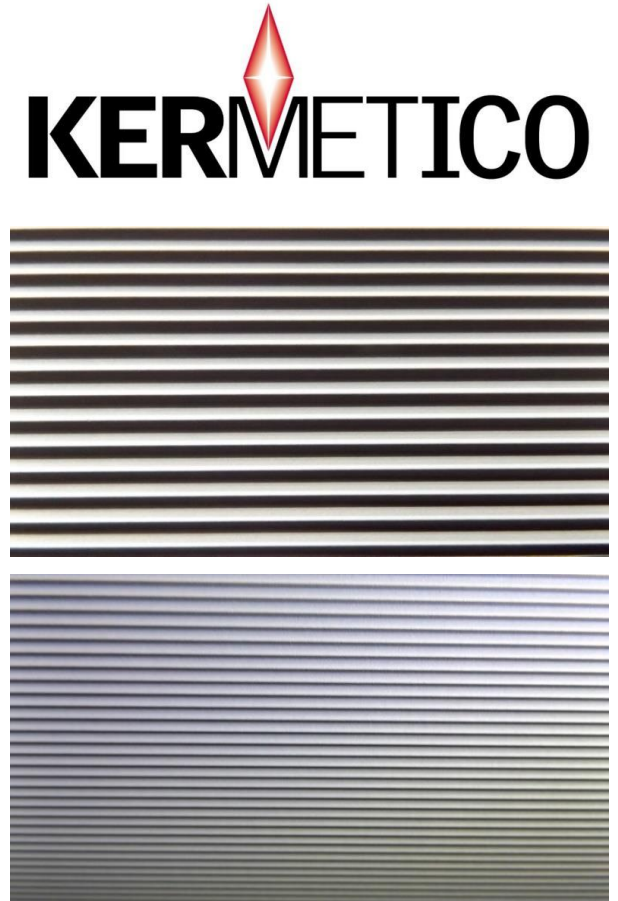
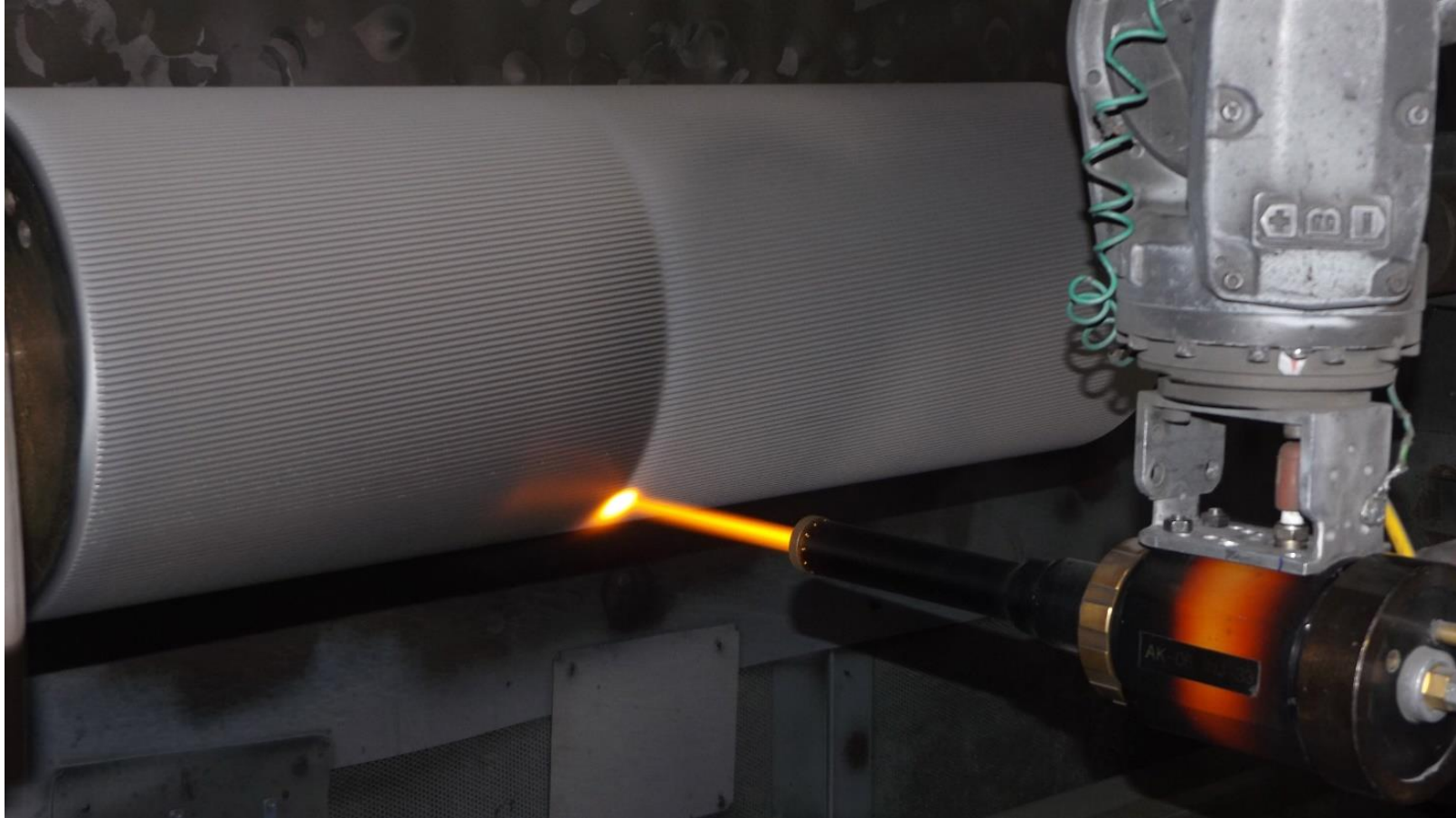


**KERMETICO**



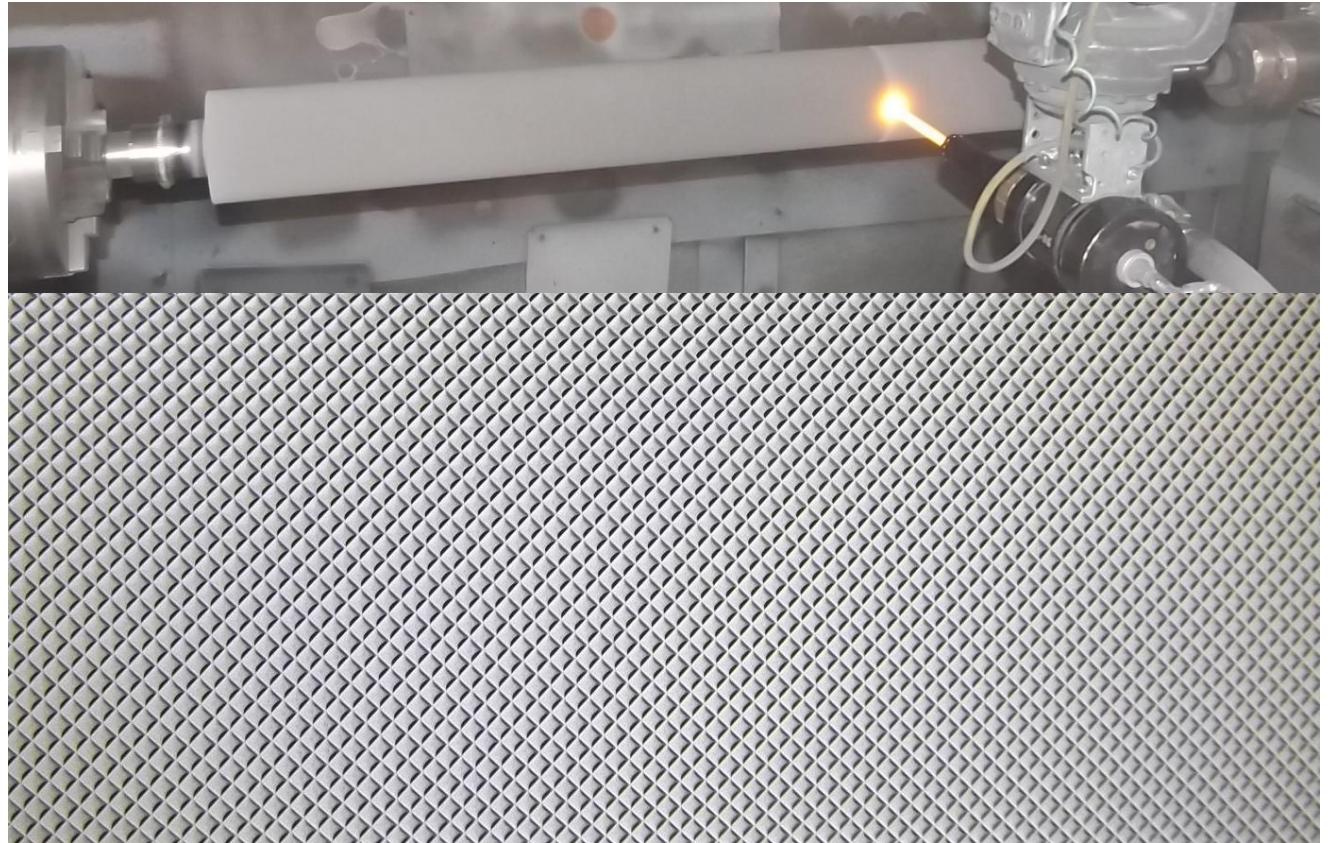
## Flash-Carbide:

Grinding rolls in agricultural roller mills and flour processors, Kermetico USA and RenCoat China





# KERMETICO



## Flash-Carbide:

High-roughness coatings:

- HVOF Blast + Flash-Carbide, Ra 12-13 micrometers on pipe grip sleeves
- Flash-Carbide, 10 micron thick, over textured surface of glue roller