

*CarBoNiP™ CR*



**METALCOATING**  
Group

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## CarBoNiP™ CR

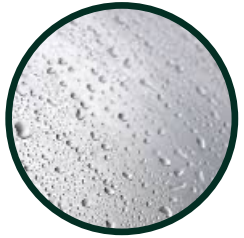
- Lead and fluorine free
- Not continuous disposal – environmentally friendly
- Wear rate 10 times lower with respect to Chrome (VI)



## Hard Chrome (VI & III)

- Presence of lead and fluorine
- Disposal due to contaminants – harmful to the environment
- Higher wear rate of Cr VI with respect to CarBoNiP (10 times)

It's an electrolytic Nickel-Phosphorous alloy (Ni-P) in which boron carbide nanoparticles ( $B_4C$ ) are homogeneously dispersed.



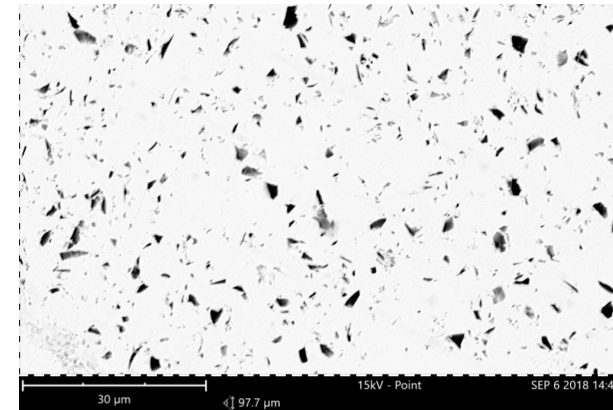
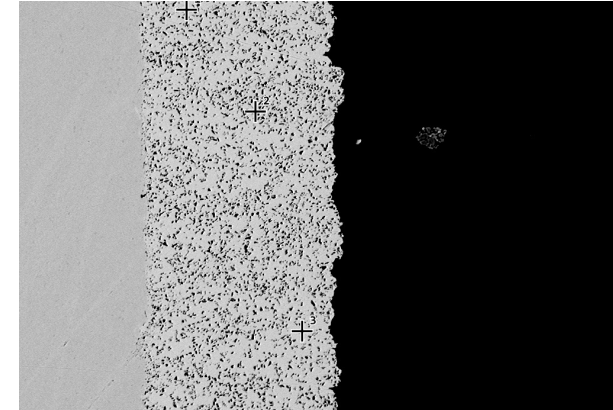
Great Corrosion Resistance



Excellent Wear Resistance



High Hardness and Deposition Rate



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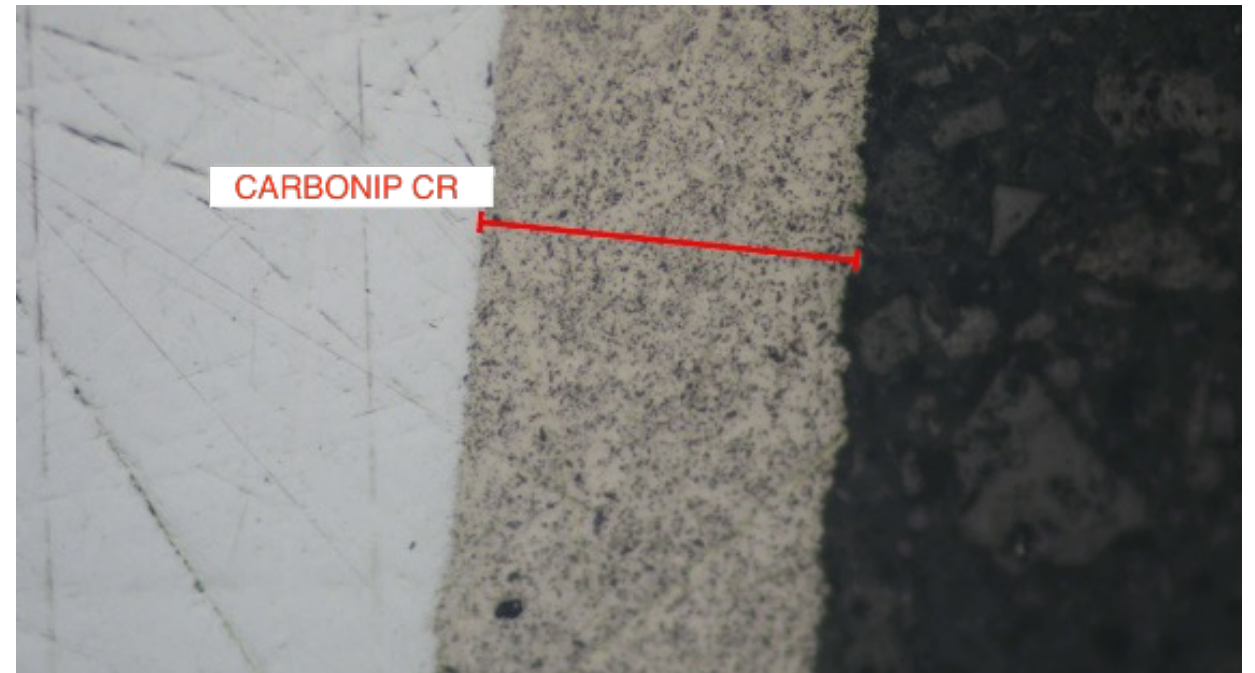
Great Corrosion Resistance



Excellent Wear Resistance



High Hardness and  
Deposition Rate


















CarBoNiP™ CR has been formulated in order to provide:

- Good stability
- Easy handling
- Low environmental risks
- ✓ It is possible to use only the matrix (Ni-P) without the presence of  $B_4C$  as a substitute of the electroless nickel.



CarBoNiP™ CR finds its application within several industrial sectors:

-  Automotive
-  Aeronautics
-  Mould for plastics and others
-  Mining industry
-  Petrochemical
-  Shipbuilding industry
-  Light, heavy and precision engineering
-  Textile
-  Chain
-  Chemical industry
-  Oleodynamic
-  Pneumatic
-  Medical
-  Electronic
-  Arms industry



II CarBoNiP™ CR is suitable to a wide selection of substrates:

- Carbon steel
- Copper and its alloys
- Aluminium
- Cast iron



The CarBonip™ process is compatible with components of any size and shape:



CarBoNiP™  
coating



CarBoNiP™  
coating +  
Teflon™



The porosity of the coating is fundamental when Teflon™ is applied.

About 3  $\mu\text{m}$  remain embedded inside the coating.

This combination leads to:

- Dramatic enhancement of the corrosion resistance
- Great reduction of the friction coefficient





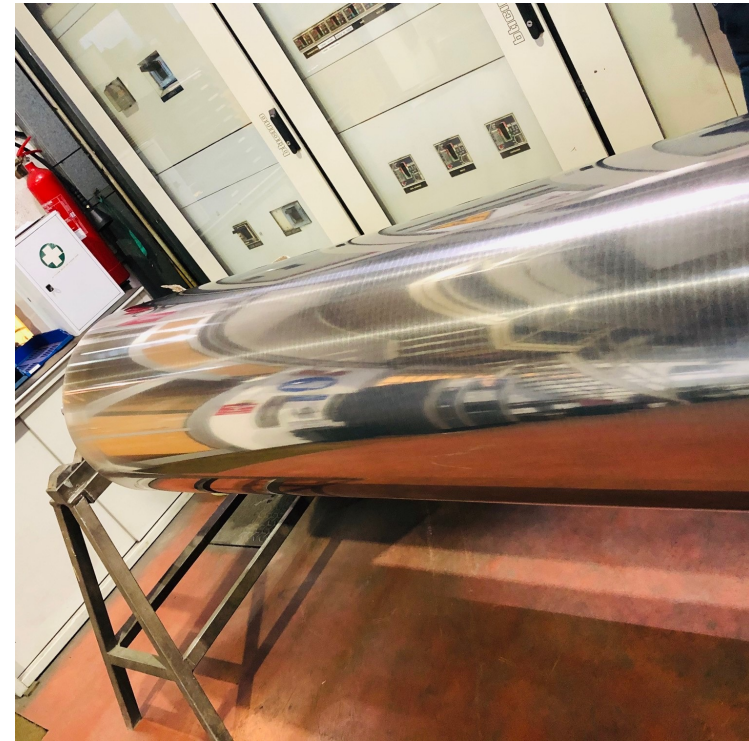
- ❑ For external deposition the rotation of the components is mandatory to obtain a uniform coating.
  
- ❑ Bigger sample production:
  - Maximum diameter = 500 mm
  
  - Maximum length = 3800 mm

The CarBonip™ process is compatible with components of any size and shape:

CarBoNiP™ coating

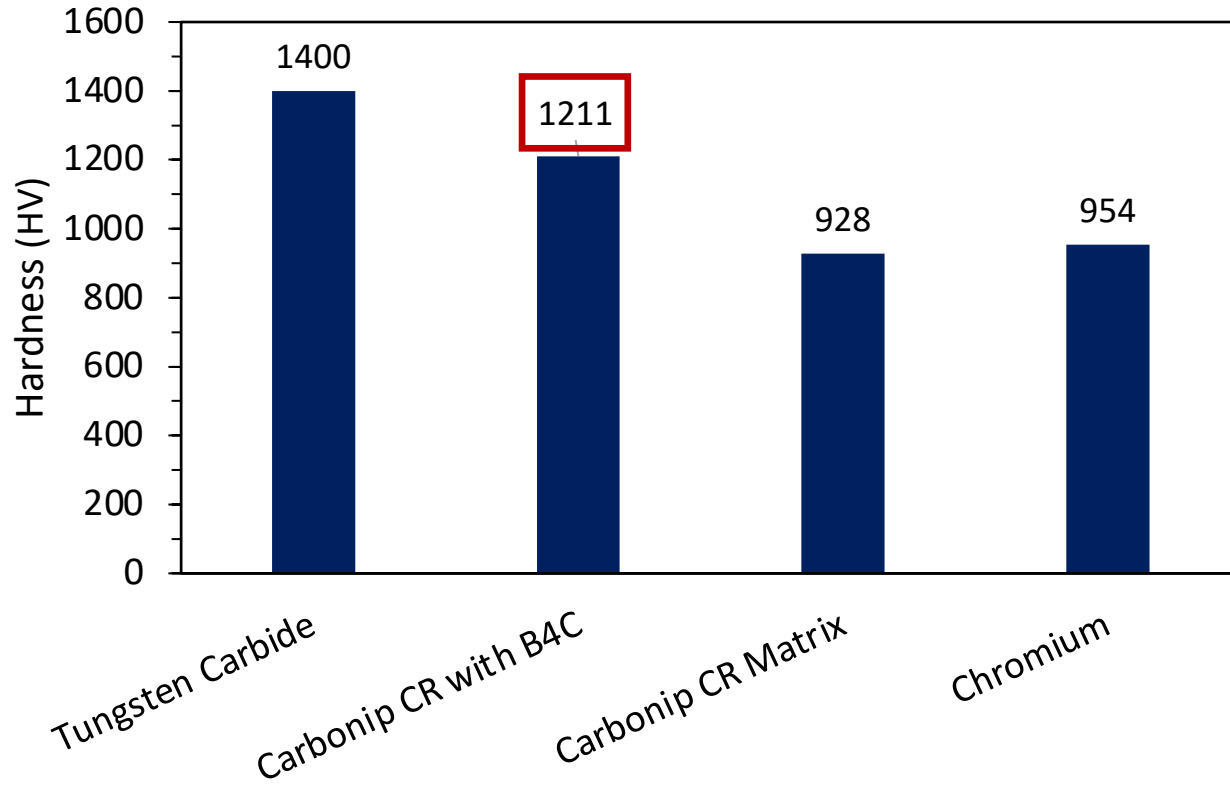


CarBoNiP™ coating polished through grinding



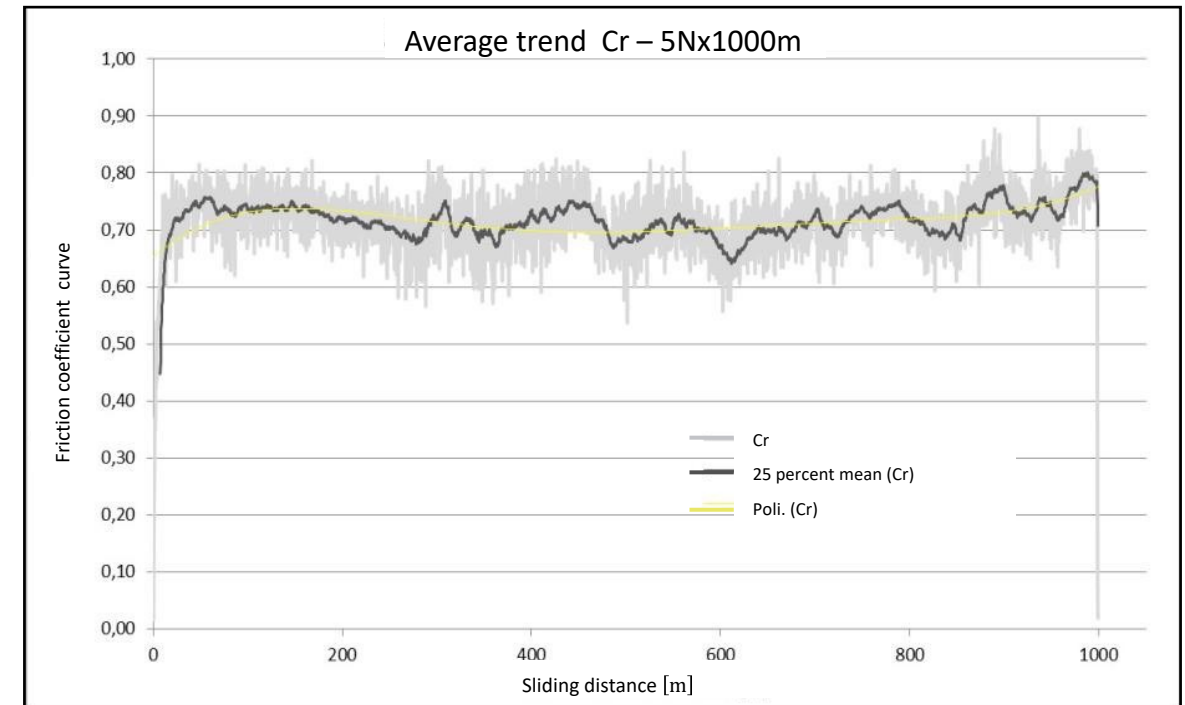
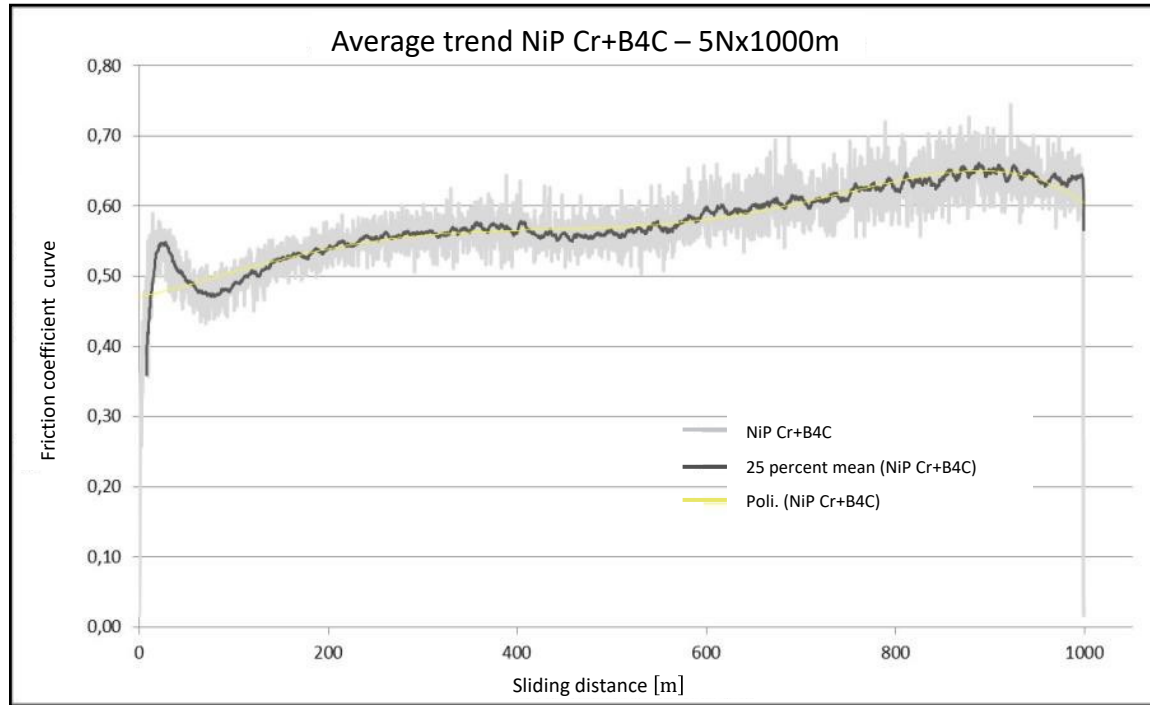
Properties and parameters	Values
Coating thickness	30 $\mu\text{m}$
Coating Microhardness	600 HV (mean value)
Post thermal treatment Microhardness	1211 HV (mean value)
Wear resistance	10 times higher than chrome VI
Phosphorus content	18%
B <sub>4</sub> C	32.5% vol
Stress	Negligible

# Microhardness test



- All the samples have been tested after thermal treatment
- Load applied: 25 grams

# Pin on disk test: friction coefficient

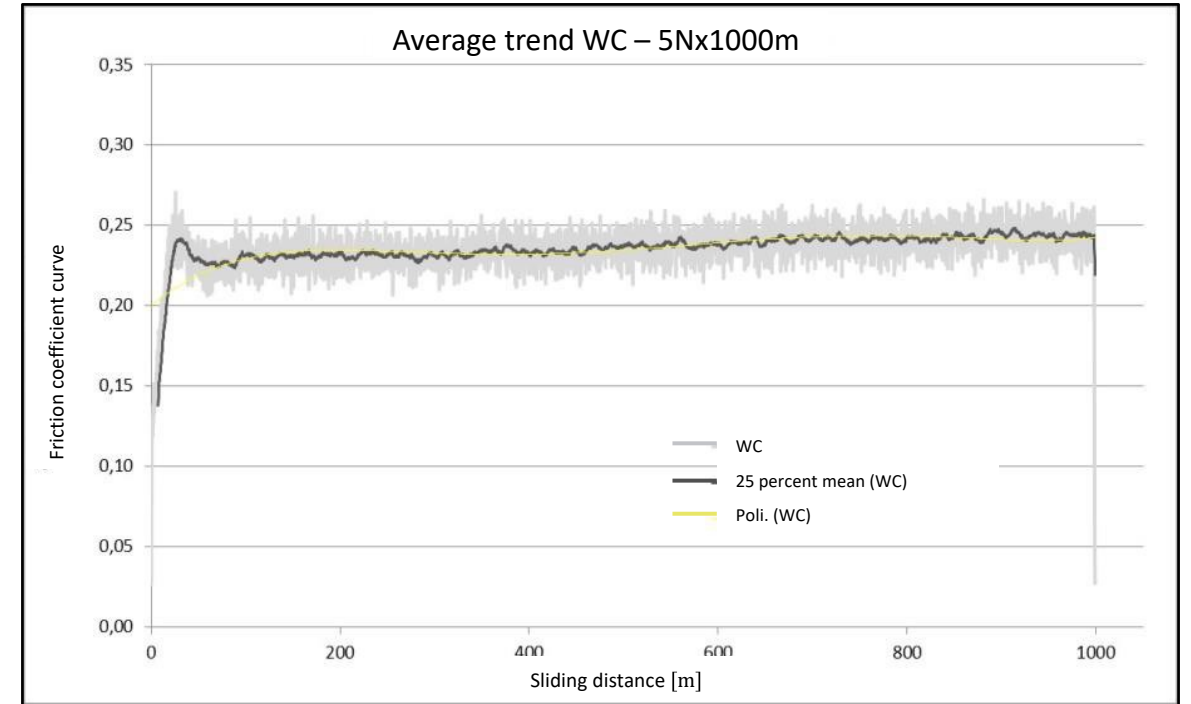
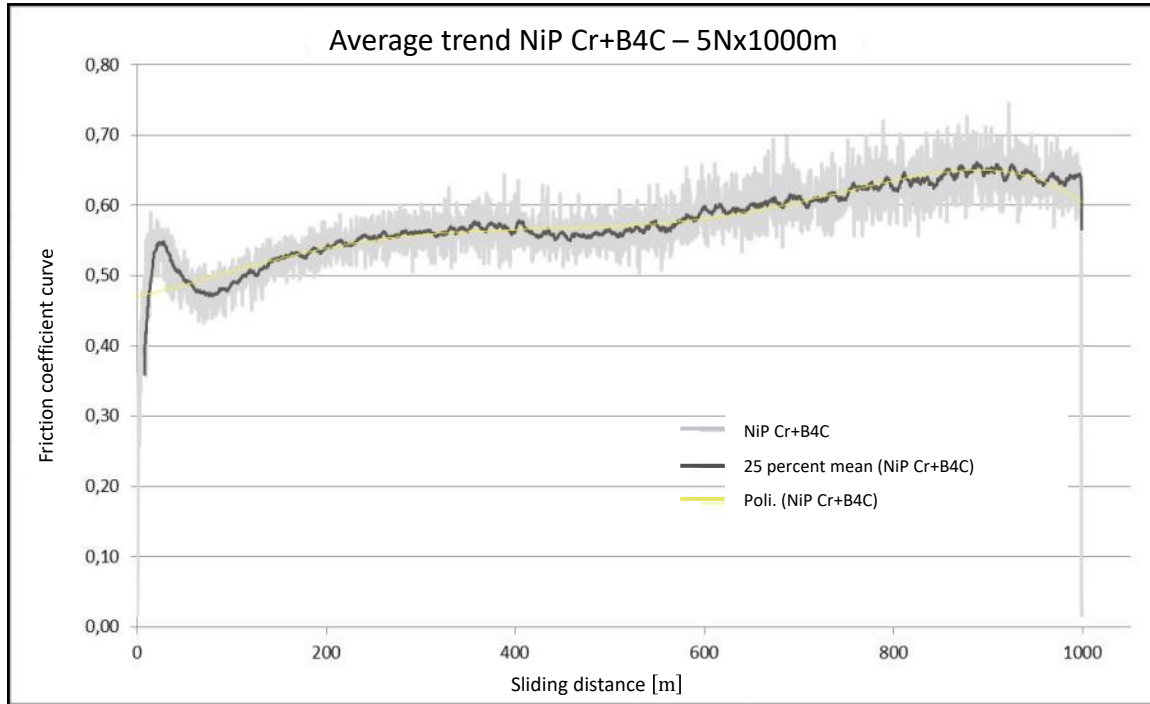


Coating roughness for each specimen  $\approx 0.8 \mu\text{m}$

Analisis carried out by Laboratorio di Materiali e Caratterizzazione-Dipartimento di Meccanica, Politecnico di Torino



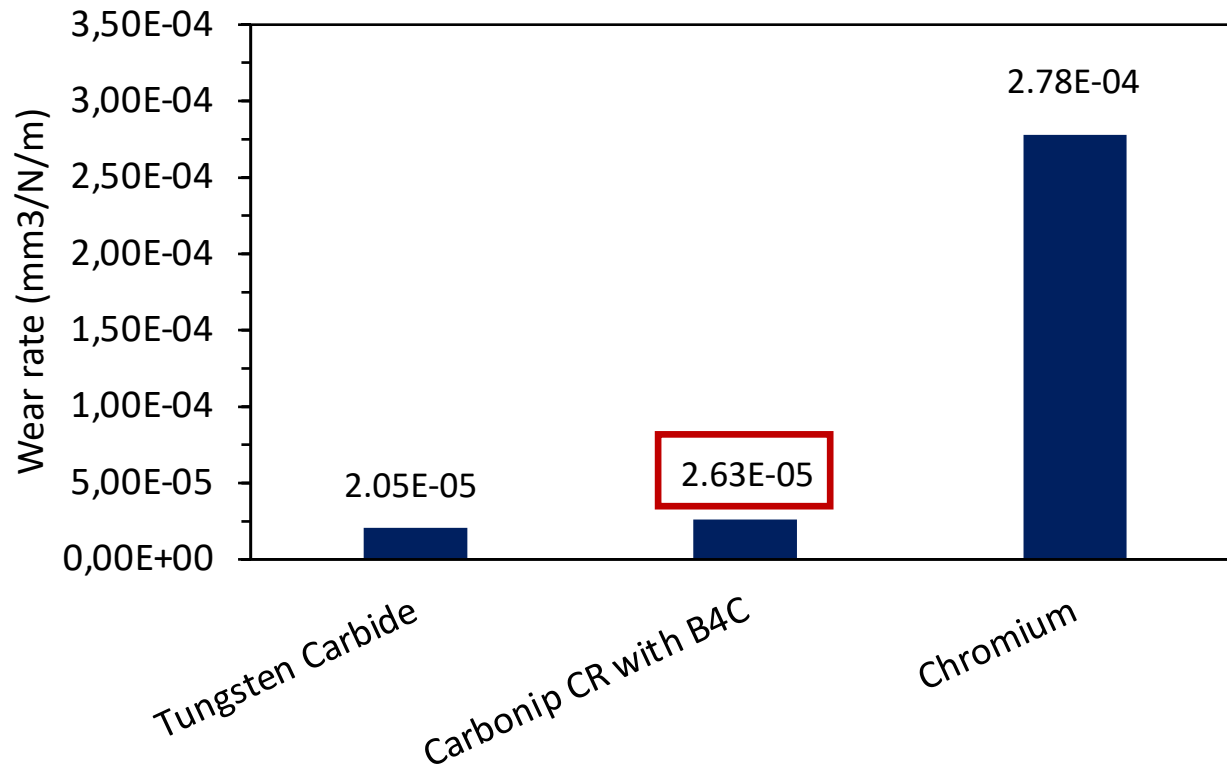
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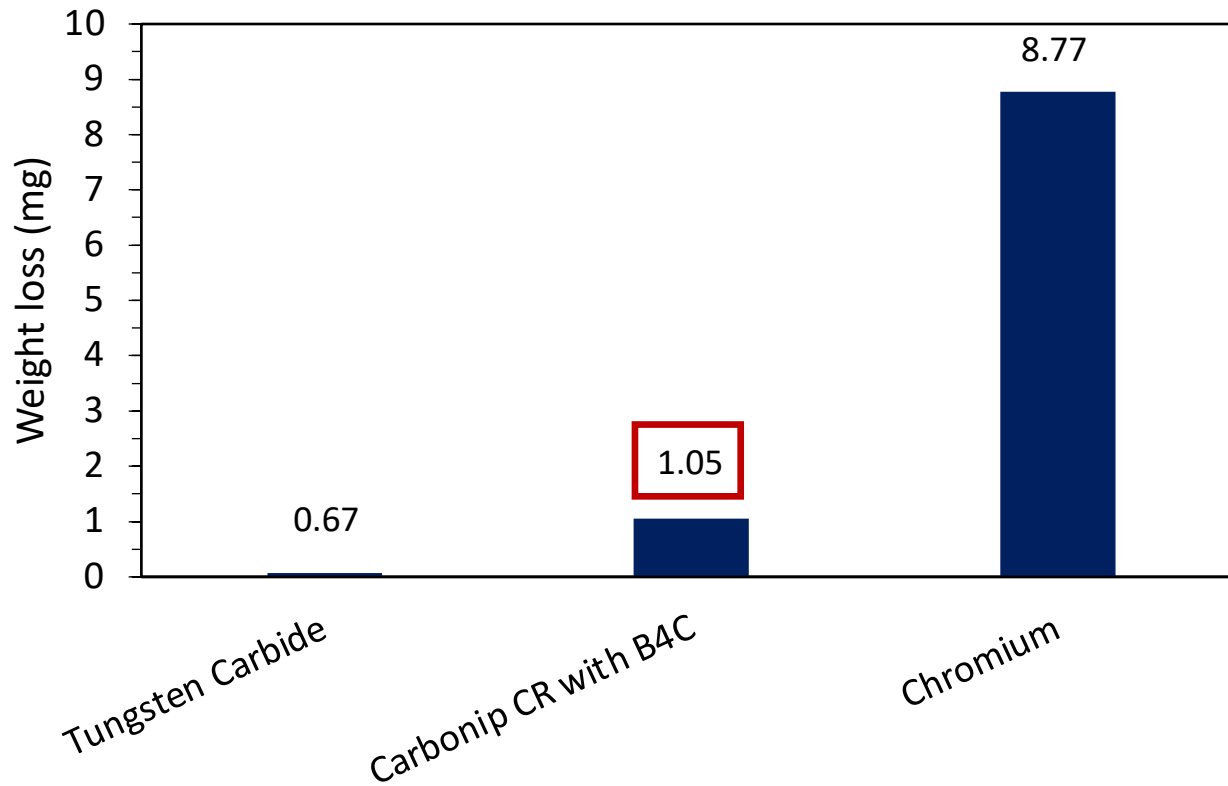
# Pin on disk test: wear rate



- ❑ Better behaviour than Chrome in presence of B<sub>4</sub>C (10 g/l)
- ❑ The wear rate can be controlled changing the concentration of the B<sub>4</sub>C nanoparcicles inside the solution from 1 g/l to 10 g/l

*Analisis carried out by Laboratorio di Materiali e Caratterizzazione-Dipartimento di Meccanica, Politecnico di Torino*

# Pin on disk test: Weight loss



- Better behaviour with respect to Chrome
- B<sub>4</sub>C addition has a positive effect

*Analisis carried out by Laboratorio di Materiali e Caratterizzazione-Dipartimento di Meccanica, Politecnico di Torino*

# Comparative Table













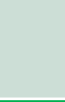





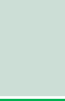








	Chrome	Tungsten Carbide	CarBoNiP™	CarBoNiP™ matrix
Hardness	Good	Excellent	Excellent	Good
Corrosion resistance	Good	Low	Excellent	Excellent
Environmental impact	Awful	Excellent	Excellent	Excellent
Wear resistance	Good	Excellent	Excellent	/

# Comparative Table

## Legend:

 Positive

 Negative

	CarBoNiP		Cr (VI)		Cr (III)	
Current efficiency	44%		12%		8% (change with the electrolyte)	
Temperature	80°C		50°C		20-45°C	
Disposal	No		Yes		Yes	
Contaminants sensibility	High		Low		High	
pH	2.0		0		0-4.0	
Deposition rate	20-25 µm/h		10-12 µm/h		10-20 µm/h	
Anode used	Platinized titanium		Tin-Lead		Platinized titanium / Graphite	
Presence of sludge	No		Yes		No	
Thermal Treatment	Yes		No		No	



























# Comparative Table

Legend:

 Positive

 Negative

	CarBoNiP™		Cr (VI)		Cr (III)	
Handling	Easy		Easy		Complex	
MicroHardness	1000-1211 HV		900-1050 HV		900-1050 HV	
Ventilation	Yes		Yes		Yes	
Current density	2-5 A/dm <sup>2</sup>		20-30 A/dm <sup>2</sup>		20-80 A/dm <sup>2</sup>	
Hydrogen embedding	Low		High		High	
Corrosion resistance	400 h		90 h		< Cr (VI)	
15 µm deposition time	45-36 min		90-75 min		90-45 min	
Aesthetic aspect stability	Good		Good		Non-constant	

# Appendix: hydraulic cylinders



1- raw material

2- CarBoNiP™ coating ( $B_4C$  10 g/l)

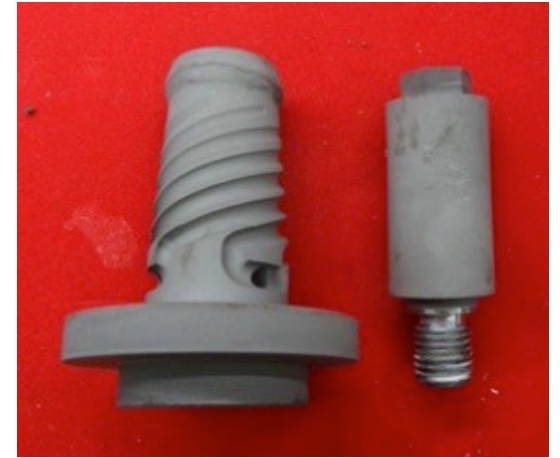
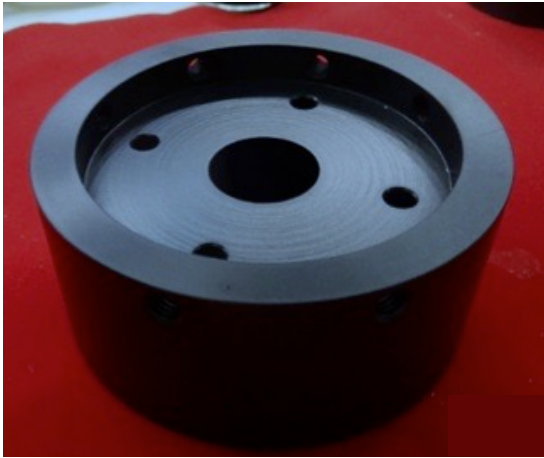
3- CarBoNiP™ coating ( $B_4C$  5 g/l)

4- Polished CarBoNiP™ coating through taping machine

5- Polished CarBoNiP™ coating through diamond tool

6- CarBoNiP™ coating + Teflon™

7- CarBoNiP™ coating + Teflon™ after abrasive cloth contribution



Extrusion layer bubble film components : CarBoNiP™ coating + Teflon™





Plastic materials reinforced mould:  
CarBoNiP™ coating + Teflon™



Extrusion screw: CarBoNiP™ coating + Teflon™

