K-EL 850®

Alternative and improved plating for ball & gate valve trims

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What is Electroless Nickel Plating ?

- Chemical technique to deposit a nickel-phosphorus alloy through an auto-catalytic process on a solid work piece

- Protection from corrosion and wear

- Self-lubrication properties facing the harsh Oil & Gas environments:
  - Abrasive and corrosive attacks
  - Temperature and pressure variations

What is K-EL 850® ?

- K-EL 850® is a composite material made from the addition of shaped *submicron* Silicon Carbide particles into high phosphorus Electroless Nickel.

- K-EL 850® is used to enhance
  - Performance
  - Protection
  - Increased lifetime on Oil & Gas components

Solution of K-EL 850®

K-EL 850® for Oil & Gas applications

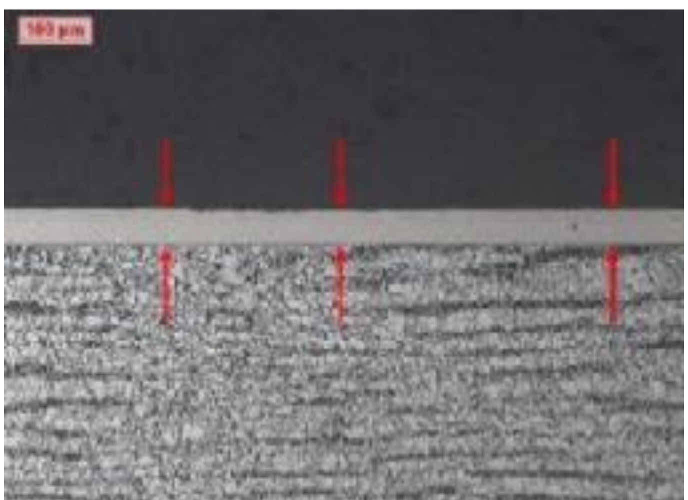
- ✓ Reduced wear
- ✓ Reduced friction
- ✓ Temperature ranging from cryogenic up to 850 °C
- ✓ Allow the use of less noble alternative steel base materials
- ✓ Replace environmentally unsound coatings
- ✓ Reduced lead time

Extended characterization and lab testing

Surface thickness

- Uniform and measurable
- Smooth surface
- Uniform multilayer deposit
- No need for post coating grinding

K-EL 850® coated ball

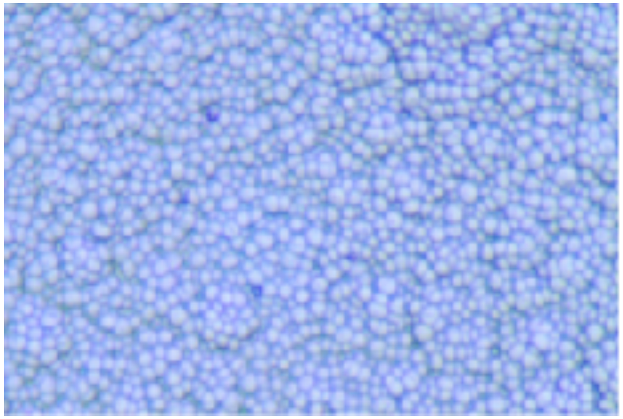


Cross section of double layer K-EL 850® deposit

Microscopic observation of 50µ K-EL 850® multilayers

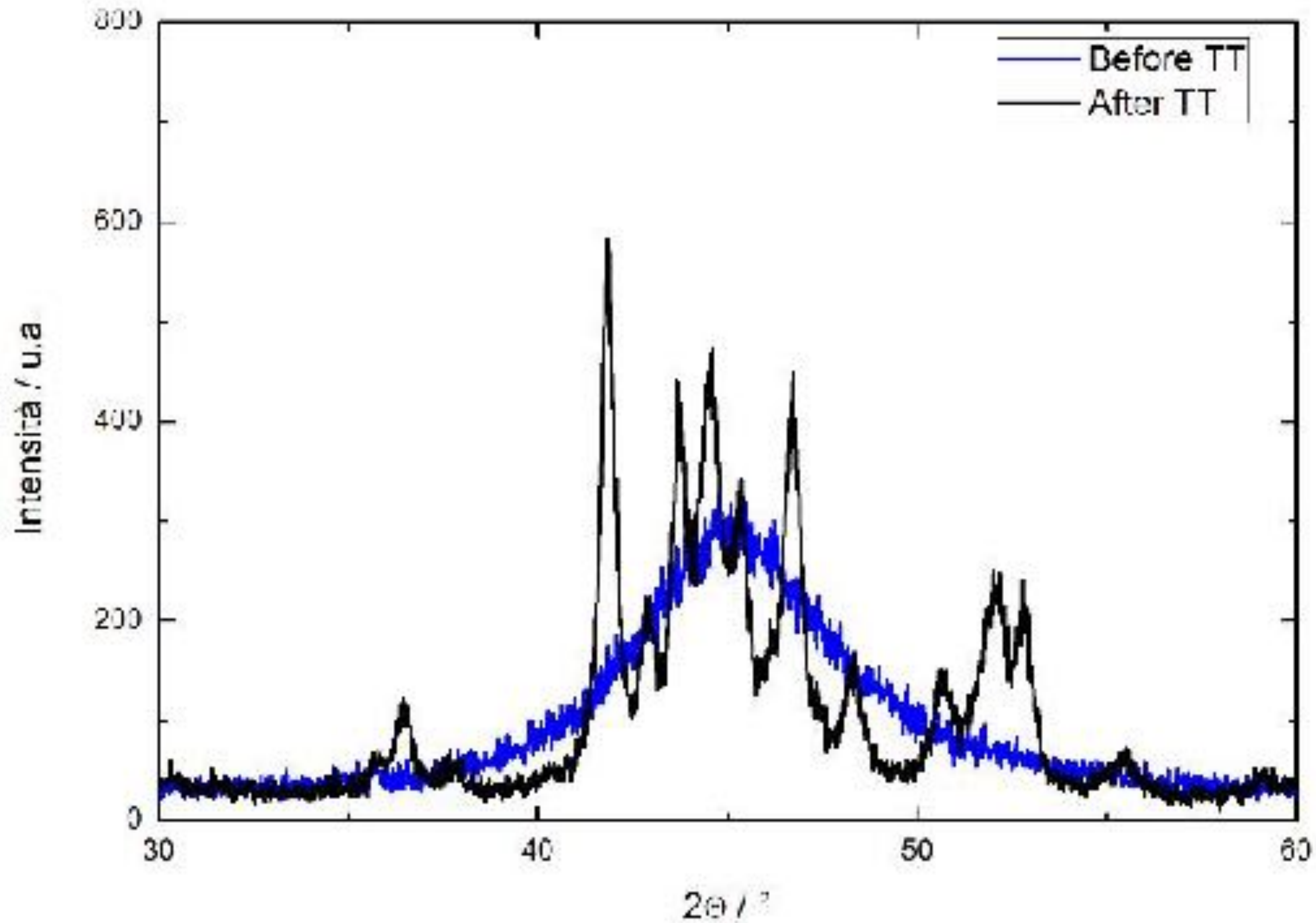
Roughness

- Unique shape and dimension of submicron silicon carbide particles
- Low friction characteristics also at high temperature
- Same roughness of the substrate



Sub-micron particles of nickel silicon K-EL 850®

X-Ray



Phase transformation with partial retaining of the amorphous phase after thermal treatment

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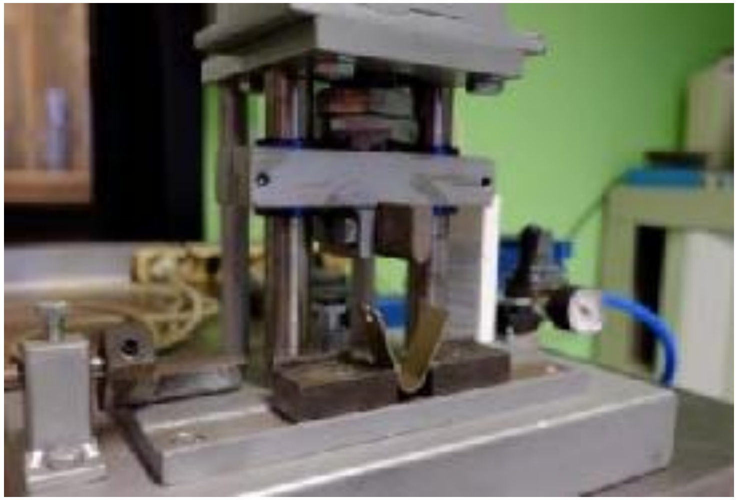
Hardness

- Minimum hardness guaranteed : **1150 +-50 HV (100 g load)** on all coated surfaces
- Uniformity of coating
- Uniform distribution of sub-micron silicon carbide particles

Bond strength and heat resistance

- Preliminary results: over 370 MPa
- Thermal resistance from -200 °C up to 850 °C
- Adaptation to all base material deformation subject to thermal expansion



Bonding test according to ASTM B571 PAR 3

Wear resistance

Coating or base material	Taber wear index per 1000 cycles (10^4mils^3)
K-EL 850®	1.159
HVOF Tungsten Carbide	> 1.44**
Electroplated Hard Chromium	4.699
Tool steel hardened RC 62	12.815

Taber test results of K-EL 850® compared to alternative surface treatments and a hardened tool steel

** Henke et al., Wear 256 (2004) 81–87

Corrosion resistance

- High resistance to corrosion thanks to ENP matrix and a multi-layer composite solution with no porosity:
  - Underlayer of nickel
  - Overcoating with sub micron silicon carbides
  - High performance in neutral, acetic and higroscopic chamber also in sour environment

K-EL 850®

Ferroxyl test results

K-EL 850® for valve trims

- ✓ Application time
- ✓ High quality standards and proven process
- ✓ Temperature ranging from cryogenic up to 850°C
- ✓ Uniform application
- ✓ Reduced components wear
- ✓ Reduce friction
- ✓ Reduce lead time

Immersion process of K-EL 850®

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Application testing phase at Schuck's facility

Practical case study: comparative test between two 24" Schuck's trims coated with TCC and K-EL 850® aiming at measuring the Break to Open and Running torque of the two alternatives.

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SCHUCK GROUP
www.schuck-group.com

Description of the kit used

- 2 state of the art simple piston effect kits of 24” metal to metal class 900 with a base material of carbon steel ASTM A694 F60
- 1 kit coated with Tungsten carbide lapped after grinding
- 1 kit coated with 50µ K-EL 850® lapped before K-EL 850®
- Same valve and same conditions (water, temperature, operators…)

Protocol of test

- Pre-bubble test:
  - Procedure: According to ASTM E515 – 11 with alcohol and a 6 bar pressure
- API 6D :
  - Hydrostatic shell test :235 bar
  - Hydrostatic upstream seat test : 160 bar
  - Hydrostatic downstream seat test :160 bar
  - Double block: 150 bar
  - Hydrostatic body cavity relief test : 15 bar
  - Gas low-pressure seat test each side 6 bar
  - Gas low-pressure seat test each side 0.5 bar
- Endurance test: cycles of Opening/closing with torque measurement
  - 10 open/close cycles upstream –160 bar/water
  - 10 open/close cycles downstream - 160 bar/water
- Post-bubble test
  - Procedure: According to ASTM E515 – 11 with alcohol and a 6 bar pressure
- Visual inspection

Sealing performance during high pressure opening/closing cycles

- Identical results for both kits:
  - No leaks according to ISO 5208 rate D with the bubbles unit of leakage rate
  - No leak at high pressure with water (160 bar)
  - No leak at low pressure with air (6 bar)
  - No leak at very low pressure with air (0.5 bar)
  - Bubble test after endurance test according to ASTM E515 – 11 with alcohol and a 6 bar pressure

K-El 850® coated seat after endurance test

Tungsten Carbide coated seat after endurance test

Torque measurements

K-EL 850® torque: max variation of ± 7%
K-EL 850® coated valve maintain its initial properties over time

Torque measurements

First stroke measured torque: 33% lower with K-EL 850® than with TCC
After 20 cycles: torque value of K-EL 850® coated kit is half the TCC's

Conclusion

- K-EL 850® is already a viable and used alternative to HVOF type of applications, providing several benefits:
  - ✓ Reduced wear
  - ✓ Reduced friction
  - ✓ Wide temperature range
  - ✓ Corrosion protection
  - ✓ Reduced lead time

- Extensive lab and valve test are currently on going to further assess and measure the full potentiality of this innovative coating.