

Application of surface modifications and coatings in suspension systems

Dr. auf dem Brinke | June 2010

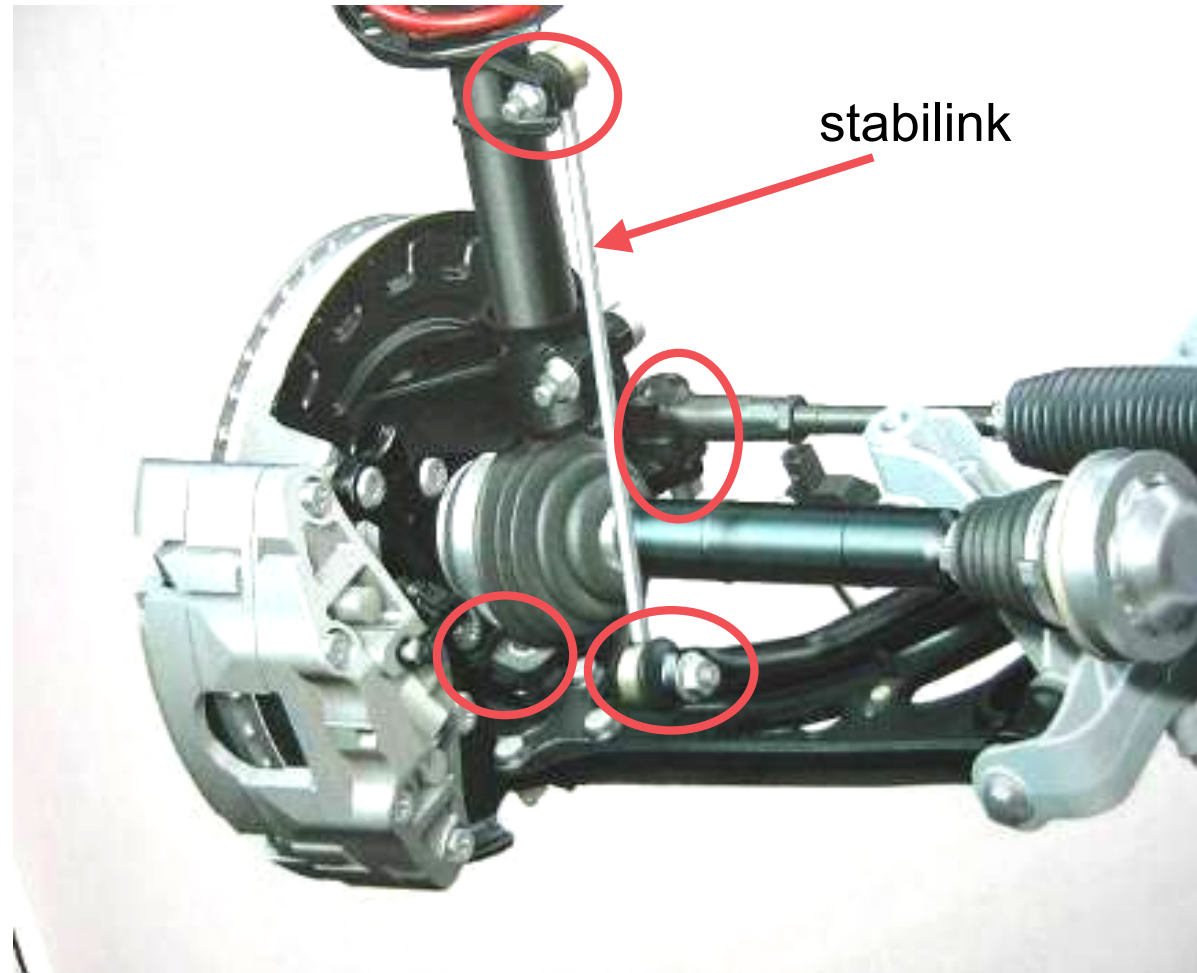


Modern front wheel drive suspension Application Ball Pin – Corrosion and Friction



support ball pin

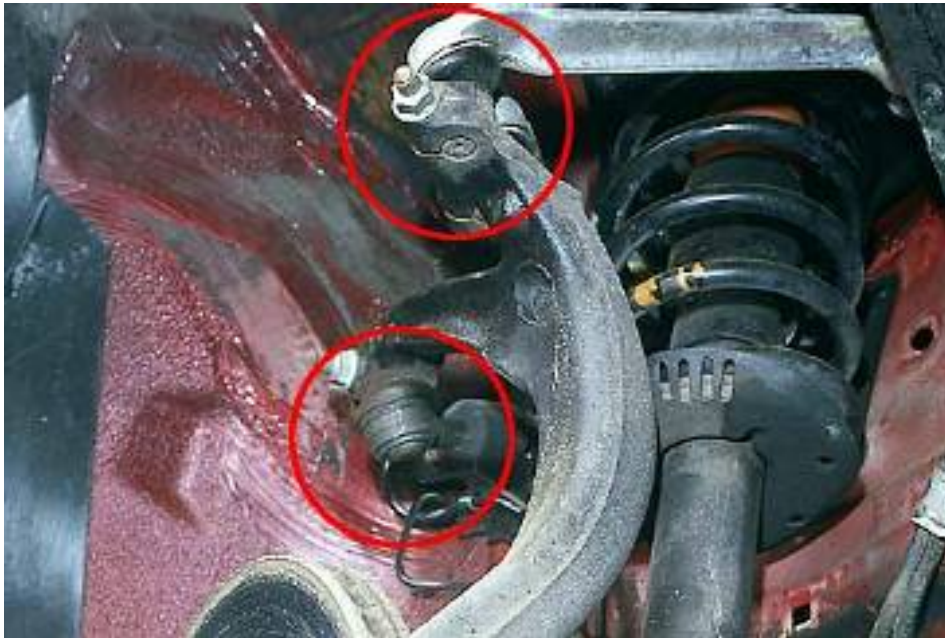
front axle with cross link



Situation ball pin today

Application Ball Pin – Corrosion and Friction

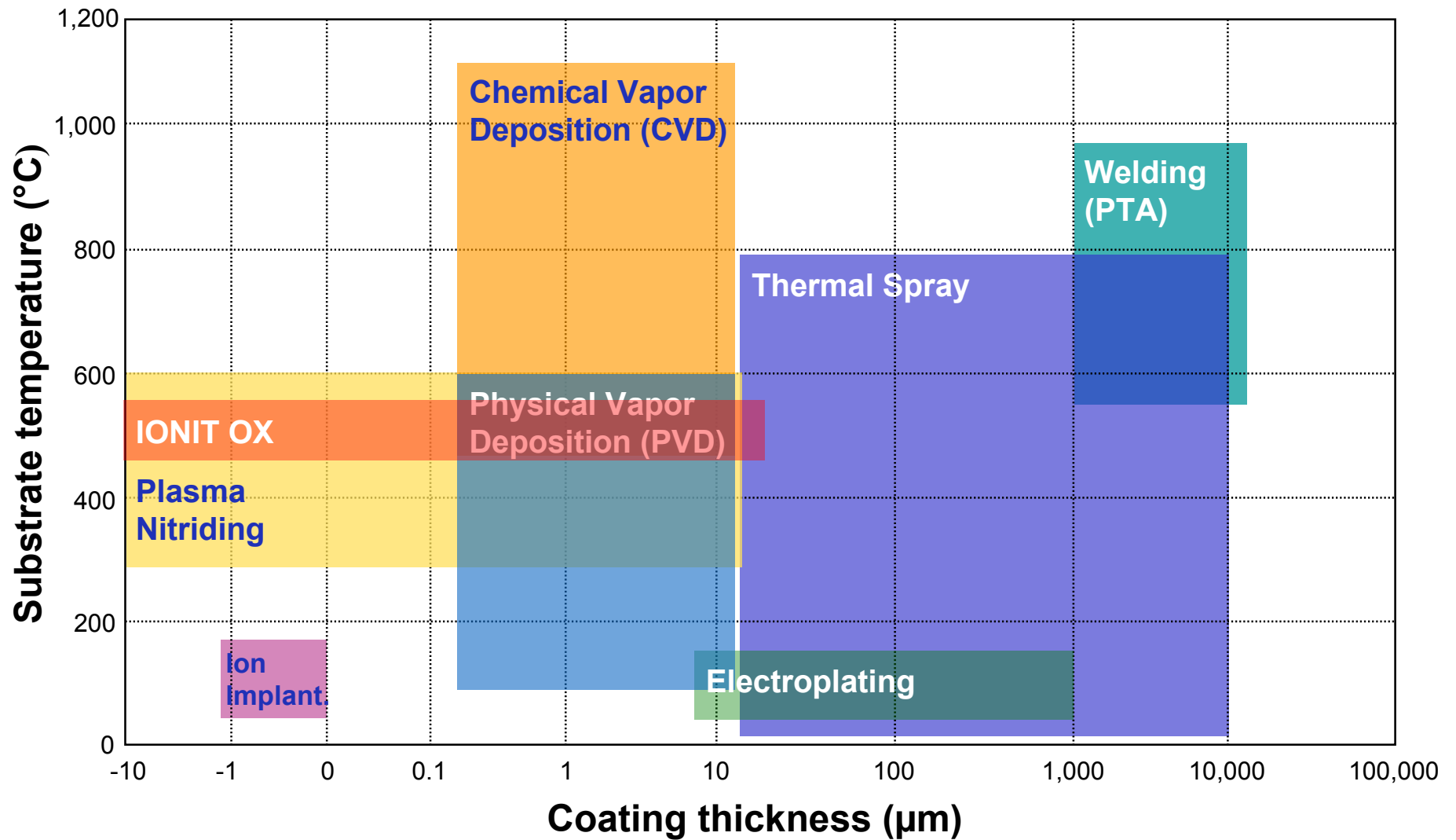
- ball joints linkage – no contact corrosion in combination with light alloy suspension



front axle with cross link

Our tools

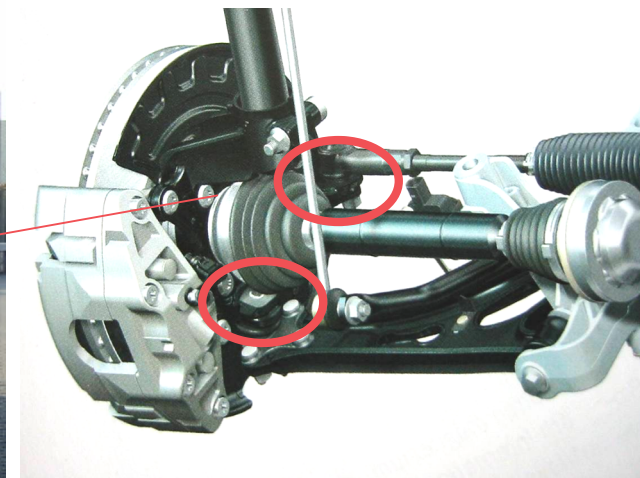
Classification of Key Surface Treatments



Graph for illustration purposes only, not scientifically exhaustive

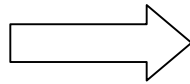
Finding out about wear in service

- objective of the study: Verifying the performance of IONIT OX treated ball joints
 - ball joint in company car VW-Touran (car driven by Sulzer sales agent)
 - road performance: 173790 km in 2 years on the road



IONIT OX ball joint
installation

The ball pin is near to new condition



Feedback of VW Garage:

"Since the introduction of IONIT OX no ball joints had to be exchanged any more. There is no more necessity to keep spares on stock for this component.

Before IONIT OX untreated ball joints were installed that had to be replaced regularly after 60.000 km "

(Garage foreman, VW SZ – 18.01.2006)



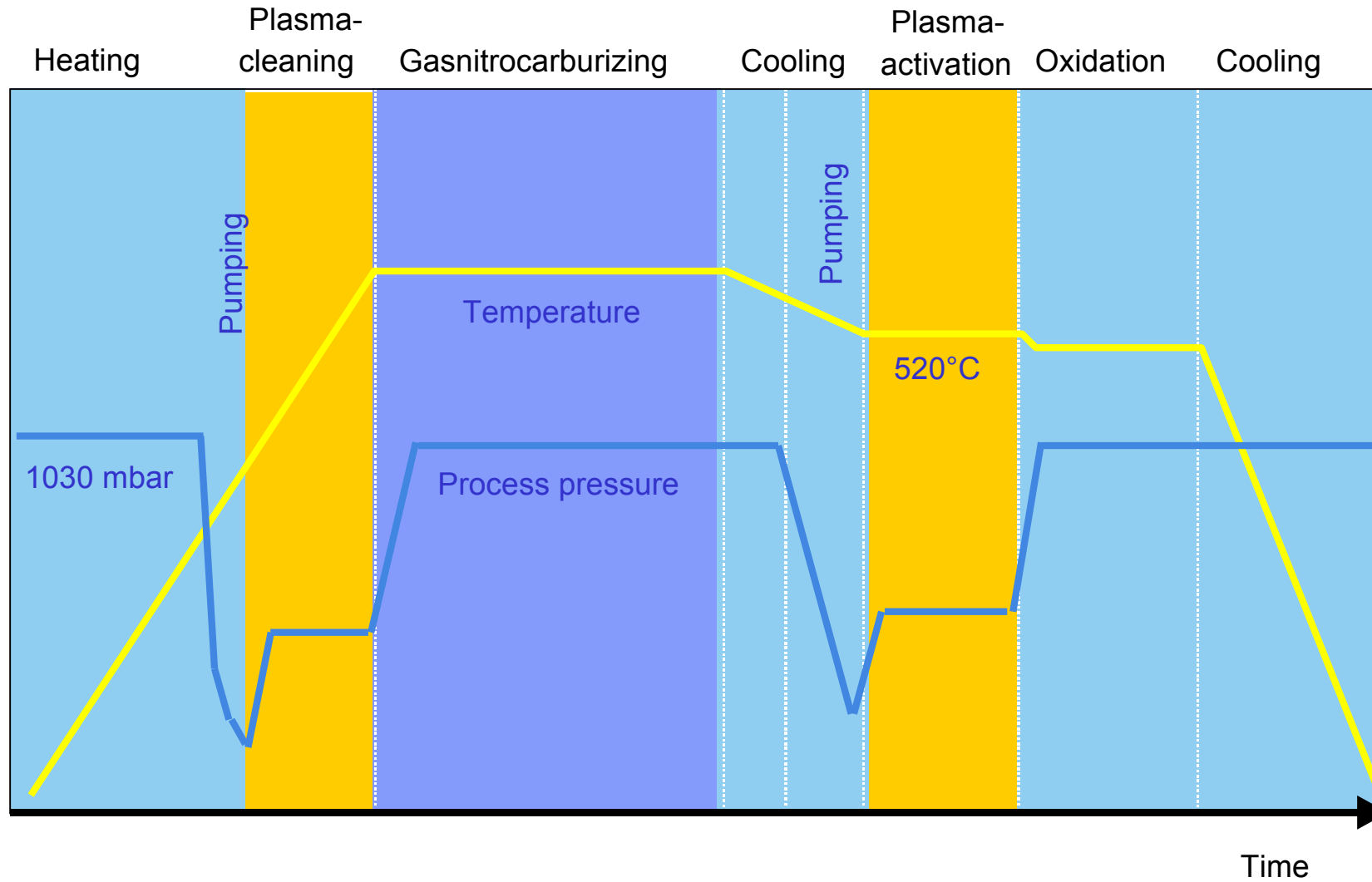
IONIT-OX: no rust after 173790 km

What is the IONIT OX[®] Process ?

Combination process of

- ➔ Gasnitriding/-nitrocarburizing
to increase the surface hardness by the
formation of Fe_{2-3}NC
- ➔ Plasma-activation
to activate the surface for oxidation
- ➔ Oxidation
to form a Fe_3O_4 layer (Magnetite)
for corrosion protection

IONIT OX[®] Process Sequence

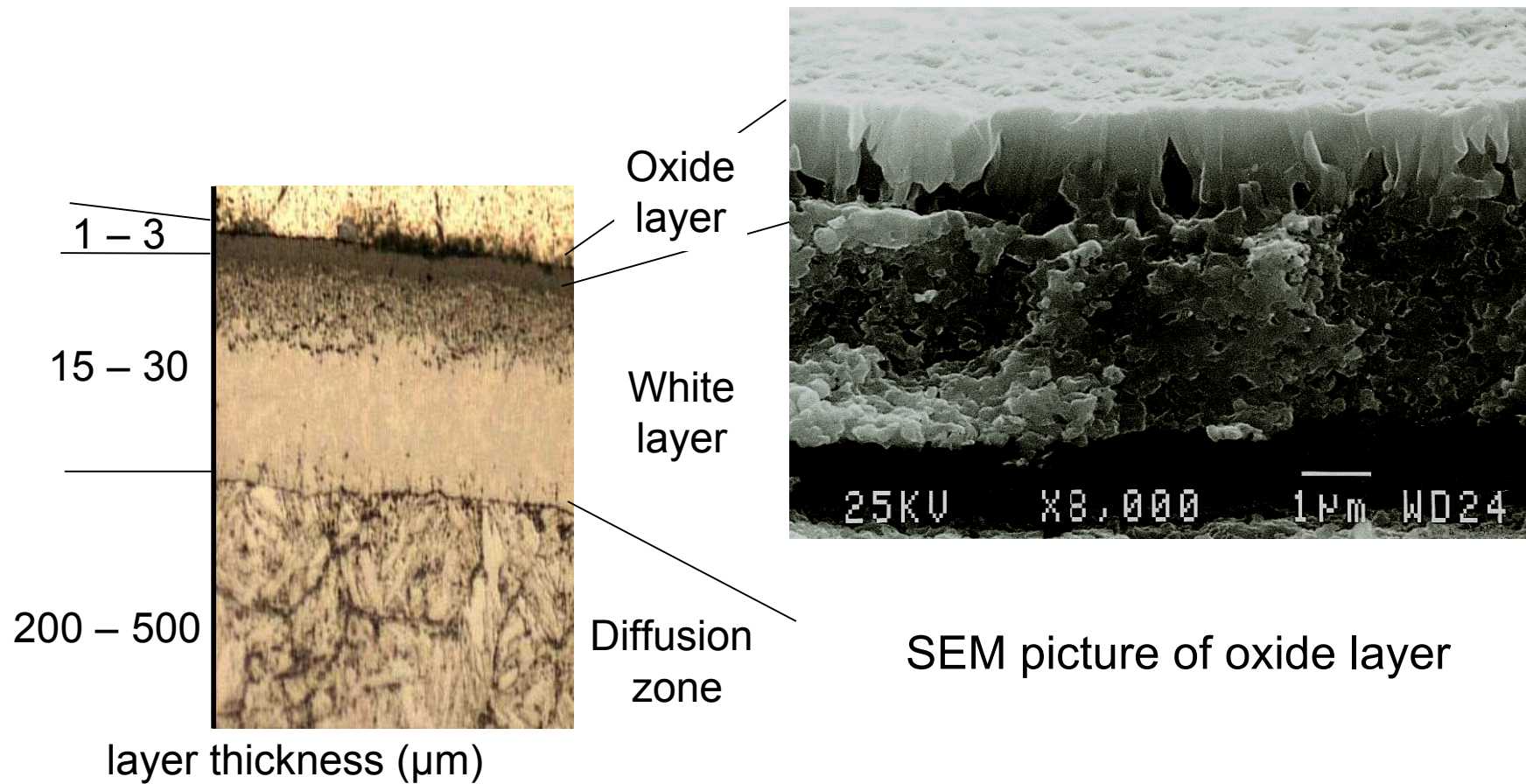


IONIT OX[®] Process

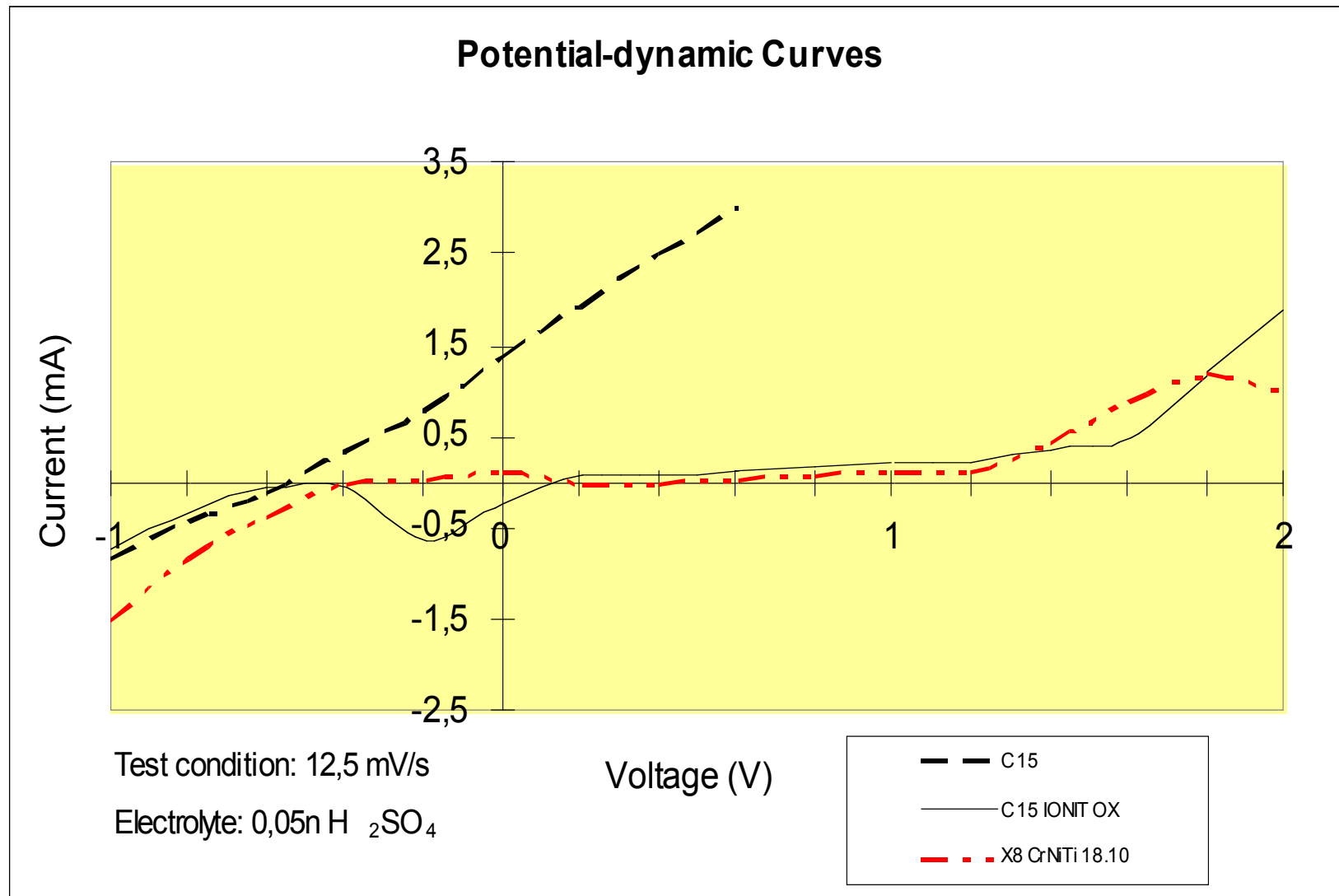
What is the role of the Plasma-activation step in the IONIT OX[®] process?

- **fine cleaning of surface** by sputtering
- Sputter-ions create lattice defects working as **crystallization-seeds during oxidation** thus leading to a dense and **fine-grained oxide-layer**
- Compensation of nitrogen and carbon diffused out during cooling cycle before oxidation → ϵ -nitride

IONIT OX[®] Layer Pictures



Corrosion Performance?



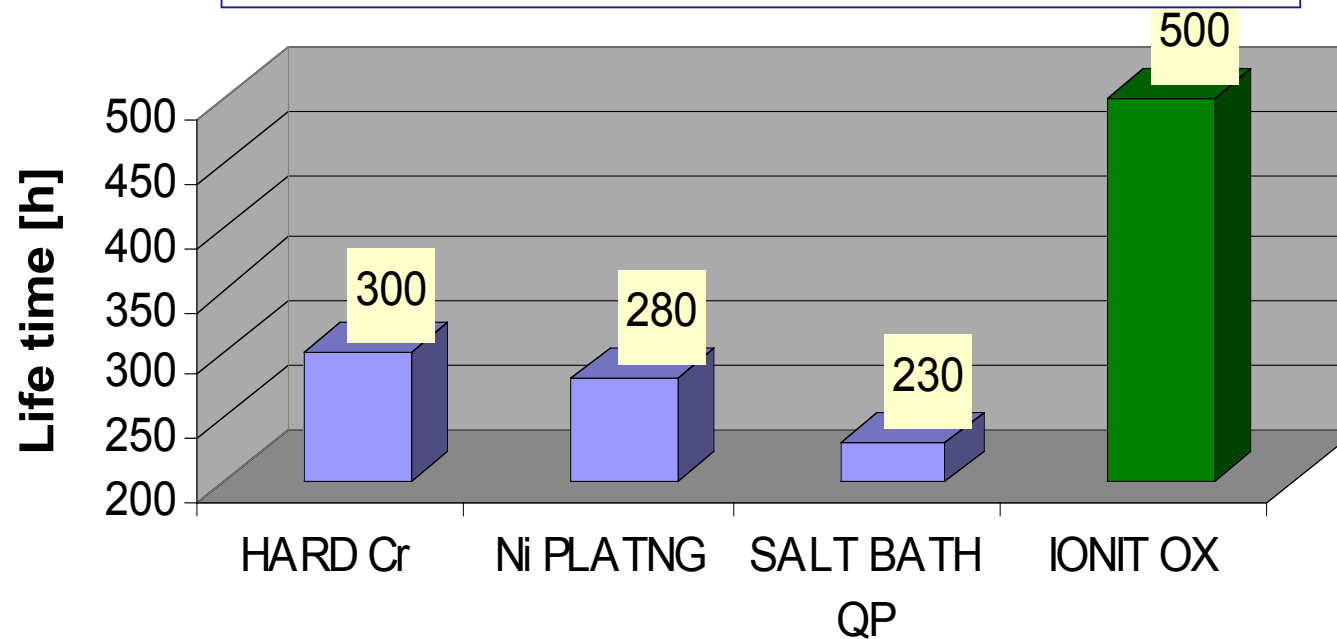
Corrosion Resistance!

Basic Material: C 35

Layer Thickness of Hard-Cr and Ni-Plating: 20 μm

IONIT OX[®]: Compound Layer >15 μm Oxide Layer: 2 μm

Salt Spray Test DIN 50021 SS / ASTM B 117

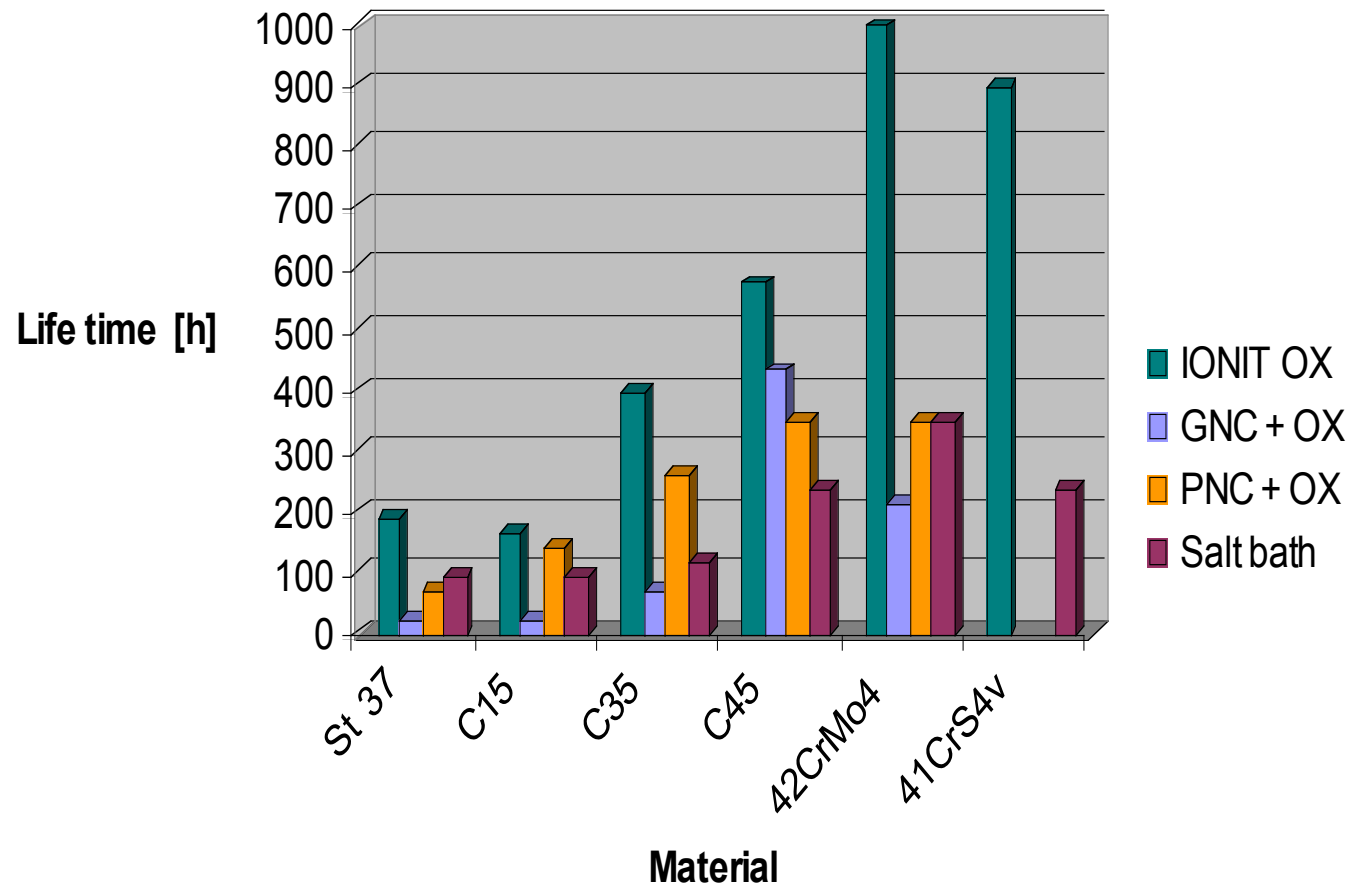


IONIT OX[®] in corrosion test

Reference tests with identical samples

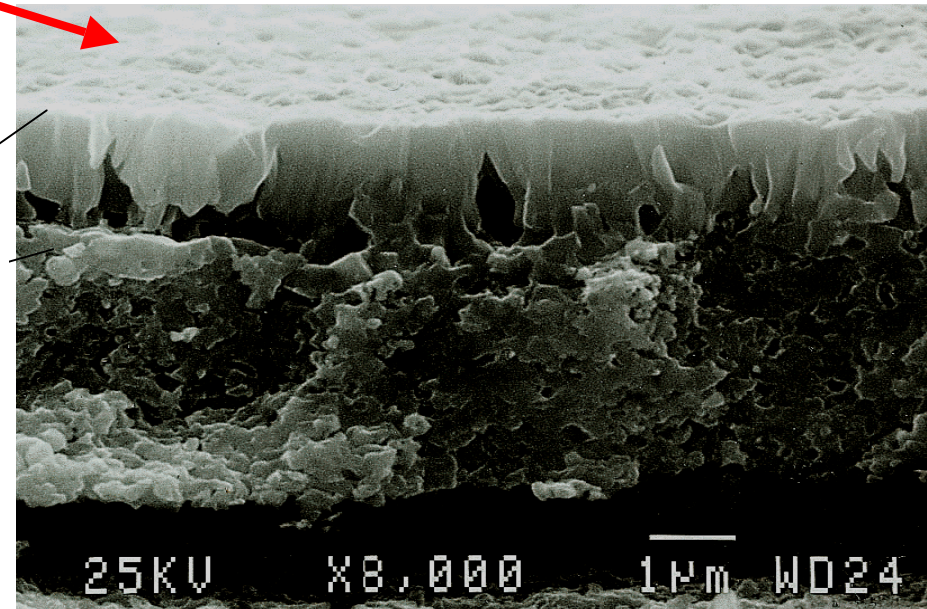
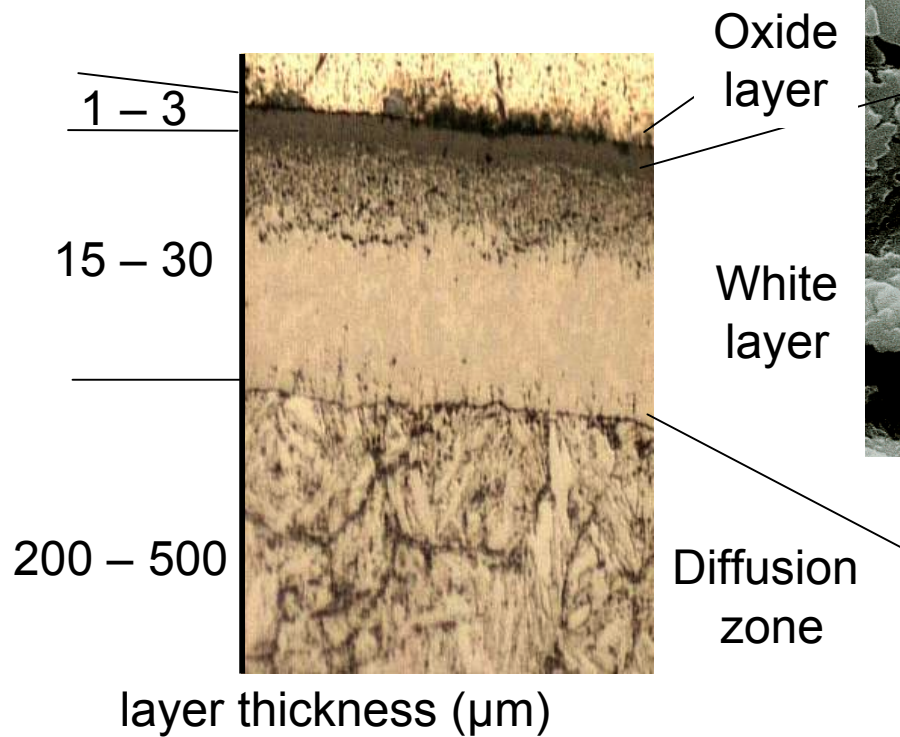
Test results from similar treated test coupons of the same batch

Corrosion resistance acc. to ASTM B 117



Wear, corrosion and friction? IONIT OX[®] Process

Smooth surface structure
reducing friction

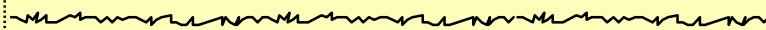


SEM picture of oxide layer

What about surface roughness?

■ Surface Roughness of IONIT OX[®] treated Components

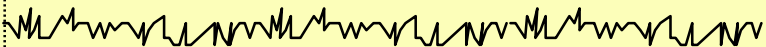
untreated, polished



Ra = 0,06 μm, RZ = 0,59 μm
R_{MAX} = 0,84 μm, RPM = 0,21 μm

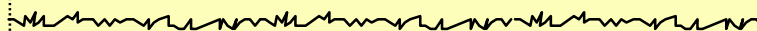


IONIT OX[®]



Ra = 0,47 μm, RZ = 1,77 μm
R_{MAX} = 1,82 μm, RPM = 0,66 μm

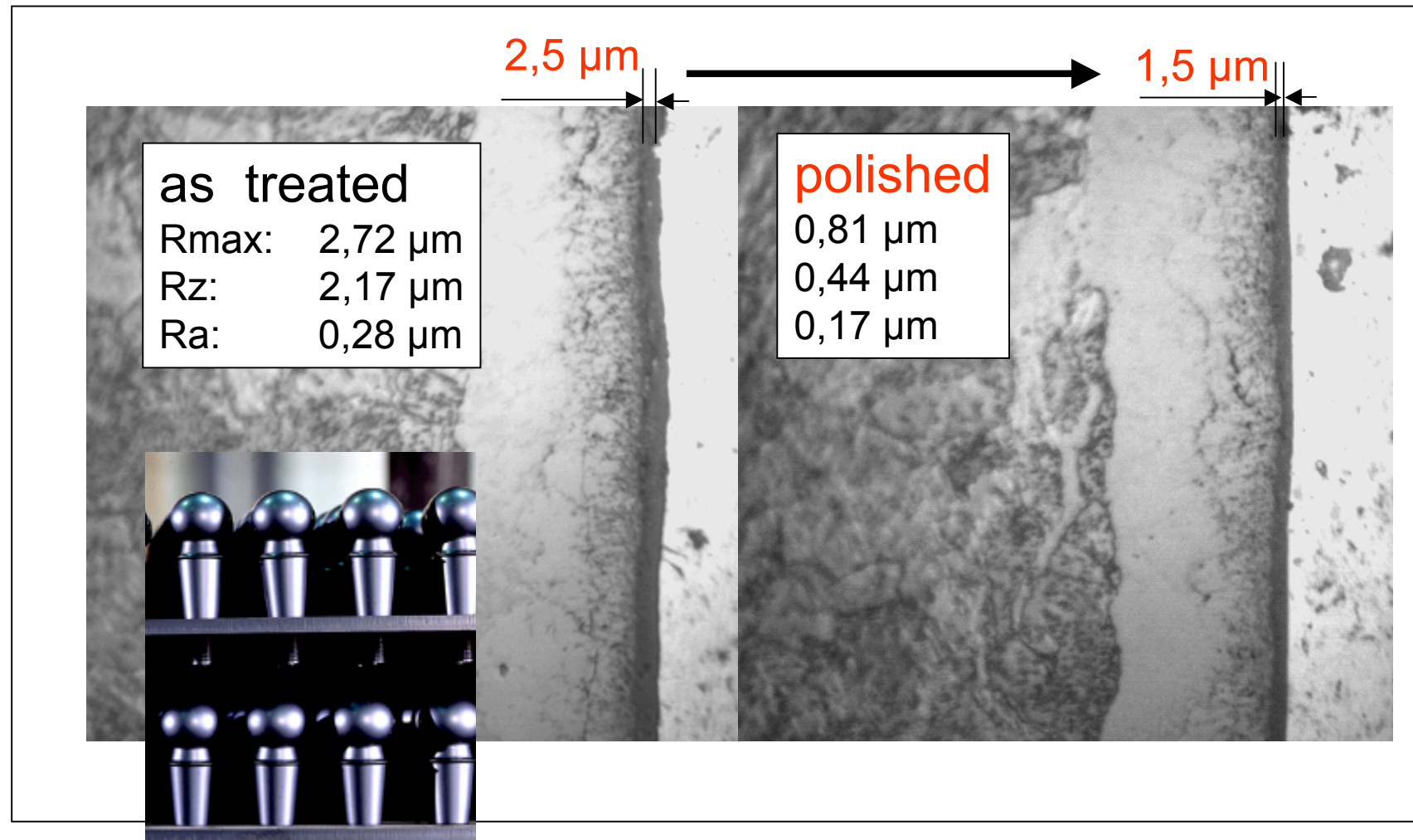
IONIT OX[®], polished



Ra = 0,09 μm, RZ = 0,72 μm
R_{MAX} = 0,86 μm, RPM = 0,23 μm

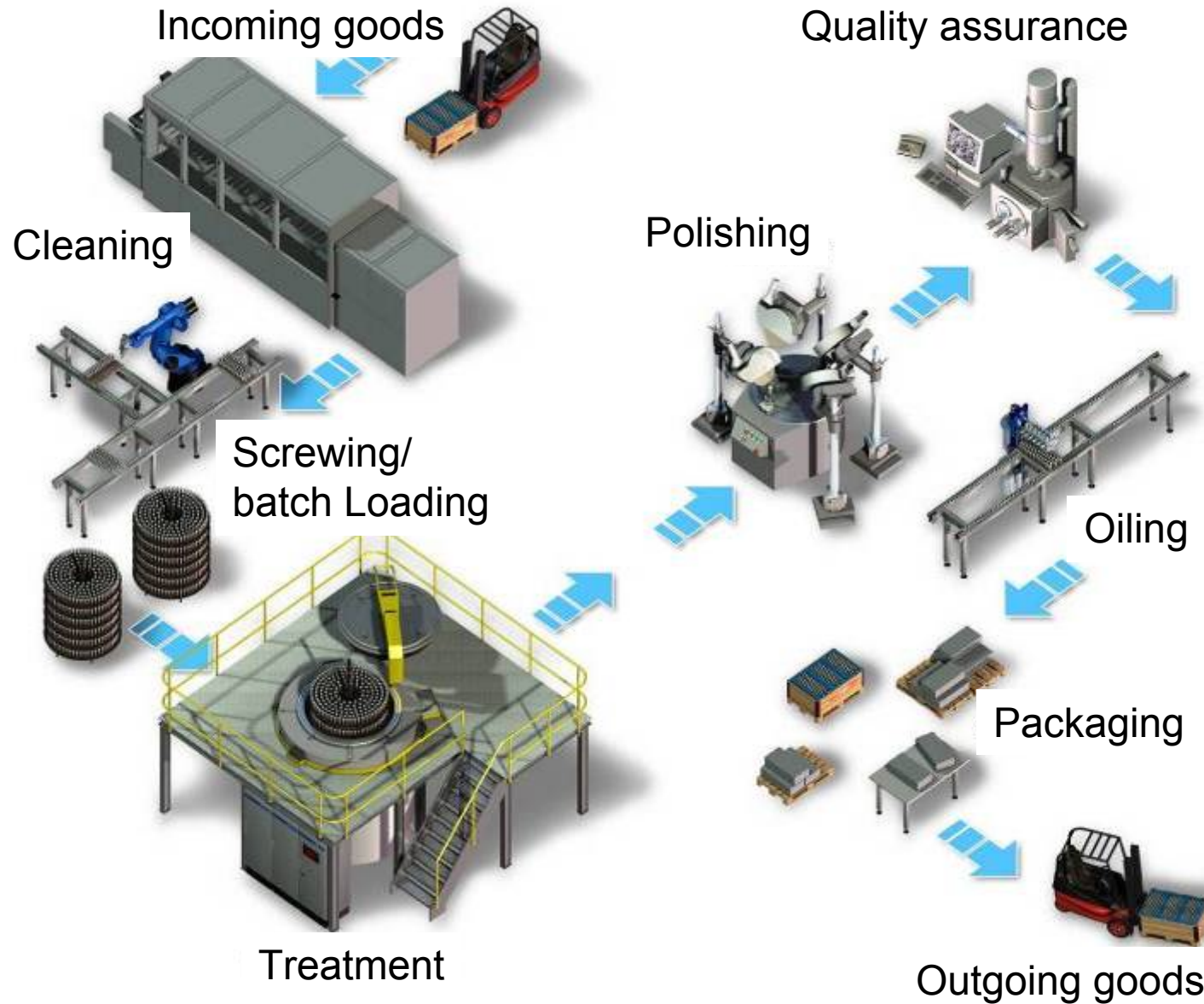
Sufficient layer after finishing?

- Nitrocarburizing, Oxidizing and Polishing 42CrMoV4



Application Ball Pin

Batch Process and Mass Production?



Chrome-6-Alternative

IONIT OX[®]

Korrosionsschutz
Corrosion Protection

SULZER

Sulzer Metco

Chrom-6-Ersatz in der Hydraulikindustrie.
Chrom-6-Alternative in the hydraulic industry.

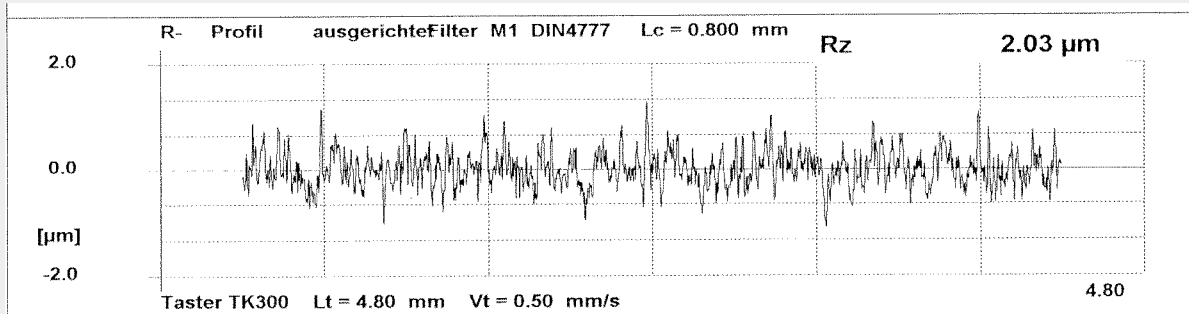


www.chrom-6-ersatz.com

Potential for other applications

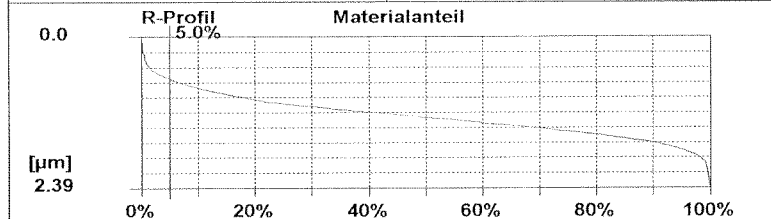
Interaction piston rod with seals

Test by Busak & Shamban of IONIT OX[®] Treated Hydraulic Piston Rod



Rmr0	0.67 µm
Rmr01(5.0 %)	0.00 µm
Rmr02(10.0 %)	0.14 µm
Rmr03(15.0 %)	0.24 µm
Rmr04(20.0 %)	0.33 µm
Rmr05(25.0 %)	0.39 µm
Rmr06(30.0 %)	0.44 µm
Rmr07(35.0 %)	0.49 µm
Rmr08(40.0 %)	0.53 µm
Rmr09(45.0 %)	0.57 µm
Rmr10(50.0 %)	0.61 µm
Rmr11(55.0 %)	0.65 µm
Rmr12(60.0 %)	0.70 µm
Rmr13(65.0 %)	0.74 µm
Rmr14(70.0 %)	0.79 µm
Rmr15(75.0 %)	0.84 µm
Rmr16(80.0 %)	0.89 µm
Rmr17(85.0 %)	0.95 µm
Rmr18(90.0 %)	1.02 µm
Rmr19(95.0 %)	1.13 µm
Rmr20(100.0 %)	1.72 µm

Pt	2.63 µm	Rpk*	0.87 µm
Wt	0.52 µm	Rpk	0.39 µm
Ra	0.27 µm	Rk	0.87 µm
Rz	2.03 µm	Rvk*	0.68 µm
Rmax	2.24 µm	Rvk	0.31 µm
Rt	2.39 µm	Mr1	12.0 %
		Mr2	91.4 %



STATISTIK n = 2						
Nr.	Kenngrößen	Xq	Range	S	Xmax	Xmin
1	Ra	0.26	0.02	0.01	0.27	0.25
2	Rz	1.88	0.29	0.14	2.03	1.74
3	Rmax	2.32	0.15	0.08	2.39	2.24
4	Rt	2.39	0.00	0.00	2.39	2.39
5	Rpk	0.28	0.22	0.11	0.39	0.17
6	Rk	0.85	0.05	0.03	0.87	0.82
7	Rvk	0.43	0.24	0.12	0.55	0.31

- Results :**
 (Tests carried out for 35 different coatings)
- excellent profile (see attached) 50-70 % Tp
 - seals have longer lifetime than hardchrome, nitriding or ceramic plating
 - lowest friction value (wet: 0,05 dry: 0,35)

IONIT OX ranking no. 1 for PTFE and TPU Seals

What about dimensional tolerance?

Application: differential gear shaft



Process IONIT OX®

- Improvement of mechanical properties
- Raising of endurance limit
- reproducible dimensional changes
- Good wear and friction properties

Technical benefits

- Reduced friction
- No regrinding necessary
- Easy assembly

Requirements

- High endurance limit
- Axial, radial and cross loading
- Close tolerance k6 (app. 10 µm)
- Reduced friction force
- Excellent wear behaviour
- No contact corrosion

Potential savings

- Reduction to 2 production stages:
- Machining to final measures
- IONIT OX® - treatment



Shift shaft

- transfers shifting into the gear box



IONIT OX[®] treatment

Reduction of production process to only 2 steps:

- 1.) Machining
- 2.) IONIT OX[®] - treatment

Cost savings:

Savings due to conversion to IONIT OX[®] approximately 30 % per piece .

Growing demand by BIO-fuels

IONIT OX[®] of pump cover for injection pump

Demands

- Guaranteed resistance against corrosion and tribo-oxidation.
- Low adhesion to fuel.
- Resistance against intruding abrasive particles.
- Guaranteed straightness, e.g. lowest distortion
- High endurance limit
- no problems with alternative fuels like
 - biodiesel (up to 20% water)
 - bioethanol



Racing camshafts IONIT OX treated



What else can we do – Gas springs



IONIT OX[®] Parts for the Automotive Industry

ball pivots, guide bolts, gear selector shaft, piston for gas springs, etc.

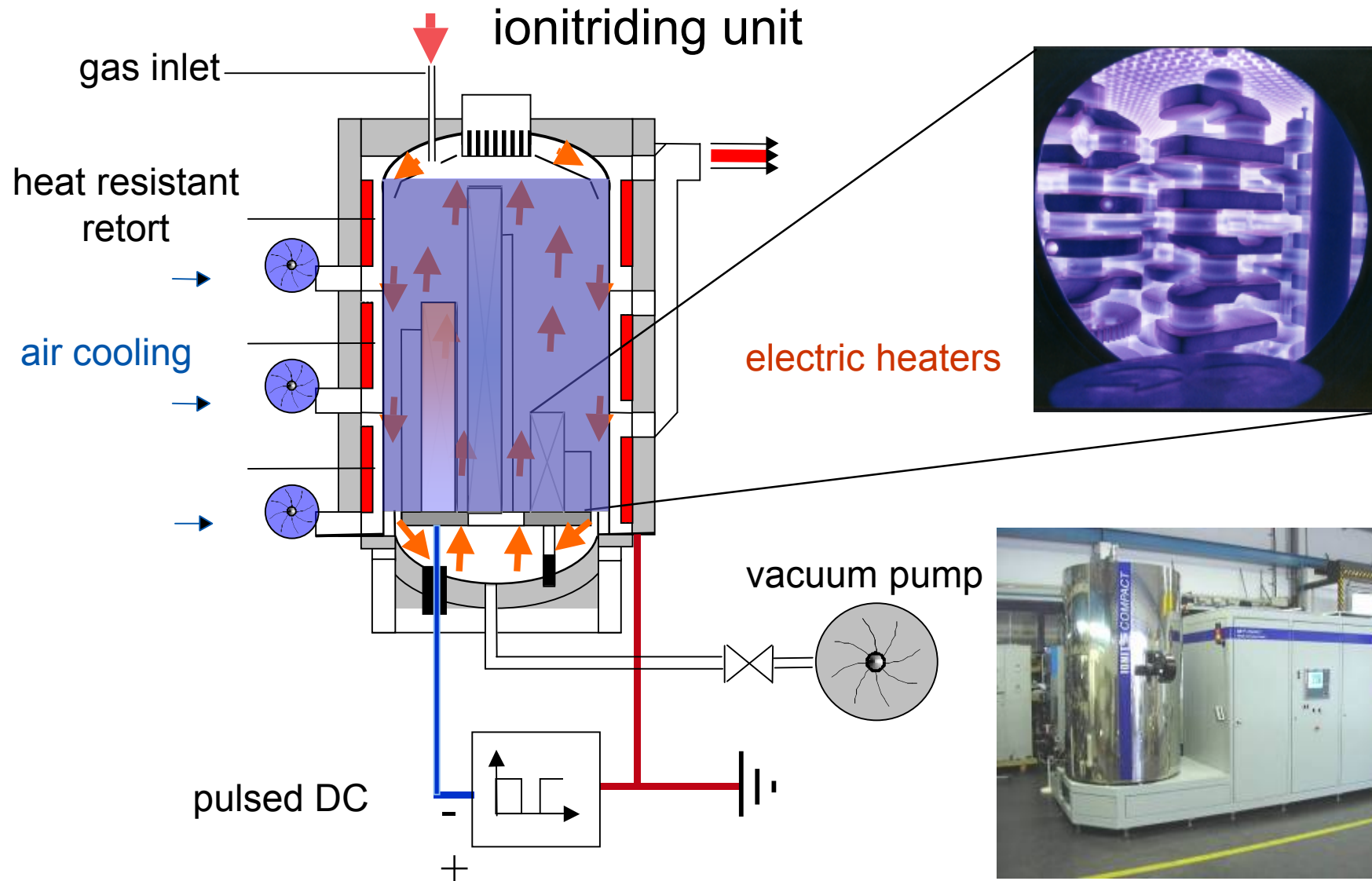


Specification

- high corrosion resistance
- improvement of wear resistance and sliding properties
- increase of fatigue strength and lifetime
- no contact corrosion to Aluminium

Driving High Technology

Nitriding Systems: plasma nitriding



Applications railed vehicles



- Coupling element
- railed vehicles
- Voith Schaku

Application IONIT OX[®] - Substitution Chrome



Mobile crane hydraulics (each 2 t)

Requirements

- better corrosion resistance than Chrome
- Resistance to abrasive particles
- better gliding properties
- no regrinding after the treatment

Production flow:

- turning of piston
- grinding of cylinder face
- IONIT OX[®] - treatment



Off Shore IONIT OX[®] application

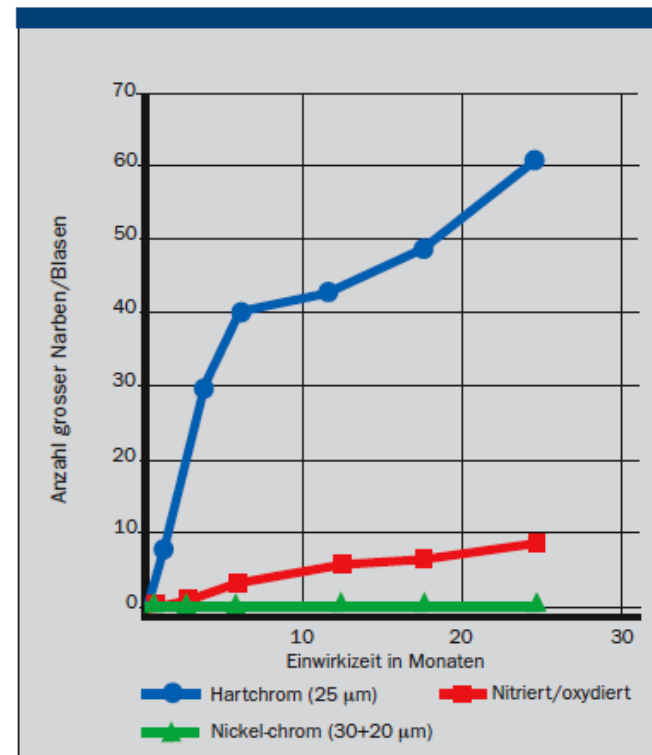
Body for oil drilling system

Requirements

- excellent corrosion resistance, better than Chrome
- Resistance to abrasive particles
- excellent sliding properties
- low breakaway torque (bearing load 350 t)



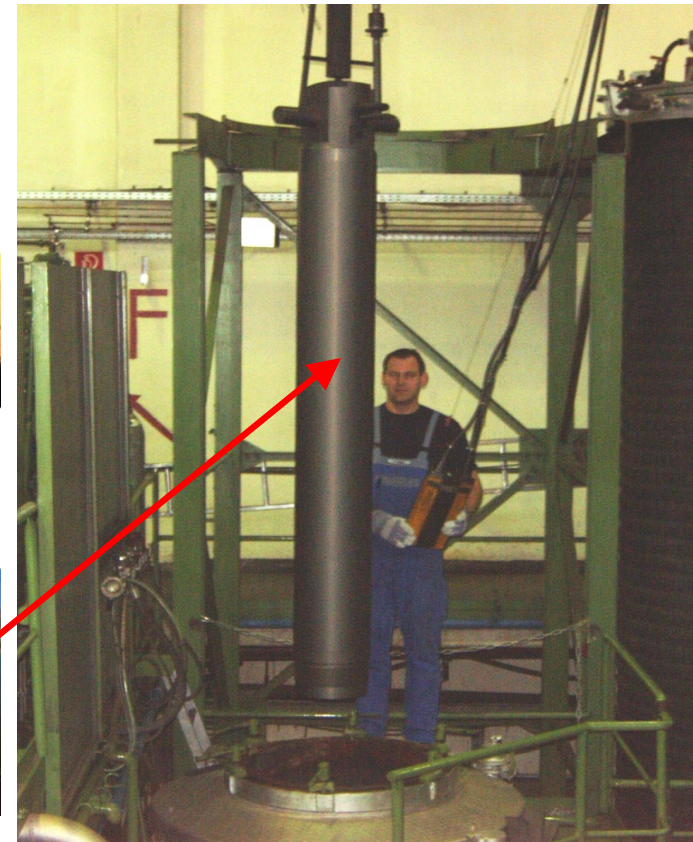
Langzeittest mit Kolbenstangen Im Meeresklima



Quelle: Swedish Institute for Production Engineering
Bericht Nr. 90811

Engineering applications

- **Finzel Hydraulics:** Heavy rod for off-shore hydraulic equipment, IONIT-Ox coating





Thank you for your attention !