



PCT

Protective Coating Technology

PCT MAO's
Enhanced
Performance by
Specially Designed
Sealers for
Superior Service &
Environments

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE NOV 2014		2. REPORT TYPE		3. DATES COVERED 00-00-2014 to 00-00-2014	
4. TITLE AND SUBTITLE PCT MAO's Enhanced Performance by Specially Designed Sealers for Superior Service & Environments				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) PCT Protective Coating Technology, 103 Halutzei Hatasia St., Haifa Bay, 26110 Israel,				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES ASETSDefense 2014: Sustainable Surface Engineering for Aerospace and Defense, 18-20 Nov 2014, Fort Myer, VA.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 32	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



PCT - Protective Coating Technologies develops and applies unique corrosion-resistant protection solutions where other coating methods have failed.



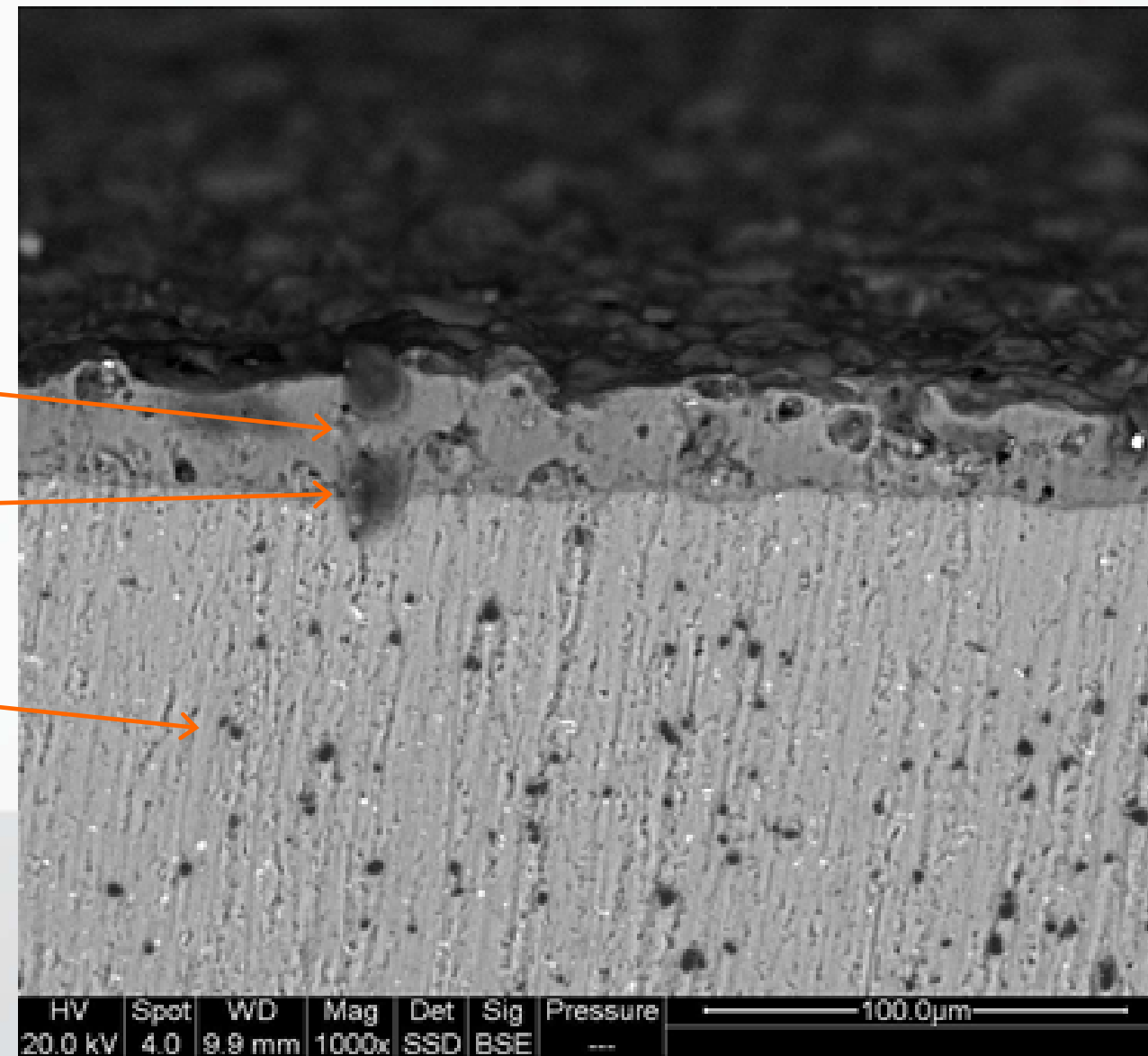
Current Technologies deployed by PCT are:

- Micro-arc oxidation (lower energy)
- Organo-ceramic sealing
- Organic Sealing in Vacuum
- Aluminized Steel

Dense Oxide Functional Layer

Intermediate Bonding Layer

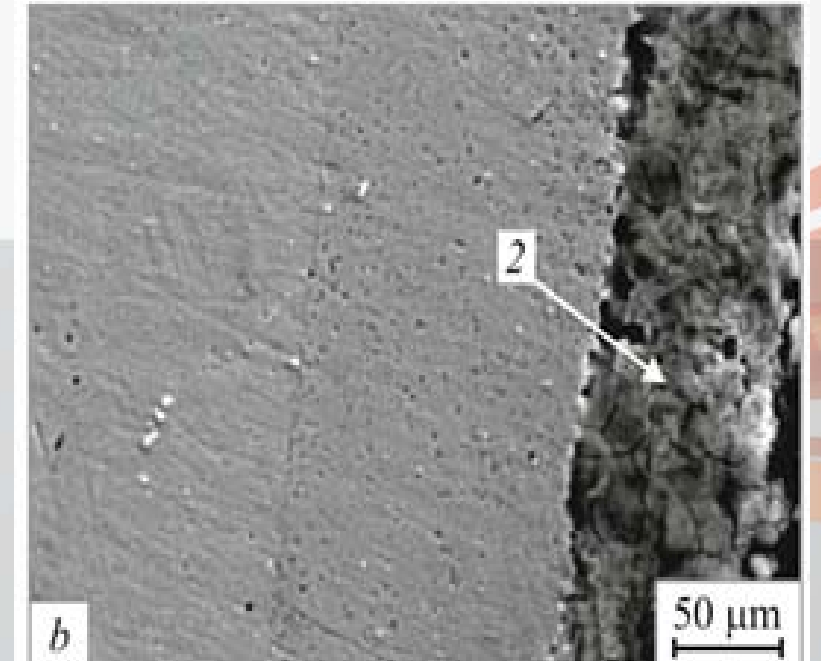
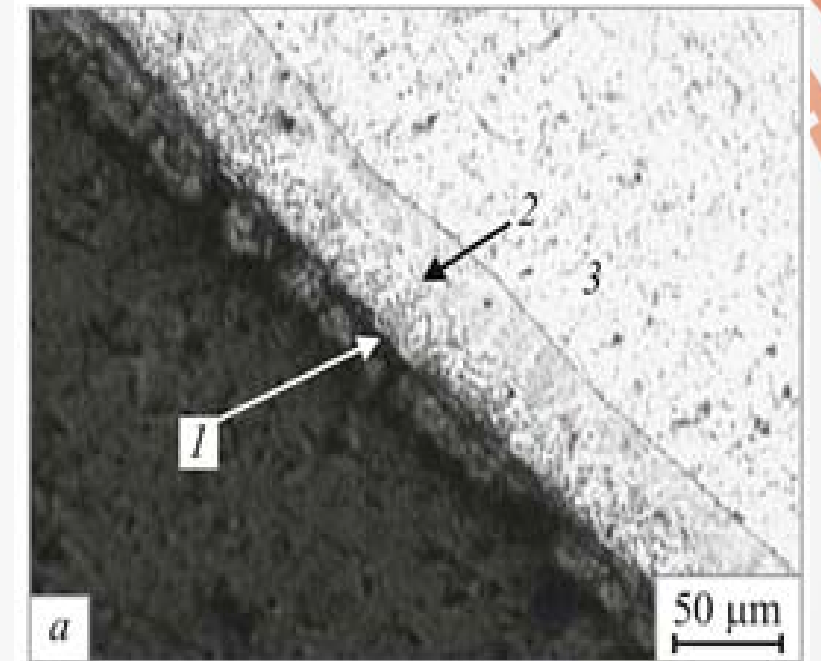
Substrate



The PCT Layer

Aluminized Steel Facts

- Aluminized steel became commercially available in the 1950's. Similar to the galvanizing process, aluminum is metallurgic ally bonded to the steel surface, providing excellent heat reflectivity and corrosion protection.
- Traditional Aluminized Steel (ASTM-A463) is hot-dip coated on both sides with an aluminum/silicon alloy coating.
- PCT's Process is with low silicon content.
- Aluminized Steel + PCT MAO can be a cost effective alternative to Stainless Steel, Super Duplex and Titanium.



PCT Aluminized Steel For MAO

PCT Solutions for Steel

Optimal protection of steel from erosion and corrosion:

Step-1: Aluminization of steel

- Coating the surface by Aluminum.

Step-2: MAO Micro-arc Oxidation

- Converting the surface to hard protective ceramic layer.

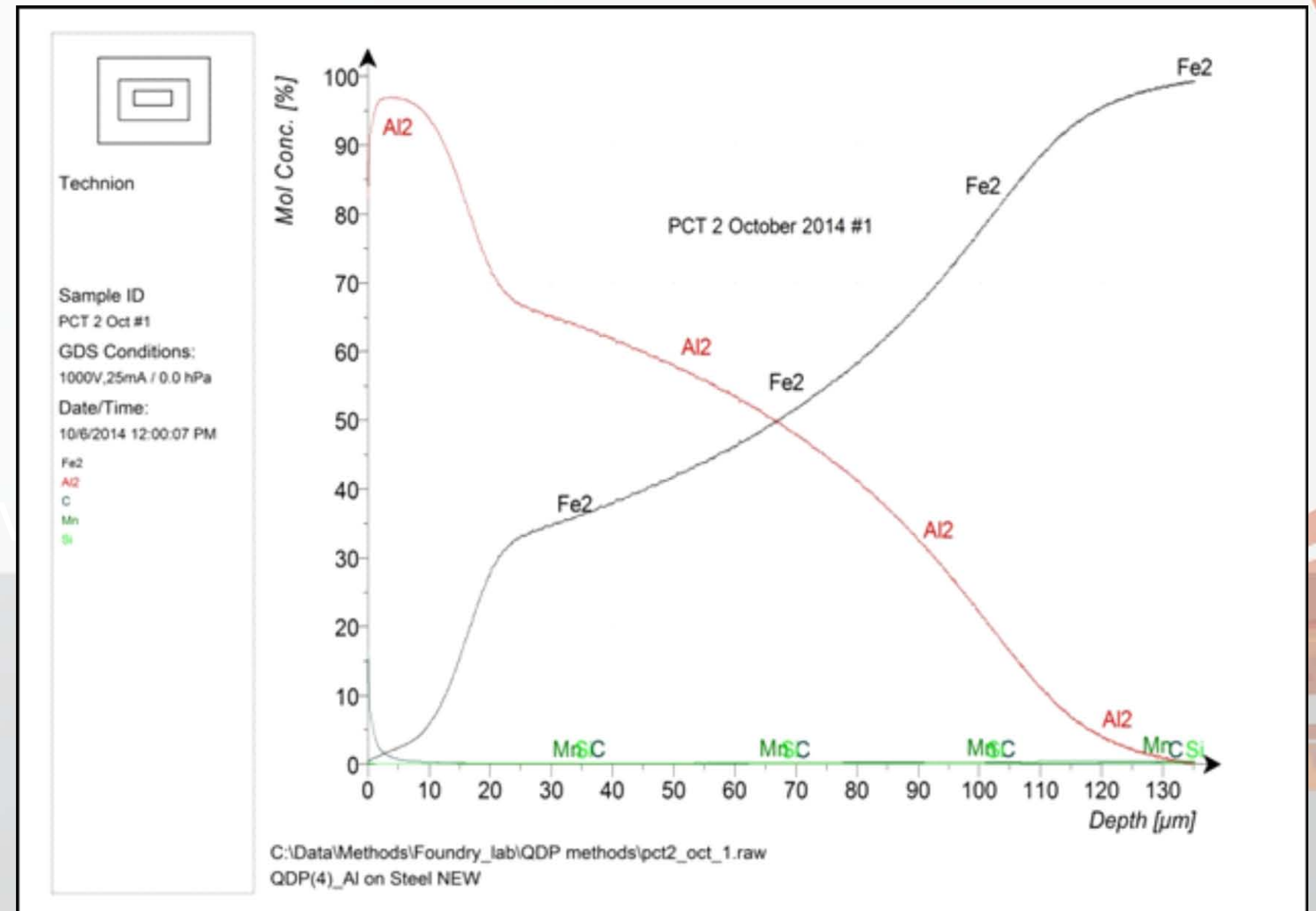
Step-3: PCT sealer (if necessary)

- Fills and planarize the pores in the ceramic layer to increase chemical resistance.

Step-1: Aluminization of Steel

Hot deep process conditions were optimized in order to receive:

- Diffusion of Al to the steel.
- An intermetallic layer to increase adhesion.
- Surface Al layer to allow the MAO process.

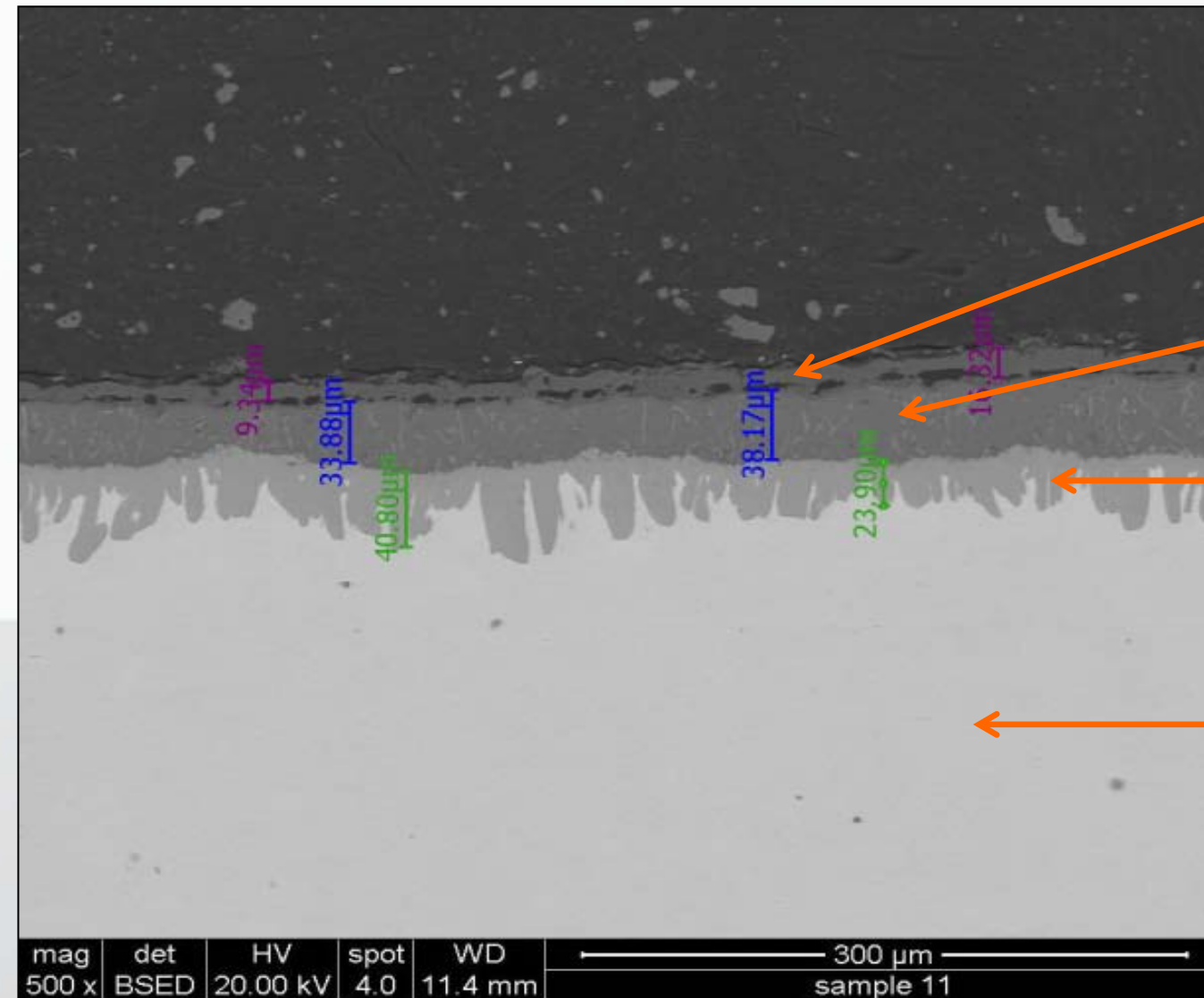


Representative GDA Spectrum

Step-2: MAO of Aluminized Steel

MAO process conditions were optimized in order to receive:

- Conversion of the Al to hard ceramic layer.
- Best adhesion of the complex layer stack.



Ceramic layer

Aluminum

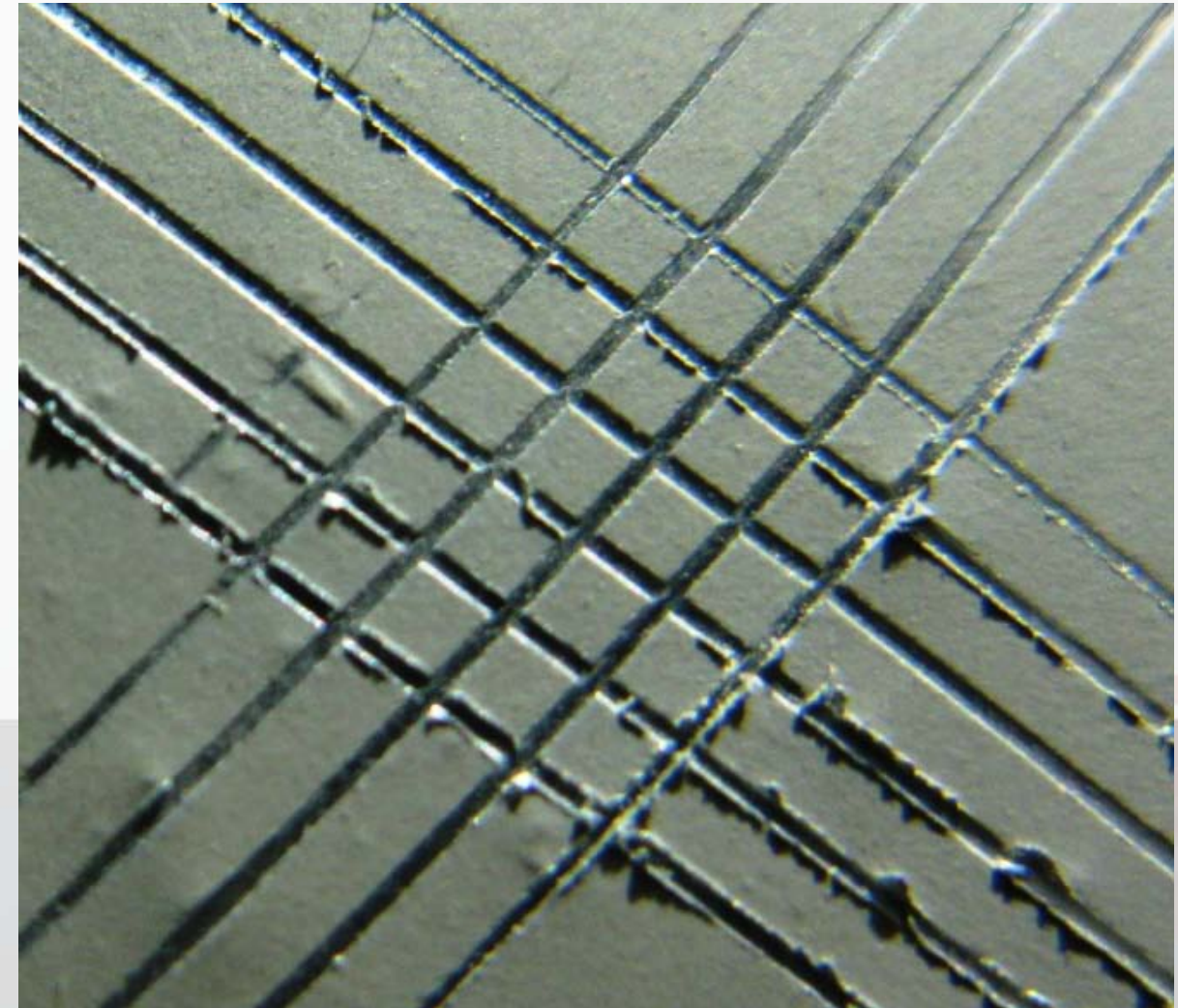
Intermetallic layer

Steel

Step-2: MAO of Aluminized Steel

Adhesion test results:

- Layer ranking: category number 1 (less than 5% of the coating was peeled off).
- The coating has excellent adhesion to the substrate.











PCT

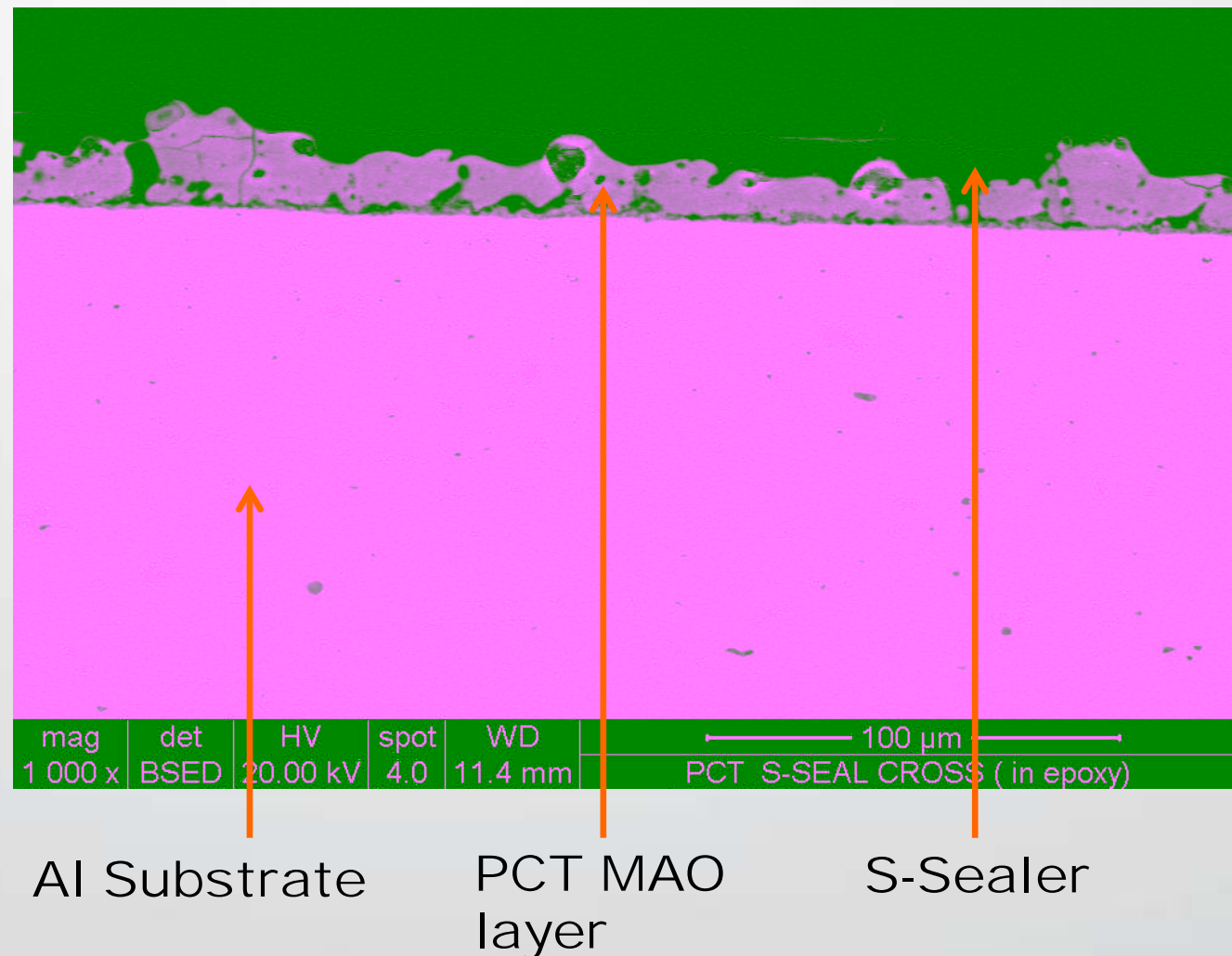
Protective Coating Technology

Special Top Coatings (Sealers):

- Organo-Ceramic
- Organic
- Conductive

TYPE OF TECHNOLOGY/ PROPRETIES	<ul style="list-style-type: none"> High corrosive resistance > 4,000 hours by Salt Spray (SST) method. Up to thermal treatment temp. 	Resists in chemical environments PH 1-11 in maintenance conditions <ul style="list-style-type: none"> Dielectric strength of up to 3 KV for a 40 micron layer. Up to 200° C 	Resists in chemical environments PH 0 to 14, in operating conditions. <ul style="list-style-type: none"> Dielectric strength of up to 6KV for a 75 micron layer. Up to 120° C 	Hardness up to 1,500HV <ul style="list-style-type: none"> Wear resistance as mil std 8625 Up to thermal treatment temp.
PCT 2000 Typical Layer thickness: 80-100 micron*		√ if the S Seal is applied 	√ if the P Seal is applied 	
PCT – P seal <ul style="list-style-type: none"> Typical Layer thickness: 40-80 micron* Organic sealer Hydrophobic surface, reduces sedimentation 				
PCT - S seal <ul style="list-style-type: none"> Typical Layer thickness: 10-40 micron* Organo-ceramic sealer Hydrophobic surface, reduces sedimentation. 				
PCT Classic 1000 <ul style="list-style-type: none"> Typical Layer thickness: 10-20 micron* Hydrophilic surface perfect preparation for paints, adhesives. 				

PCT Sealer – S Seal



SURFACE	Hydrophobic surface with antifouling and anti-scaling properties and reduces sedimentation. Adjustable friction coefficient Very low permeability to gases and water vapor
HARDNESS	Based on the primary surface parameter.
CORROSION	➤ 4,000 hours by Salt Spray (SST) method*
TEMPERATURE	Stable up to 220°C
ELECTRICAL RESISTANCE	Dielectric strength of up to 1KV for a 40 micron layer*
ENVIRONMENTS	Resists in environment pH 1-8.6 in maintenance conditions*
* above PCT 1000/PCT 2000 coating	

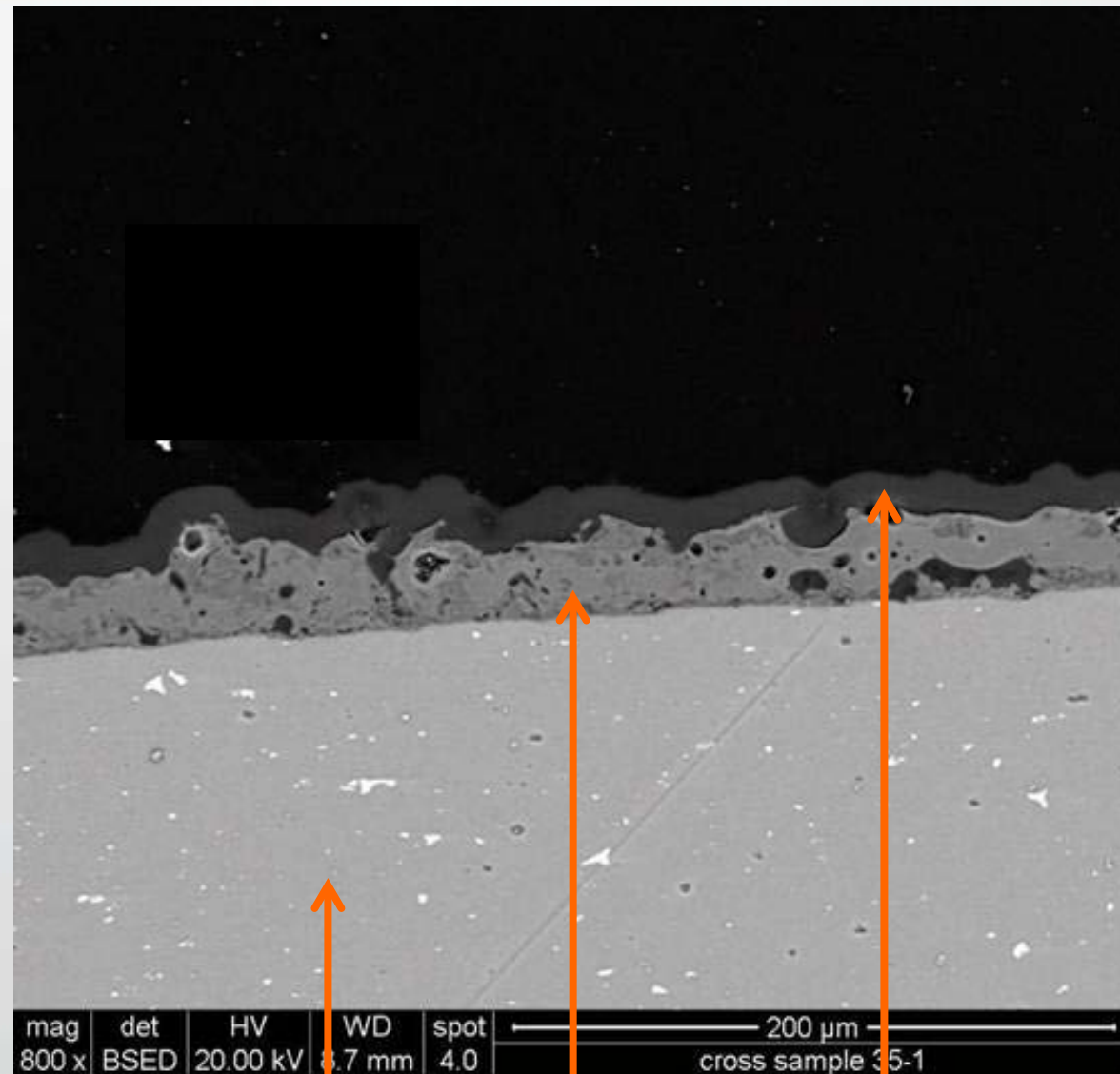
- S-Seal – unique Organo-Ceramic Sol-Gel formula.
- Applied by spraying, brushing, wiping, dipping.

The following chemical resistance tests were done on our MAO + S-SEAL coating:

Conditions	Time to failure
Sulfamic Acid, 10%, 40°C	>14 days
Sulfamic Acid, 10%, 60°C	>7 days*
7.5%wt HCl, 1.5%wt HF at 66°C	>48 hours*
EDTA PH=11 at 55 °C	>24 Days *
30% CaCl ₂ at 70°C	>60 Days*
2%wt KCl + 9%wt NaCl I at 100°C	>60 Days*
Pilot at heat exchanger, 3% salinity at 48°C	90 Days*

* = the test was stopped without failure

PCT Sealer – P Seal



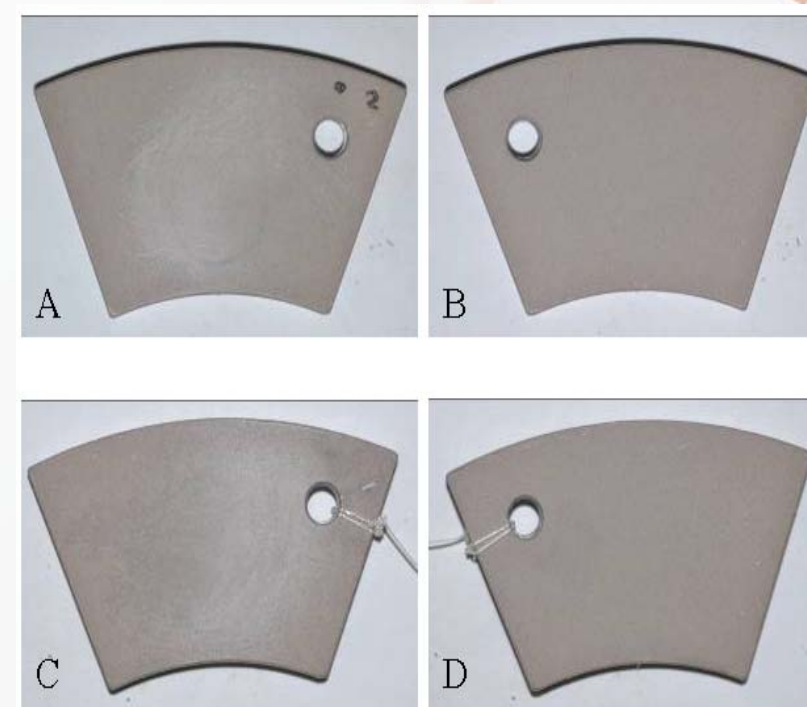
Al Substrate PCT MAO layer P-Sealer

SURFACE	Organic conformal sealer. Hydrophobic surface with antifouling and anti-scaling properties and reduces sedimentation. Completely Homogenous surface. Low intrinsic thin film stress due to deposition at room temperature. Low friction coefficient. Very low permeability to gases.
HARDNESS	Based on the on the primary surface parameter
CORROSION	➤ 4,000 hours by Salt Spray (SST) method*
TEMPERATURE	Up to 120°C
ELECTRICAL RESISTANCE	Dielectric strength of up to 5KV for a 60 micron layer*
ENVIRONMENTS	Resists in environment pH 0-14 in operation conditions, good barrier properties for inorganic and organic media, strong acids, caustic solutions, gases and water vapor*
*above PCT 1000/ PCT 2000 coating	

- P-seal – Organic Polymer.
- Applied by vacuum deposition.

The following chemical resistance tests were done on our MAO + P-SEAL coating:

Conditions	Time to failure
Sulfamic Acid, 10%, 40°C	>14 days
Sulfamic Acid, 10%, 60°C	>48 hours
7.5%wt HCl, 1.5%wt HF at 66°C	>140 hours*
15%wt HCl, at 100°C	>24 hours *
25% CaCl ₂ at 93°C	>60 Days*
2%wt KCl + 9%wt NaCl I at 100°C	>60 Days*
Pilot for IWT, pH = 11-12.5, 100°C-110°C	30 days*



Samples after 7.5% HCl + 1.5% HF test

* = the test was stopped without failure

The following chemical resistance tests were done on our MAO + P-SEAL coating:

- Fastener in 500 ppm NaCl acidified to pH 3 with HCL; Carbon steel = 0.83% weight loss; PCT treated bolt = NO WEIGHT LOSS
- PCT vs. Carbon steel bolt in 1% HCL; Carbon steel = 47.8% weight loss; PCT treated bolt = 0.39% weight loss NO CORROSION

- The PCT C1 conductive coating is a secondary electro less process which greatly improves the substrates resistance to galling and leaves a predictable, uniform nickel with low phosphorous range (1-4%) coating for high-precision parts. It can be applied on the PCT 1000, PCT 2000 conversion coating or any both ferrous and non-ferrous surfaces of any geometry or intricate shape.
- PCT C1 layer is of a uniform thickness, absent of pours and cracks for protection against corrosion where low electrical resistance is required. Meet MIL DTL 5541F Standard.

Conductive Sealer C1

SURFACE CHARACTERISTICS	A uniform deposit thickness, dense and amorphous layer.
HARDNESS	600 HV depending on the alloy and the thickness of coating
CORROSION	➤ 720 hours by Salt Spray (SST) method
TEMPERATURE	Up to thermal treatment temperature of the alloy
ELECTRICAL RESISTANCE	< 5,000 micro Ohms per square inch
ENVIRONMENTS	Resists in alkaline environments

PCT Secondary Conductive Sealer

- The PCT C2 conductive coating is a secondary electro less process which greatly improves the substrates resistance to galling and leaves a predictable, uniform nickel with high phosphorous range (10-14%) coating for high-precision parts. It can be applied on the PCT 1000, PCT 2000 conversion coating or any both ferrous and non-ferrous surfaces of any geometry or intricate shape.
- PCT C2 layer is of a uniform thickness, absent of pours and cracks for protection against corrosion where low electrical resistance is required. Meet MIL DTL 5541F Standard.

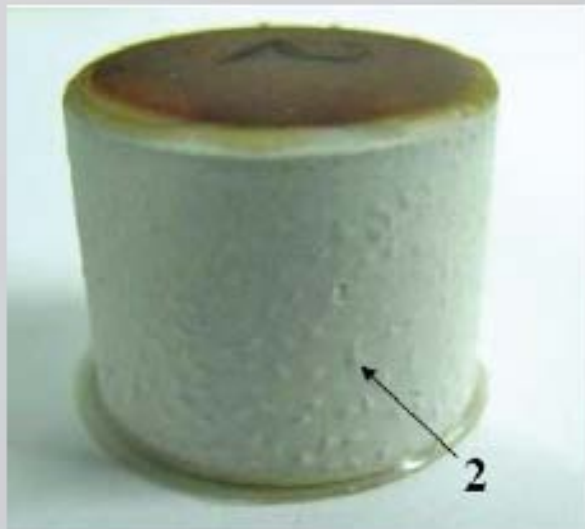
Conductive Sealer C2

SURFACE CHARACTERISTICS	A uniform deposit thickness, dense and amorphous layer.
HARDNESS	700 HV depending on the alloy and the thickness of coating
CORROSION	➤ 720 hours by Salt Spray (SST) method
TEMPERATURE	Up to thermal treatment temperature of the alloy
ELECTRICAL RESISTANCE	< 5,000 micro Ohms per square inch
ENVIRONMENTS	Resists in acidic environments

PCT Coated in
10% Sulfamic Acid
after 480 hours
No Failure

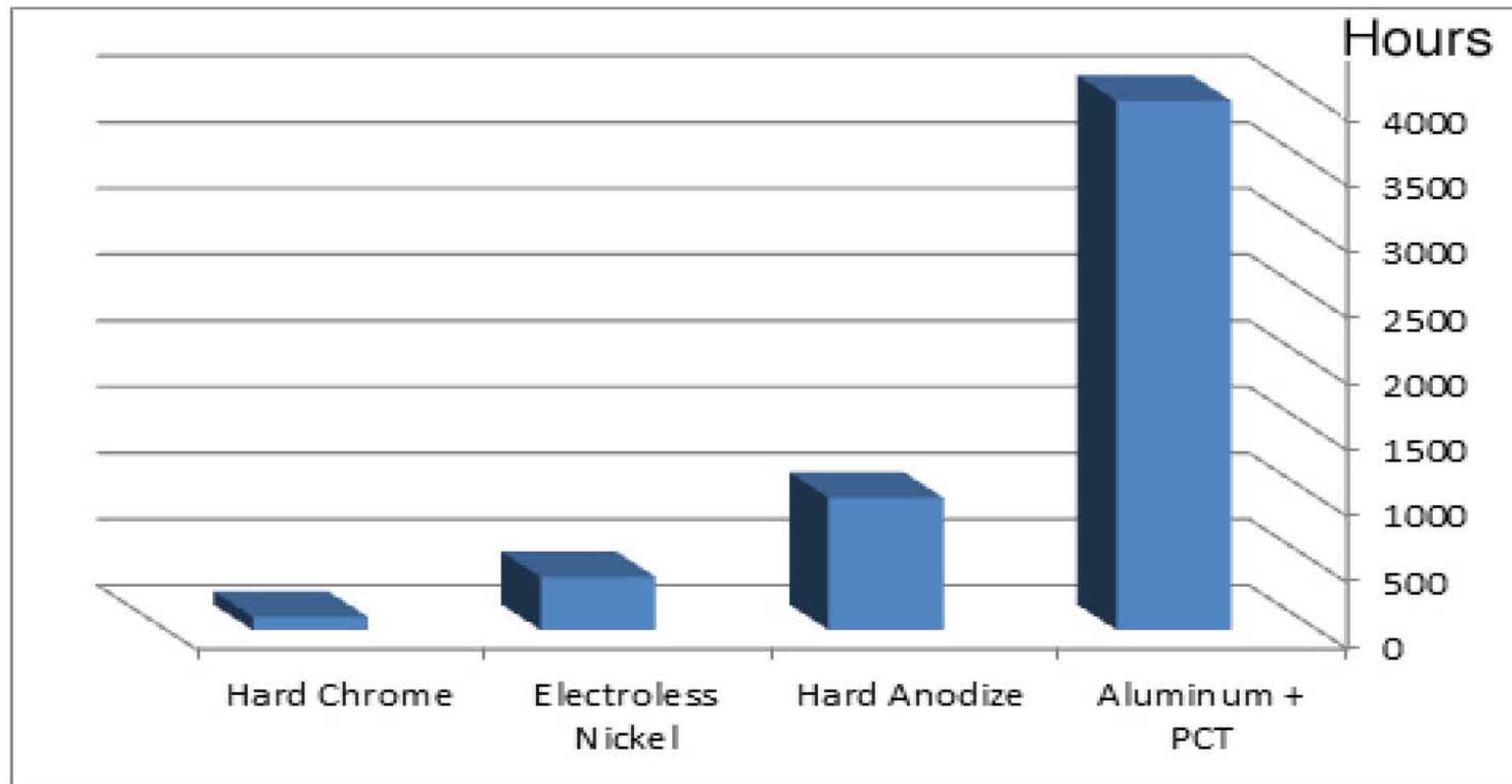


Failure in 10%
Sulfamic Acid
after 16 hours

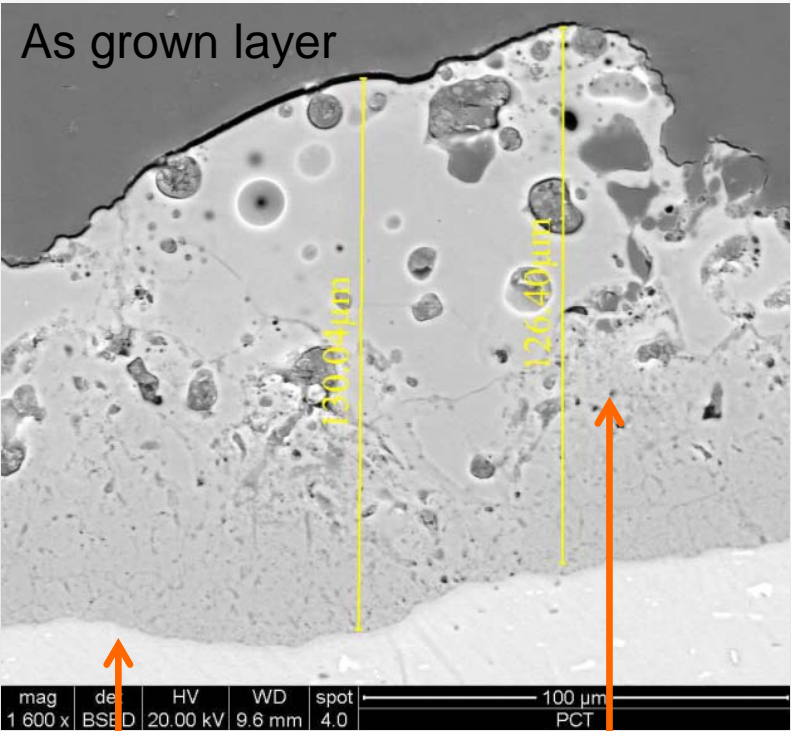


PCT treated aluminum
parts (sealed and
scratched) in highly
corrosive environments

Traditionally coated MAO
aluminum will fail after a
few hours in a corrosive
media

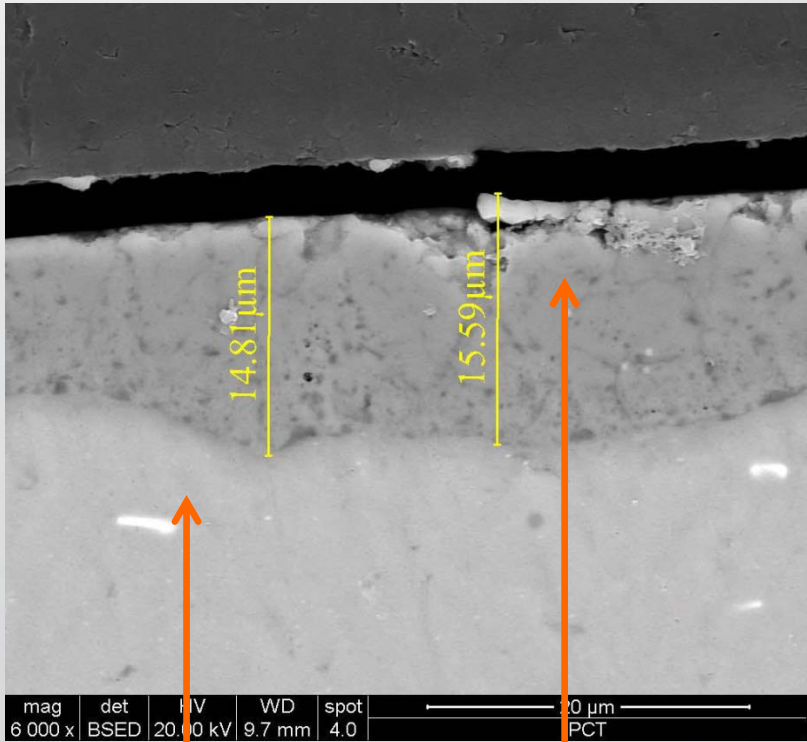


PCT2000 - Ultra Hard Coating for Aluminium



Al Substrate Ultra Hard MAO layer

After 30,000 cycles Taber wear test



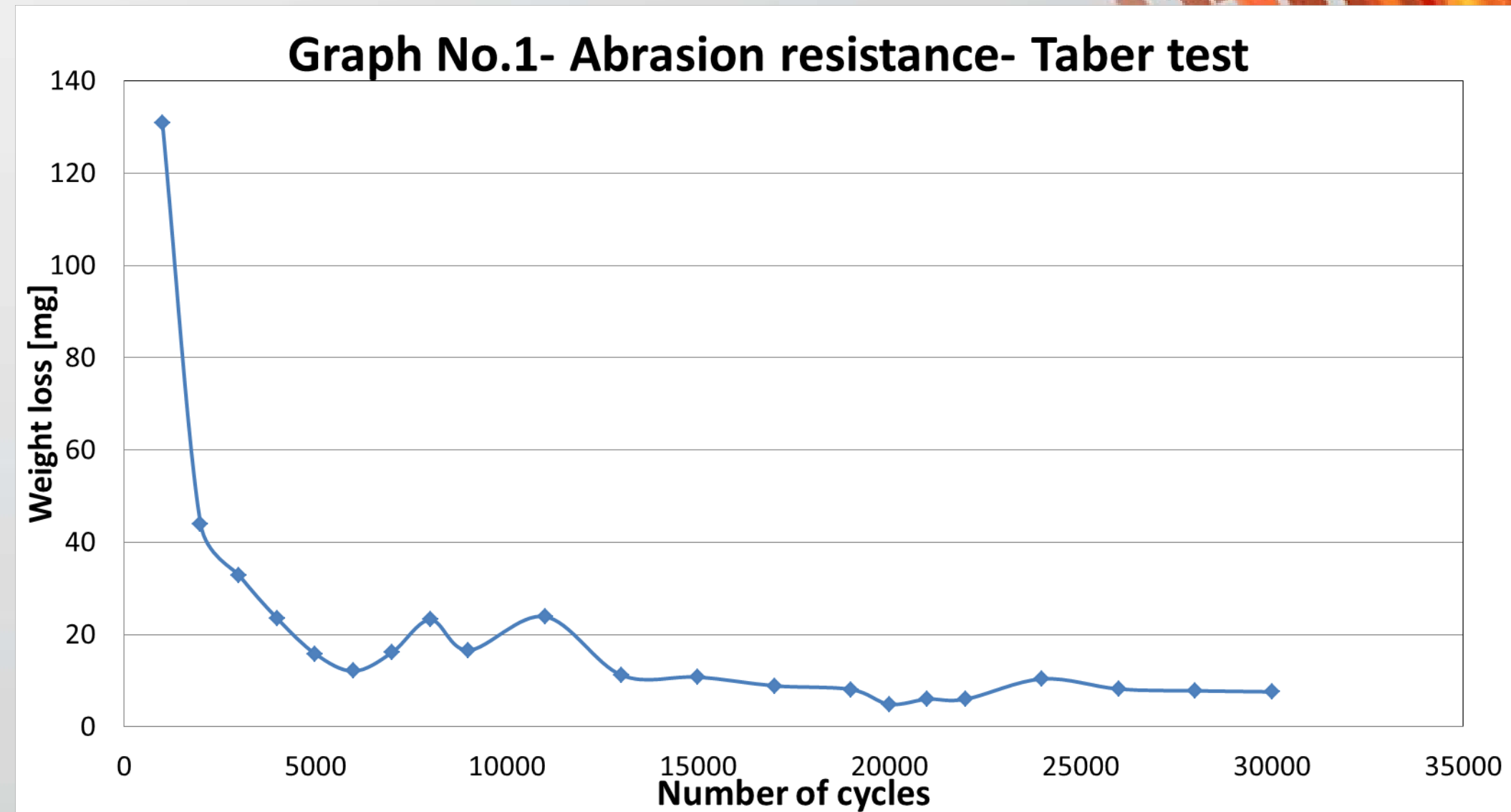
Al Substrate Ultra Hard MAO layer

SURFACE	Hydrophilic surface with high adhesive strength.
HARDNESS	1,500 HV depending on the alloy and the thickness of coating
WEAR RESISTANCE	Tested and passed MIL. STANDARD 8625
CORROSION	➤ 4,000 hours by Salt Spray (SST) method
TEMPERATURE	Up to thermal treatment temperature of the alloy.

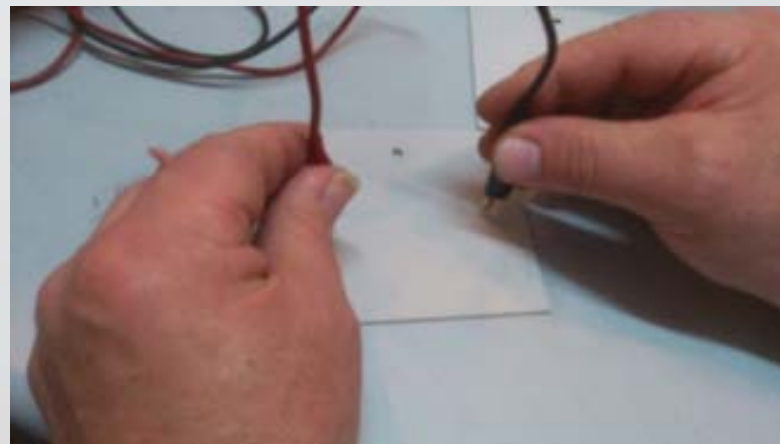
PCT2000 - Ultra Hard Coating for Al

Taber Wear Resistance Test

- TABER® Rotary Platform Abrasion Tester - Model 5135 or 5155
- Abrasive Media: CS-17 stones
- The test was conducted acc. to MIL -A-8625

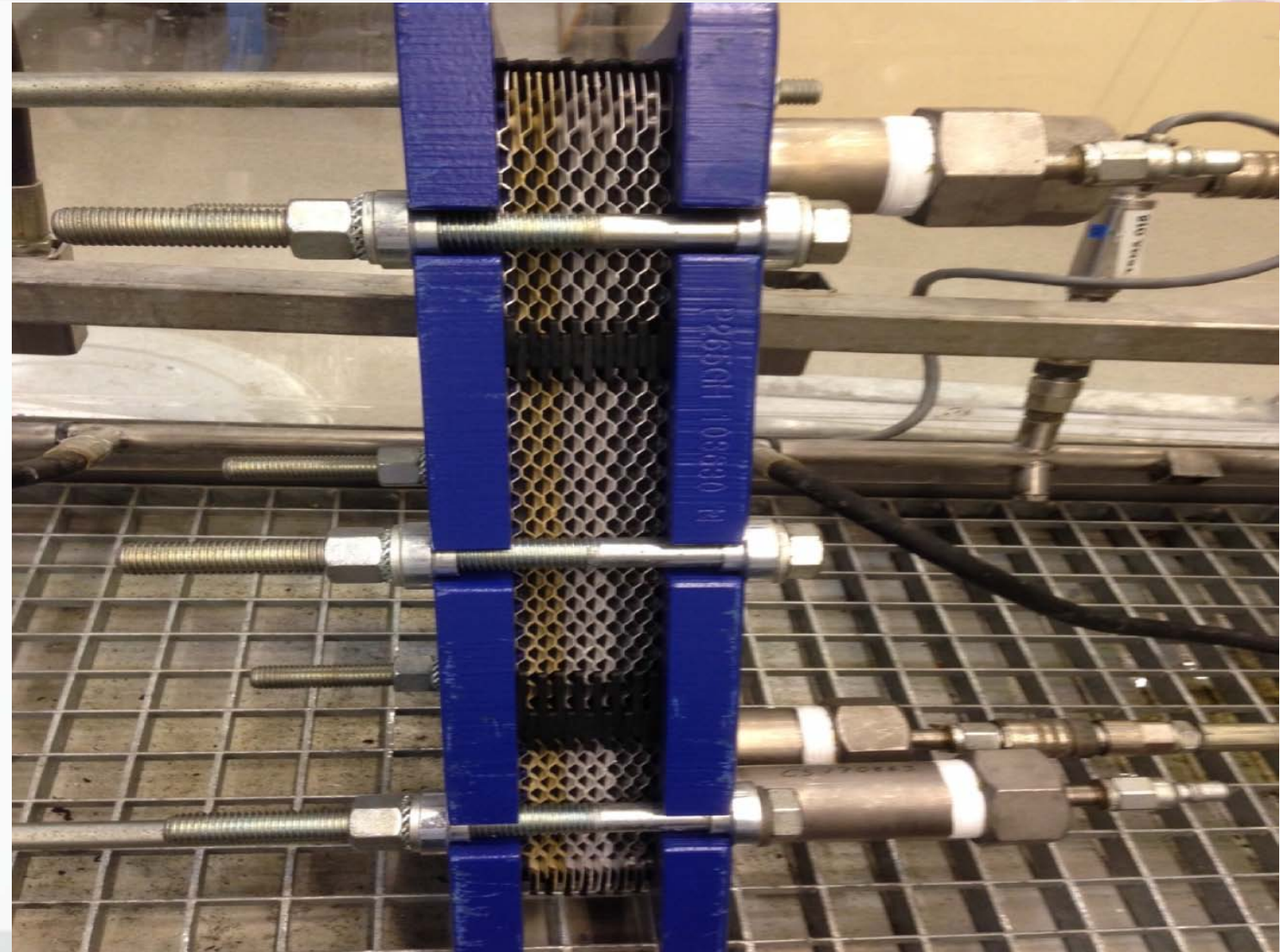


- Seawater Sedimentation – reduced by 75%
- Electrical resistance (1000V)– 5M Ω @ 5 μ ; 600M Ω @ 30 μ ;
- Thermal Shock – Scribed X, 1) +38°C for 3 hours, 2) -30°C for 3 hours, 3) immersion into ethyl alcohol -74°C for 5 minutes, 4) water steam 100°C 30 seconds – PASSED





Al-plate S-sealed P-sealed



- Passed 100.000 cycles 0-4 bars without micro cracks
- Passed 7 bars continuous pressure test

PCT Prevents Galvanic Corrosion



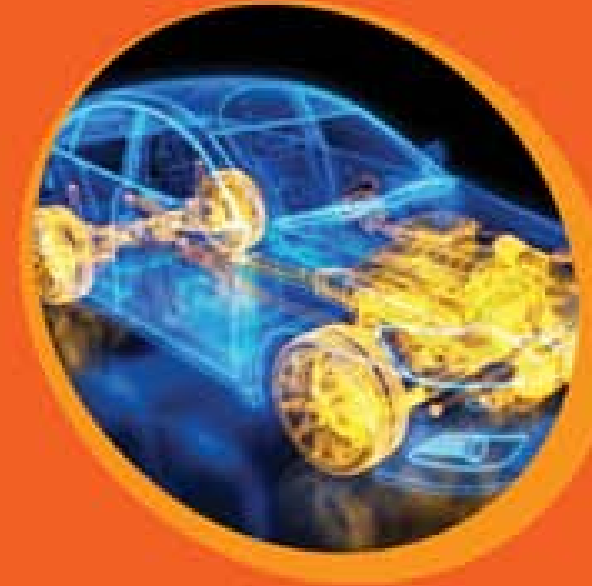
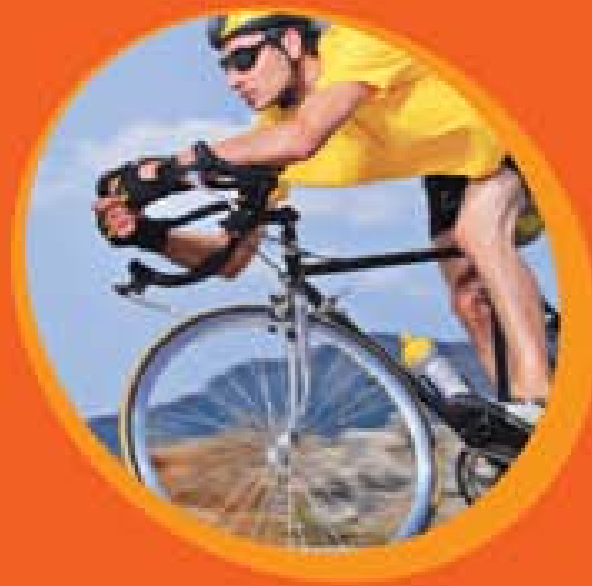
Insulating, High Dielectric Strength



- Minimum dimensional change
- No surface preparation required
- Protects against short, high-temperature flashes
- Complex geometries & internal surfaces

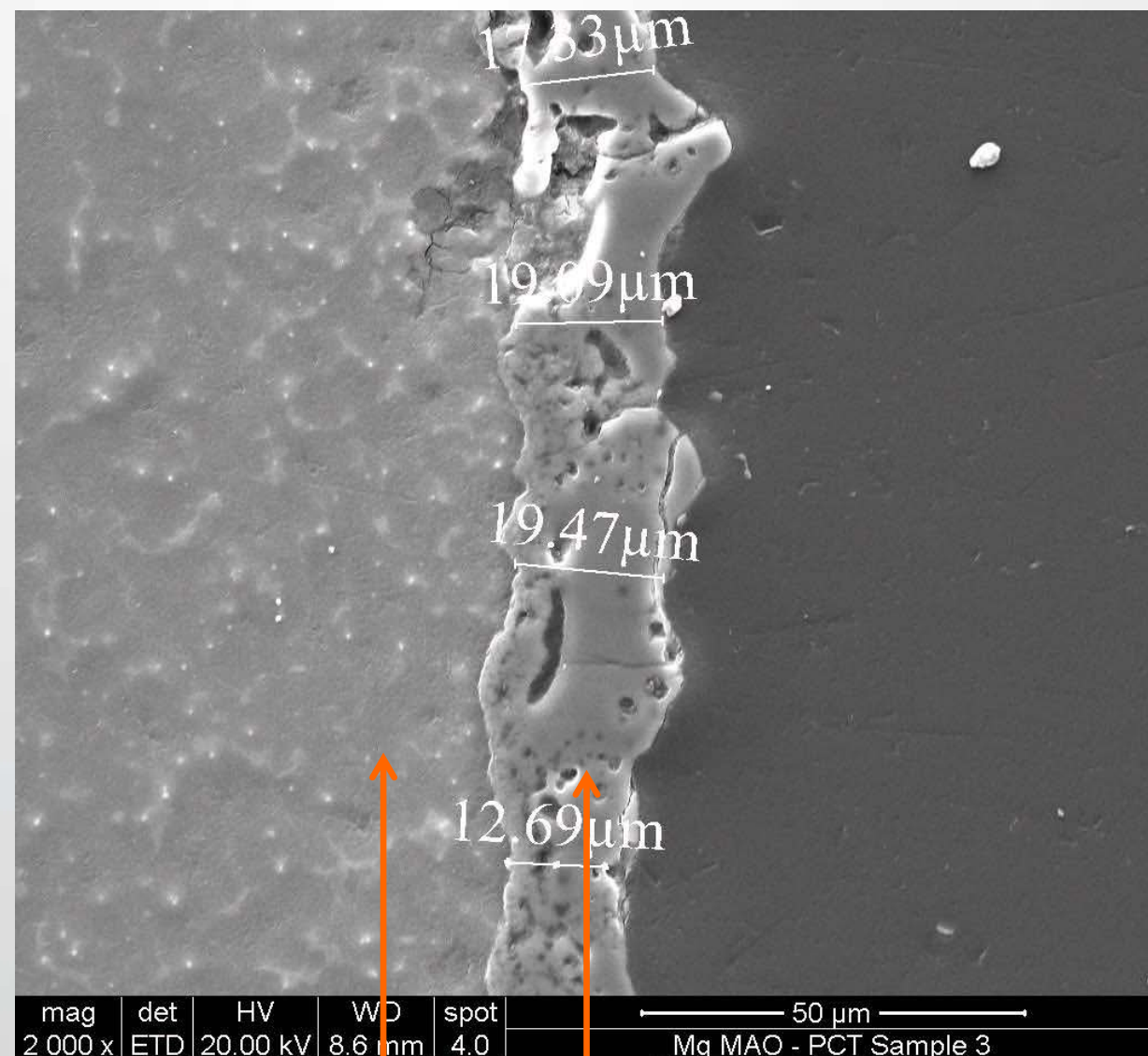
MAGNESIUM

- . . . is 35% lighter than Aluminum
- . . . has a high strength-to-weight ratio



PCT Protects Magnesium from oxidation
providing greater opportunities for weight reduction

PCT layer – Magnesium



Mg Substrate PCT MAO
layer

SURFACE	Typical layer thickness: 20 micron Hydrophilic surface
HARDNESS	700 HV
CORROSION	➤ 1,000 -2,000 hours by Salt Spray (SST) method* (sealed)
TEMPERATURE	Up to the thermal treatment temperature
WEAR RESISTANCE	Passed the Standard Specification for Hard-Coat Anodizing of Magnesium.
* above PCT 1000/PCT 2000 coating	



- Salt Spray Test – PCT 20 μ , per ASTM B117, IAI, grade 9 (0.01-0.03) surface after 336 hours
- Corrosion after Paint (aerospace test) – PCT 20 μ + epoxy-based color per IAI standard 24.3900 class 1 – passed 2,000 hours salt spray per Mil-PRF-23377

Magnesium Lab Tests



- Sports
- Aerospace
- Military

PCT in Magnesium



Marine



Automotive



Medical

PCT Applications



- Reduction of Drag force in Military High Speed boats



Thank you.

For more information:

www.pcoatings-tech.com
info@pcoatings-tech.com



PCT

Protective Coating Technology

PCT is featured in the June 2013 edition of NACE MP Materials Performance Magazine.

