

Content



Introduction



CO₂ reduction process example in pre-treatment



Nichem® MP 75 - Process performance



Nichem® MP 75 - Impact on CO₂

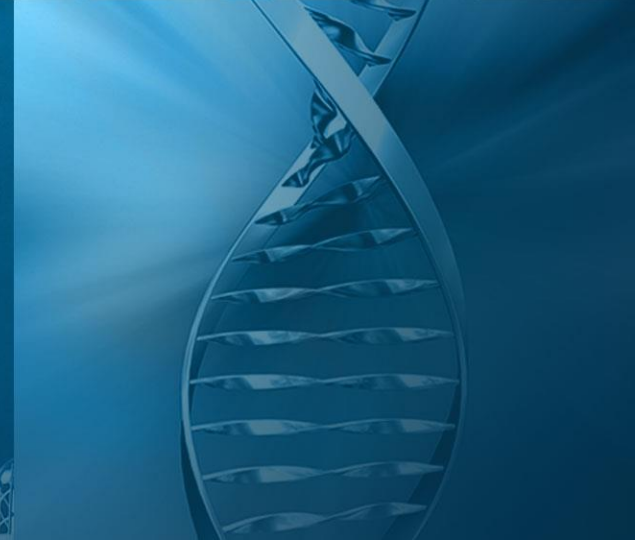


Customer case study



Summary

Introduction



Reduction of CO₂ emissions

Reduction of carbon footprint – Carbon net zero drive

What is net zero?

- Put simply, net zero means cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests for instance

Why is net zero important?

- To limit global temperature rise of the earth to max. 1.5°C

Paris agreement

- Governments of 194 parties agreed to take steps to reduce greenhouse gases

Current projects fall well below the target required

3%

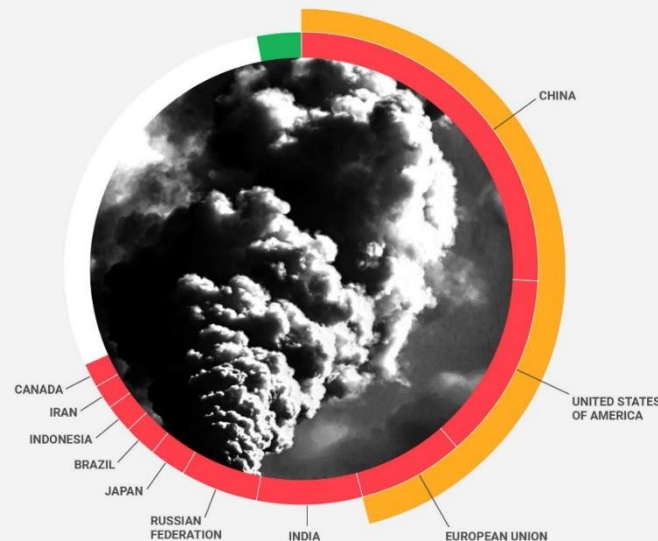
Contribution of the 100 least-emitting countries

68%

The 10 largest greenhouse gas emitters contribute over two-thirds of global emissions

46%

The top 3 greenhouse gas emitters contribute 16 times the emissions of the bottom 100 countries



Reduction of CO₂ emissions

How can Atotech processes and systems contribute

How can we reduce the impact of our processes?

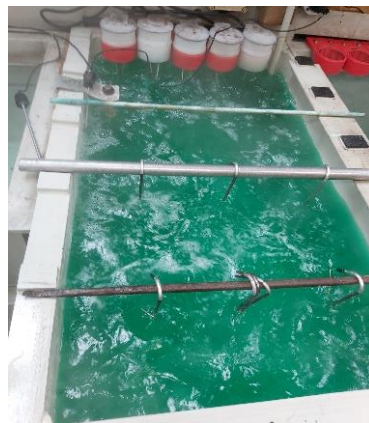
- Use chemicals with reduced impact on CO₂ emissions – Not so easy
- Make processes more efficient – Not so easy
- Reduce energy cost by reducing operating temperature – Easier than the other two possibilities

Demand from industry for net zero increasing?

- All major OEM & Tiers are now seeking low-carbon processes

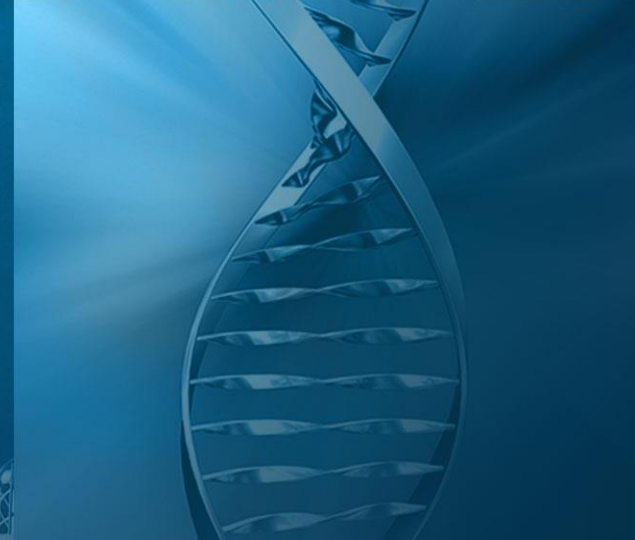
Contribution from Atotech in wear resistance coating applications

- Systems approach – DynaChrome® & EDEN® to reduce energy cost and increase production capacity
- HEEF® HMC – increased in production capacity & quality for conventional lines
- Nichem® MP 75 – Lower operating temperature to reduce energy costs



MKS strives to reduce the carbon footprint of our processes

CO₂ reduction
Process example in
pretreatment



Functional chrome etch – Chromic acid-free Process

BluCr® PE-L – Process comparison

Process parameter	Chromic acid etch	BluCr® PE
Chromic acid (g/l)	250 (200-270)	Zero
Sulphuric acid (g/l)	0 - 2.0	230 - 250
Operating temperatures (°C)	50 - 60	Ambient
Current density (A/dm ²)	20 - 45	3 - 5
Process time (s)	30 - 120	20 - 120
KWh energy consumption	100%	3%
Bath make-up cost (1,000 l)	\$1,750	\$150

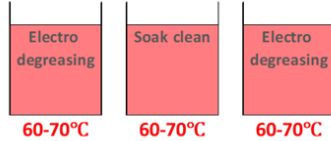


More than 97% less CO₂e compared to chromic acid etch

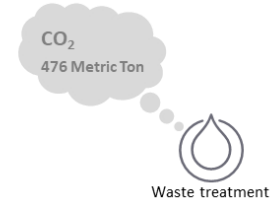
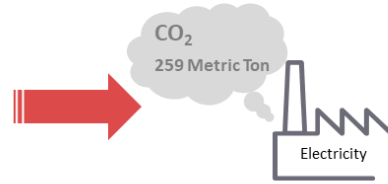
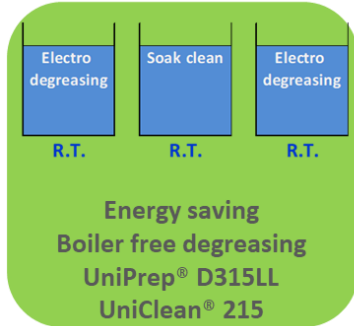
Pretreatment – Low temperature processes

Low temperature soak and electrocleaner

Current process



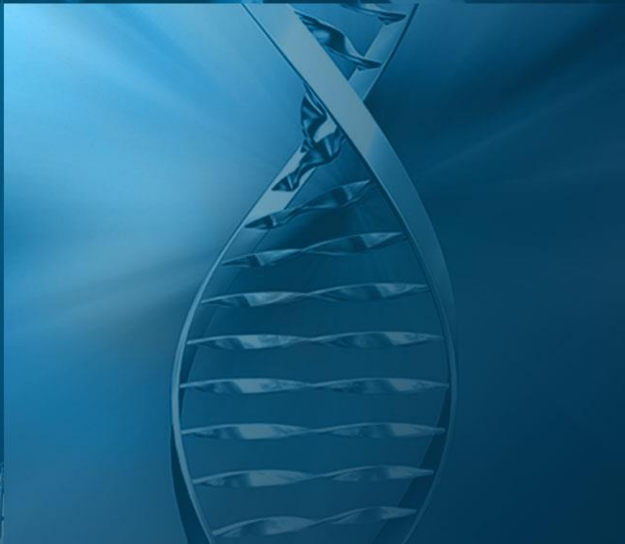
Proposal process



In term comparison between using heating and non-using heating for pretreatment
<https://www.epa.gov/energy/forms/contact-us-about-energy-and-environment>

Using UniPrep® D315L & UniClean® 215 can reduce CO₂ emissions by 100%

Nichem® MP 75
Process
performance



Low temperature EN – Nichem[®] MP 75



Why lower temperature mid-P EN



Resources

Lower temperature means less energy consumption for heating up and maintaining operation temperature (20 – 30% less)



Sustainability

Less impact on environment
Less Ni- and NH₃-aerosols
Minimize CO₂ footprint



Application

Most popular EN coating (5 – 10 wt% P)
High productivity due to high plating rate
Good corrosion and wear performance



Innovation

All current EN processes on the market operate at 88 – 90 °C
Similar benefits with less costs

Low temperature EN – Nichem® MP 75



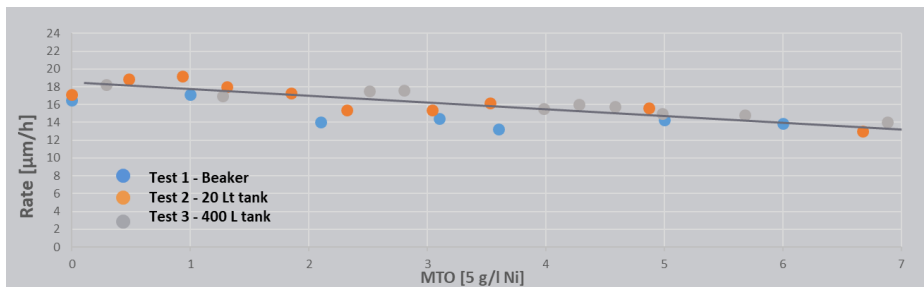
Working parameters

Parameters	Standard mid P*	Nichem® MP 75
Ni concentration	6 g/l	5 g/l
Hypophosphite	25 g/l	48 g/l
Temperature	87 - 90 °C	75 °C ± 1
pH	4.7-5.0	5.4 ± 0.1
Loading ratio	0.1-1 dm ² /l	0.1-1 dm ² /l
Solution movement	Air agitation and filtration	Air agitation and filtration
Electrolyte volume	100 litres	100 litres
Mode of replenishment	Manual	Manual

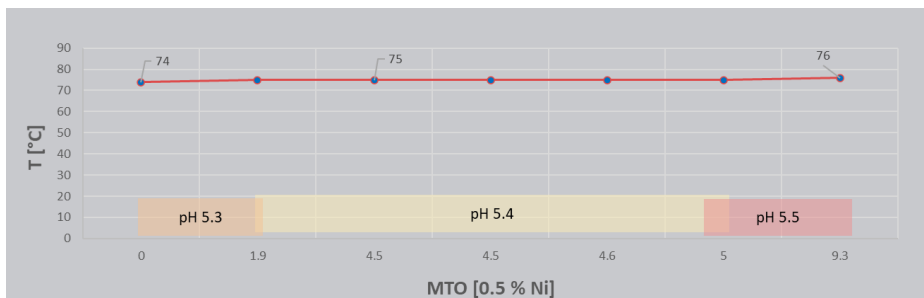
*Nichem MP 1188

Low temperature EN – Nichem® MP 75

Process features – Plating speed



Deposition rate scatters between 16-18 µm/h at new MU and decreases with the bath age reaching 14-15 µm/h

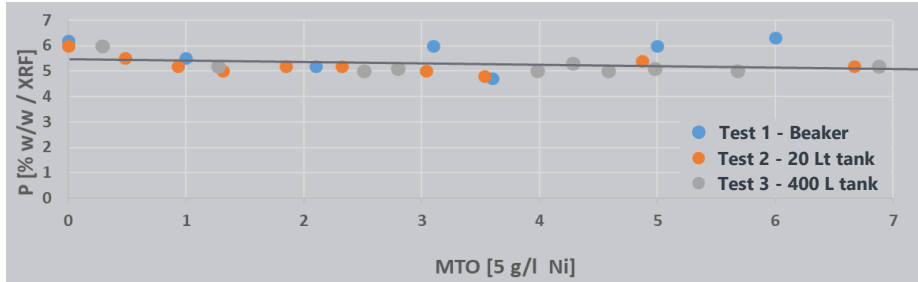


Nichem® MP 75 operates at pH of 5.3 - 5.5 and at 74 - 77 °C over the bath life

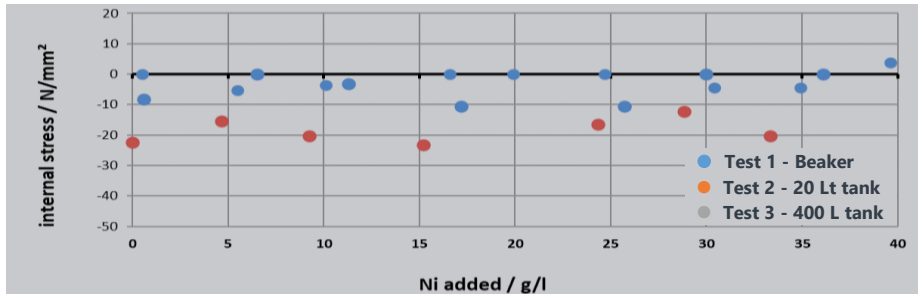
Traditional mid-P EN processes operate at a pH of 4.7 - 4.9 and 85 - 92 °C over the bath life

Low temperature EN – Nichem[®] MP 75

Process features – Phosphorus content and internal stress



Phosphorous content reaches in average 5 - 7% over the bath life

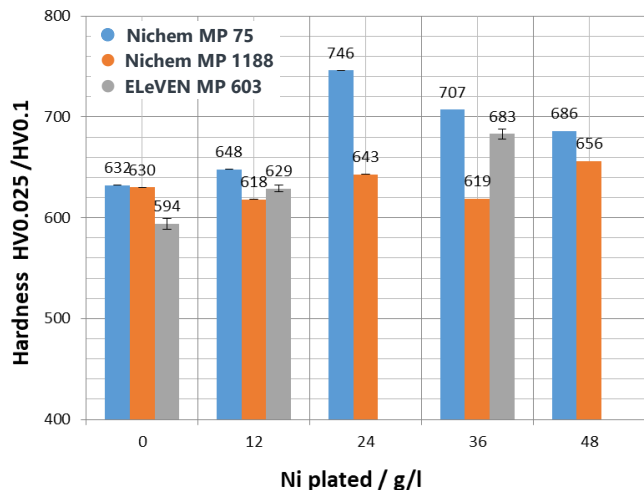


Traditional mid-P EN shows a neutral to tensile internal stress over the bath life

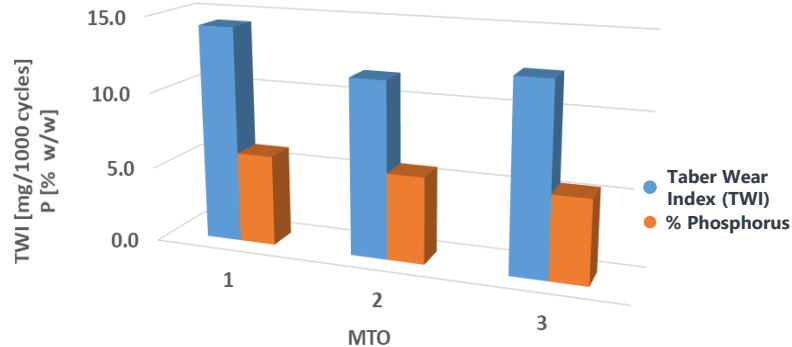
Nichem[®] MP 75 is in compressive to neutral range over the bath life

Low temperature EN – Nichem® MP 75

Process features – Deposit properties



Hardness of Nichem® MP 75 is comparable to our standard electroless process Nichem® MP 1188 and to ELeVEN® MP 603



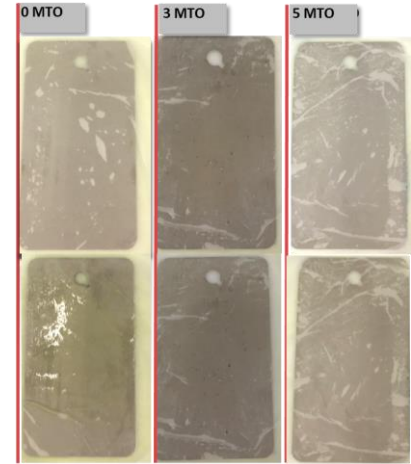
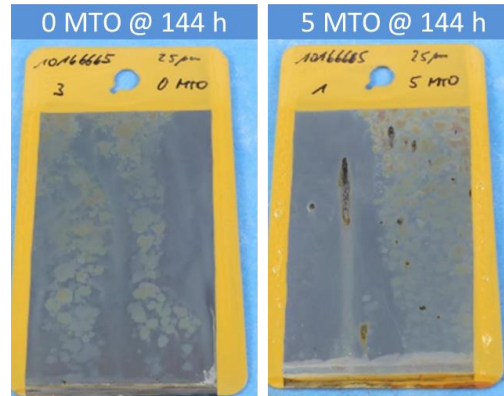
	1	2	3
■ TWI	14.3	11.6	12.5
■ P %	6.0	5.7	5.5

Nichem® MP 75 shows a TWI of 12 - 14 mg/1000 cycles, an average value for mid-P EN coatings

Low temperature EN – Nichem® MP 75

Process features – Corrosion resistance

MTO	RR corrosion in % of surface after hours	
	96	144
0	<0.1	<0.1
3	<1.0	<1.0
5	<1.0	<1.0



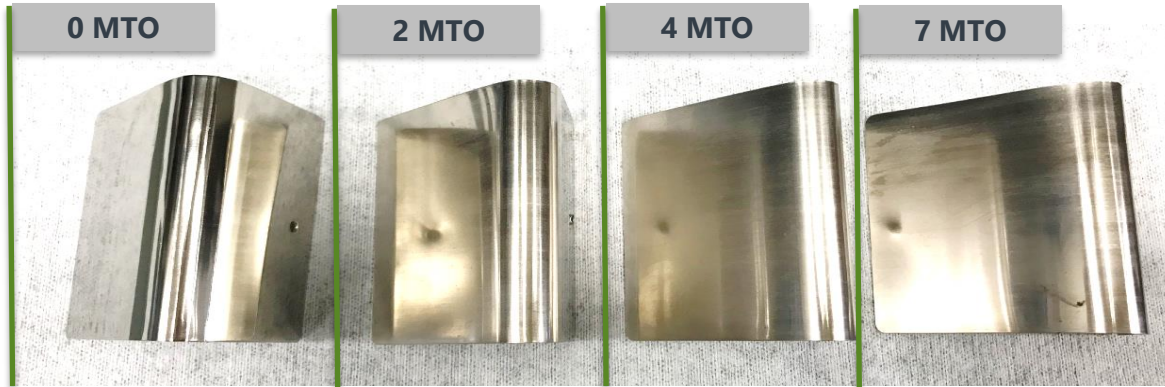
The usual requirement for 25 µm mid-P EN is 96 hours
Nichem® MP 75 fulfils this requirement

Ferroxy test –
No blue spots observed
after 5 minute exposure

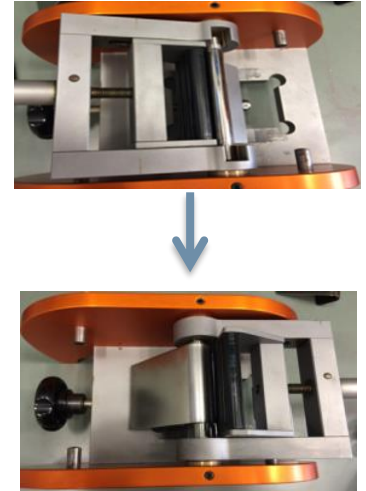
Low temperature EN – Nichem[®] MP 75

Process features – Bend test

30 μ m EN deposit thickness



No adhesion failures detected, formation of cracks but no peeling or flaking
Same results as traditional mid-P EN



controlled bending over 10 mm mandrel (according to ASTM B571 – 97)

Low temperature EN – Nichem[®] MP 75

Process features – Deposit visual appearance (Gloss)



Gloss change over bath age



Plated thickness: 25 μm



Measured angle: 20°



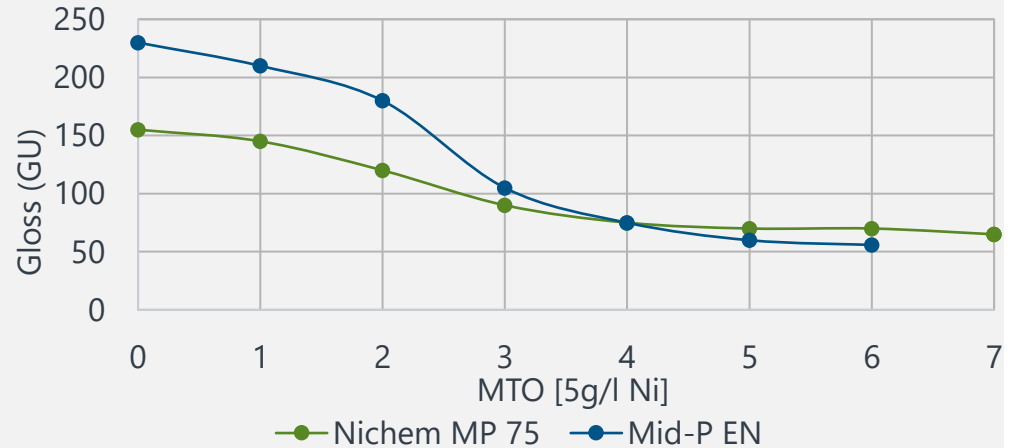
Substrate: MS panel



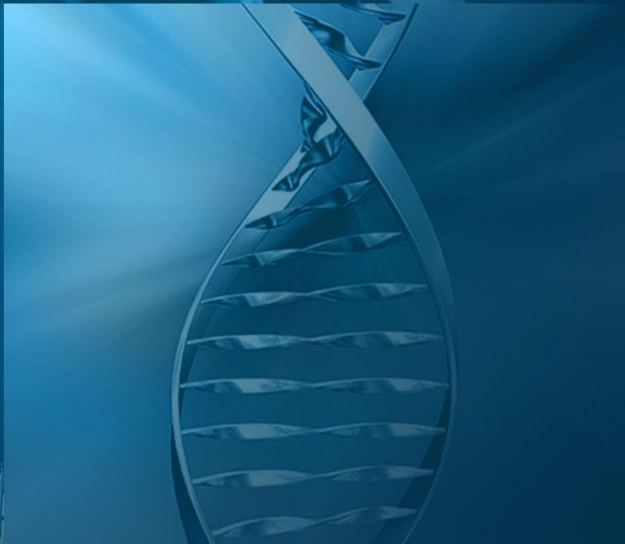
Gloss change found to decrease with bath age



Uniform matt appearance



Nichem[®] MP 75
Impact on CO₂



Low temperature EN – Nichem® MP 75

Process parameter comparison

Process features	Classical mid-P EN	Nichem® MP 75
RoHS, ELV-compliant	No Pb & Cd	No Pb & Cd
Temperature	88 - 91°C	75 (74- 77) °C
Operating pH	4.8	5.3 - 5.6
Plating rate	13 - 20 µm/h	13 -18 µm/h
P - content	6 - 10 % w/w	6 - 8 % w/w
Stress	Tensile	Compressive to neutral
Stability	Moderate	Comparable
Process cost	100%	Comparable



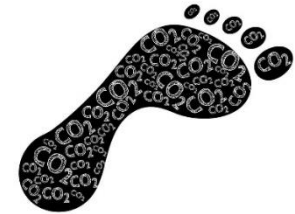
0.308 kg of CO₂e per kWh of electricity (UK)

Nichem® MP 75 operates 10 - 15°C lower in temperature compared to classical EN processes

Low temperature EN – Nichem® MP 75

Example from customer

Tank	2000 x 700 x 1,250 mm = 1,575 l (isolated with exhaust and cover)
Heating	Steam 130 °C out / 110 °C in
Heat up	8 h (parameters (line 15/18): from 20 °C to operating T)
Room temp	20 °C
Material	Substrate steel (20 °C)
Daily throughput	300 kg
Agitation	Filter pump
Agitation	With or without air



Clear process advantages need to be defined and highlighted to the customers

Low temperature EN – Nichem® MP 75

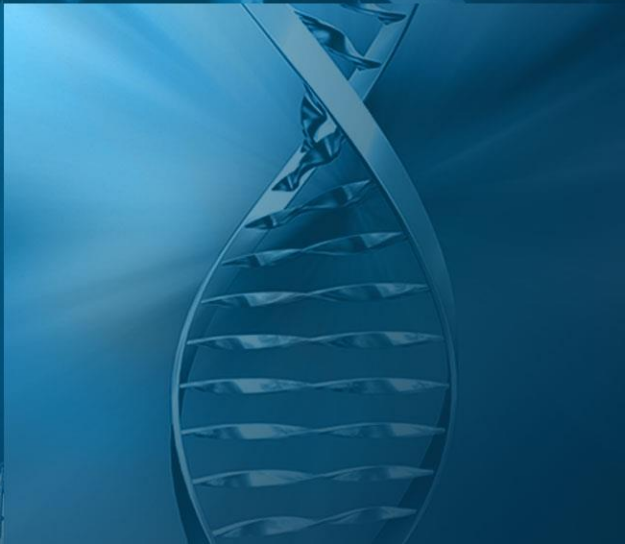
Example from customer – Plant conditions

Annual scenario		Running production	
	Product temperature(°C)	75	90
Without air agitation	Annual energy usage (KW/h)	43,273	83,617
	CO₂ emission savings (Kg)	-12,425	
	Energy cost (€/Kg)*	7,356	14,215
	Annual saving (€)	-6,859	





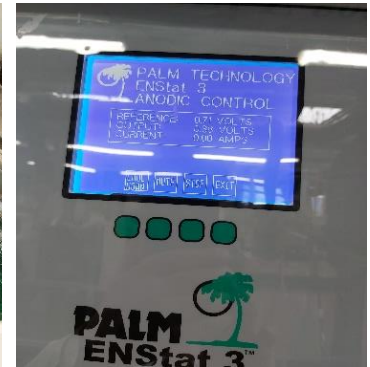
*Based on UK electricity prices from 11.2022

Nichem® MP 75
Customer case
study





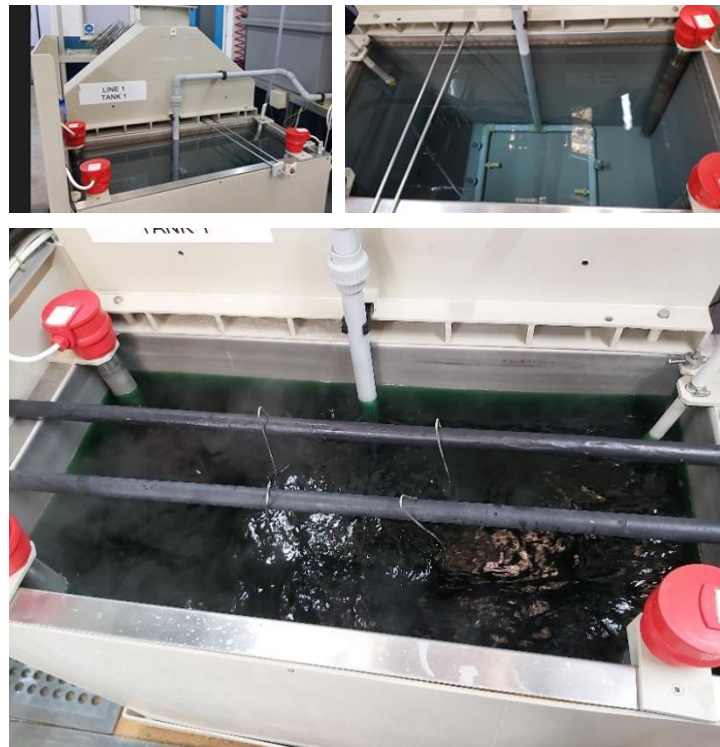
Case study – Customer 1 (UK)

 Characteristic	 PFAS mist suppressant
Tank volume	500 l
Bath agitation	Mild air & eductors (10 STO/hour)
Operating time	8 hours a day and 5 days a week
Dosing system	Automatic (Ni & pH control)
Application	Job shop (Copper & Bronze)
Operating temperature	75 - 76 °C (3.3Kw heaters)
MTO achieved	6
Conventional bath operation	88 - 91°C
Energy savings for heating	50% (based on customer data)

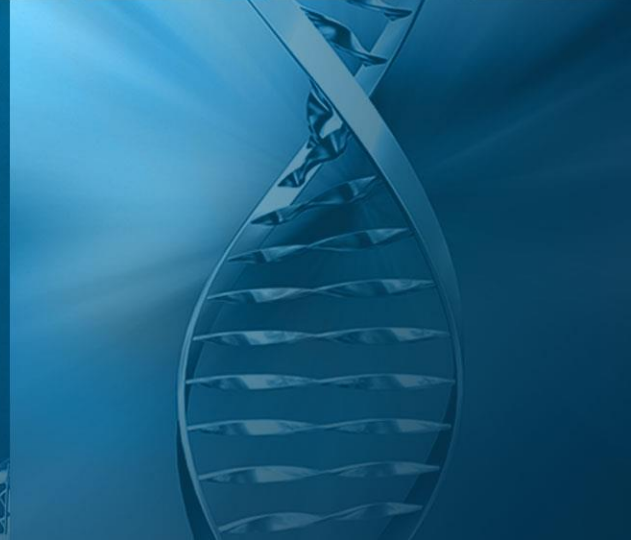


Case study – Customer 2 (UK)

 Characteristic	 PFAS mist suppressant
Tank volume	380 l
Bath agitation	Eductors (STO 18.000 l)
Operating time	8 hours a day and 5 days a week
Dosing system	Manual
Application	Aluminium precision machinery parts (in-house application)
Operating temperature	75 - 76 °C (3.3Kw heaters)
MTO achieved	6
Conventional bath operation	88 - 91°C
Energy savings for heating	30% (based on customer data)




Summary




Low temperature EN – Nichem® MP 75

Summary

 Reduction of carbon emissions is very important

 Calculation of CO₂ emissions is a completed process

 MKS is very pro-active to in developing processes which consider the impact on the environment

 The Atotech product portfolio includes processes which provide a reduction in CO₂ emissions

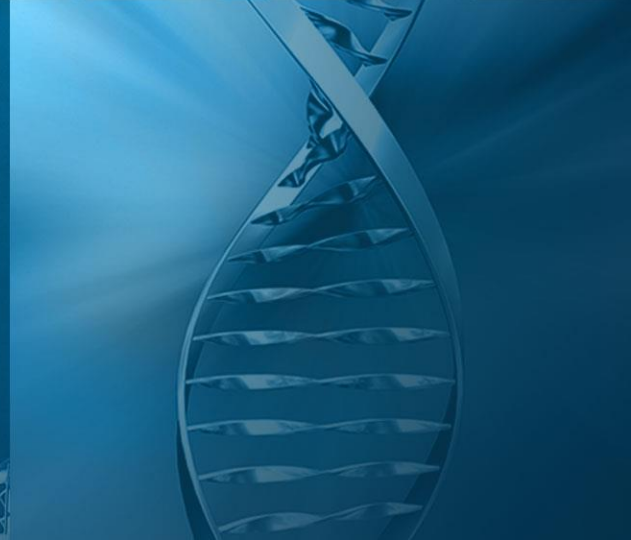
BluCr® PE

UniPrep® D315 LL

UniClean® 215

Nichem® MP 75

Any questions?



Content



Introduction



Process features

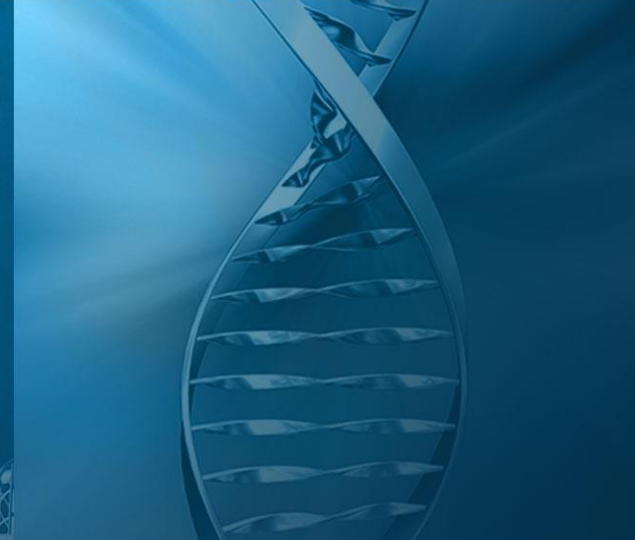


Process performance



Summary

Introduction



Nichem[®] One MP

Nichem[®] One MP

Only one product required for bath make-up & replenishment

Easy to operate & savings in logistical costs

Fast plating rate & long bath life

Bright appearance

ELV compliant: Pb and Cd-free (ELV, RoHS, WEEE)

Easy bath maintenance
Lower drag out

Lesser waste

Advantage

Reduces chances of product cross-contamination

Simpler logistics

Industry proven worldwide available for use in over 20 countries and 5 continents:



Suitable with stainless steel, polypropylene and lined tanks



Compatible with both rack and barrel application



Manual and automatic lines



Used for a wide variety of substrate (steel, stainless steel, aluminum alloys and copper alloys)



Used by NADCAP and ISO certified plating facilities

Simplified logistics and bath control offers significant advantages for busy plating job shops:

One additive system - Easy to maintain inventory, less documentation

Simpler logistics - Only one product to ship

Less products on shop floor - More floor space near line and warehouse

One product to make-up & replenish bath - Easy to maintain with lower risk of imbalance

Reduced risk of mistake by operator - More economical and better quality in the long run

Sustainable process - Pb, Cd, EDTA and boric acid-free, ELV, RoHS and WEEE compliant

Less dosing pumps - Lower cost for dosing EQ



Process features



Nichem[®] One MP



Parameters	Standard mid P	Nichem [®] One MP
Ni concentration	6 g/l	5 g/l
Hypophosphite	25 g/l	25 g/l
Temperature	190 °F	85°C (85 - 90°C)
pH	4.7 - 5.0	4.8 - 6.1
Average plating rate	16 - 20µm/h	17 - 24µm/h
Ideal loading ratio	0.75 - 2.5 dm ² /l	0.75 - 2.5 dm ² /l
Solution movement	Air agitation and standard filtration	Air agitation and standard filtration
Replenishment	Manual or automatic	Manual or automatic



Nichem[®] One MP – Bath make-up & replenishment

Single additive which is used for both bath make-up and replenishment

Nichem[®] One MP

Make Up for 100 l

15.0 l

Adjust pH to 5.8 with ammonia (12.5%)

Nichem[®] One MP

Maintenance

1 MTO = 150 ml/l = 5.0 g/l nickel

pH adjustment with ammonia (12.5%)

approx. 25 ml/l per MTO

Nichem[®] One MP – Substrate pretreatment



Pretreatment for steel/copper

Soak cleaner

Electro cleaner

Acid dip

Nichem[®] One MP

Pretreatment for aluminum

Soak cleaner

Etch

Desmut

1st zincate

Zincate strip

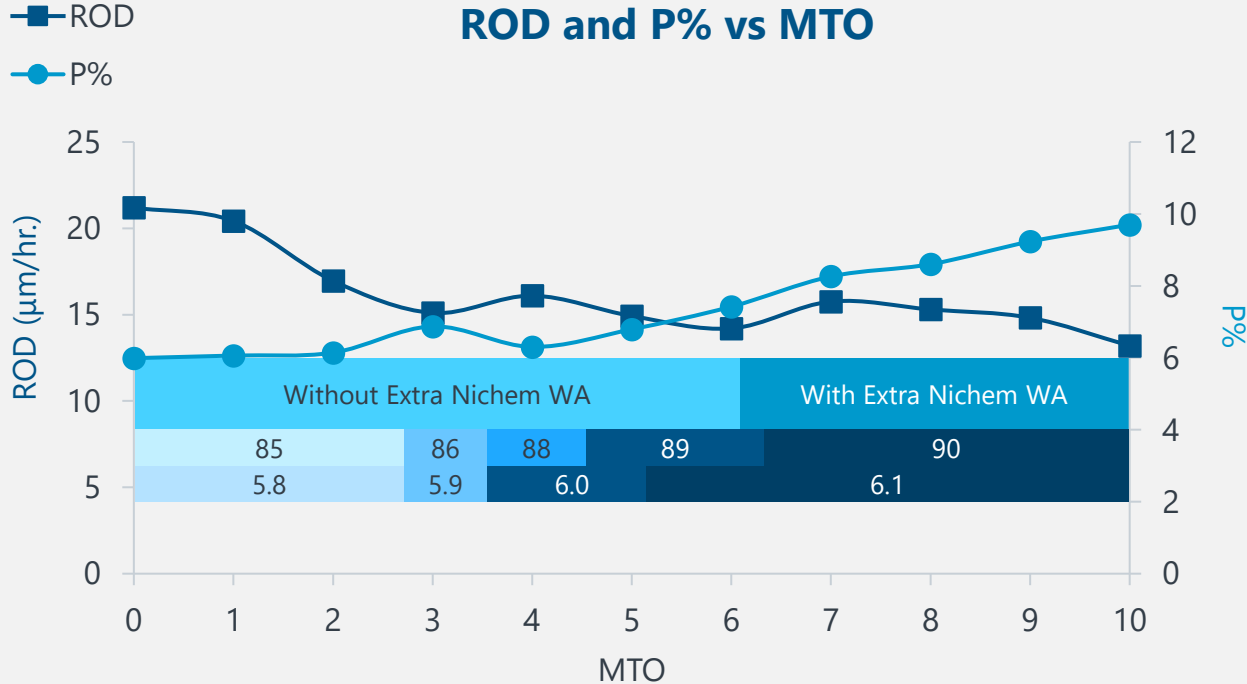
2nd zincate

Nichem[®] One MP

Process
performance



%phosphorus & rate of deposition over bath age



Consistent plating rate between 15 - 24 $\mu\text{m/h}$ over 10 MTO

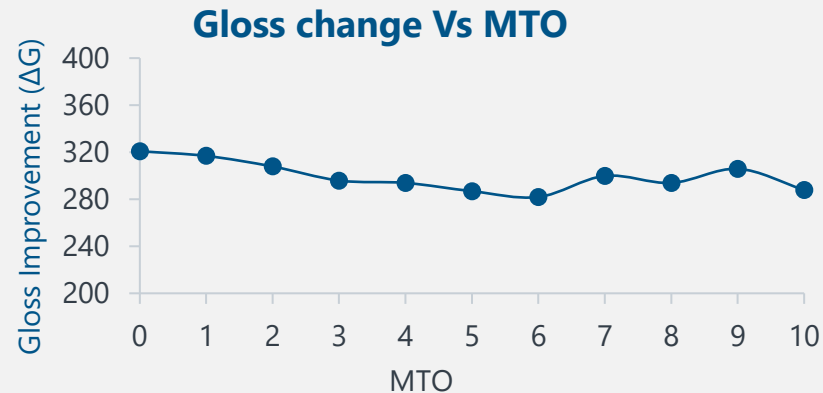
Nichem[®] One MP

Consistent appearance over the bath life

- Plated thickness : 25 μm
- Measured angle: 20°
- Gloss change decreases slightly with bath age



MS piston plated in Nichem[®] One MP



Al piston plated in Nichem[®] One MP

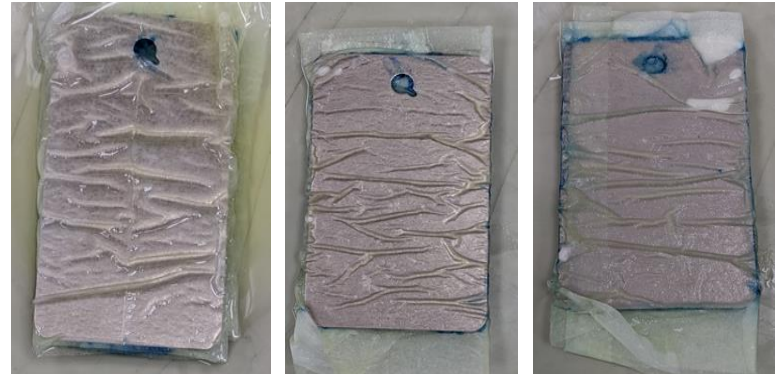
Nitric acid test

- Plating thickness for nitric acid test = $16 \pm 2 \mu\text{m}$
- Except panel plated at 0 MTO have thickness 21.2 μm
- Nitric acid test failed within a second for each MTO panel



Porosity - FerroxyI test

- Test carried out as per Atotech SOP
- Nichem[®] One MP passed FerroxyI test throughout the bath age
- Testing done at 30, 60 and 300 seconds



Bend test

- Plated Thickness: 35 μm
- No coating fracture or blister occurred during bend test at 0, 2, 4, 6, 8, 10 MTO
- Panels plated pass the bend test as per Atotech SOP



Bath stability (beaker test)

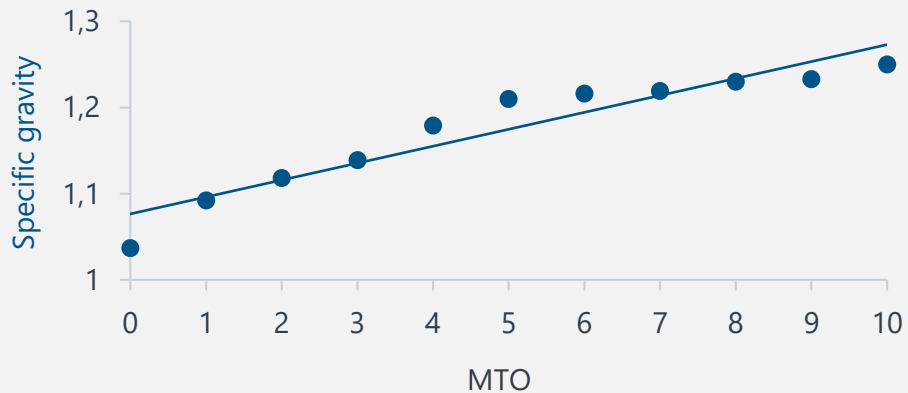
- Test carried out as per Atotech SOP
- Bath stability over bath life with acceptable limit (2 - 4 cycles)

Bath age (MTO)	Nichem [®] One MP (cycles)
0	3
3	2.5
6	2
9	2

S.G v. bath age

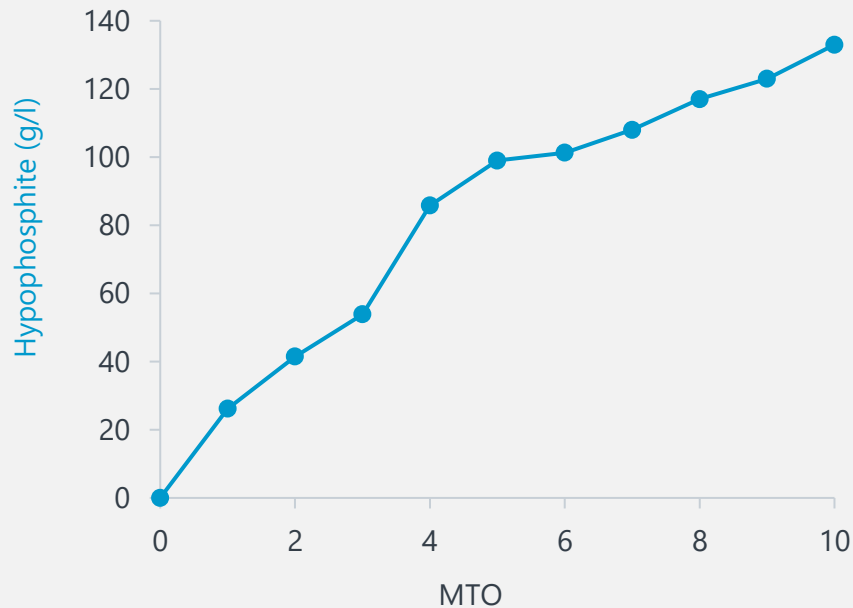
- Specific gravity over bath age lies between 1.037 to 1.25
- It increases with bath age

Specific gravity with bath age



Orthophosphite v. MTO

Orthophosphite vs MTO



Stress test

- Plated Thickness: 10 μm
- Strip constant (tensile stress): 0.2727
- Stress increases with bath age

Stress Vs MTO



NSS test results

NSST hrs till > 1% corrosion (r>6)

Plating thickness (μm)	2 MTO	4 MTO	6 MTO
10	48 hrs	48 hrs	216 hrs
25	>96 hrs	96 hrs	336 hrs
50	360 hrs	120 hrs	120 hrs

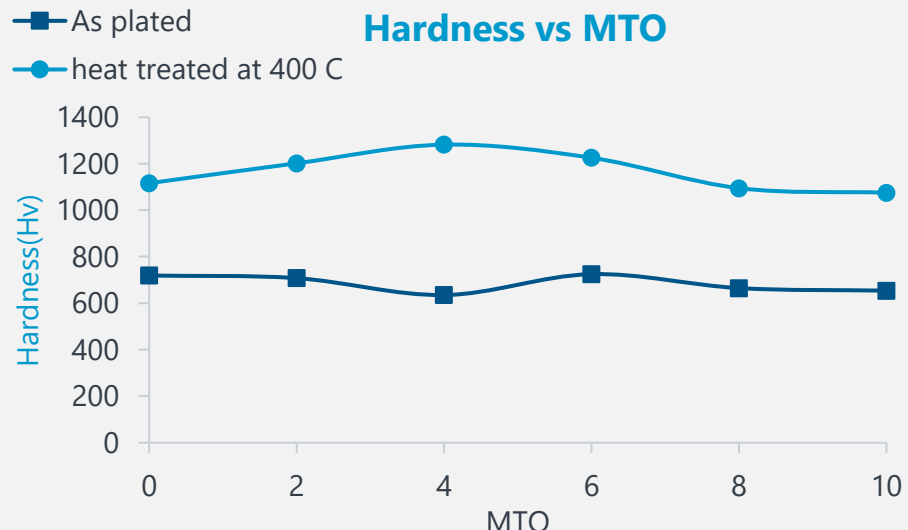
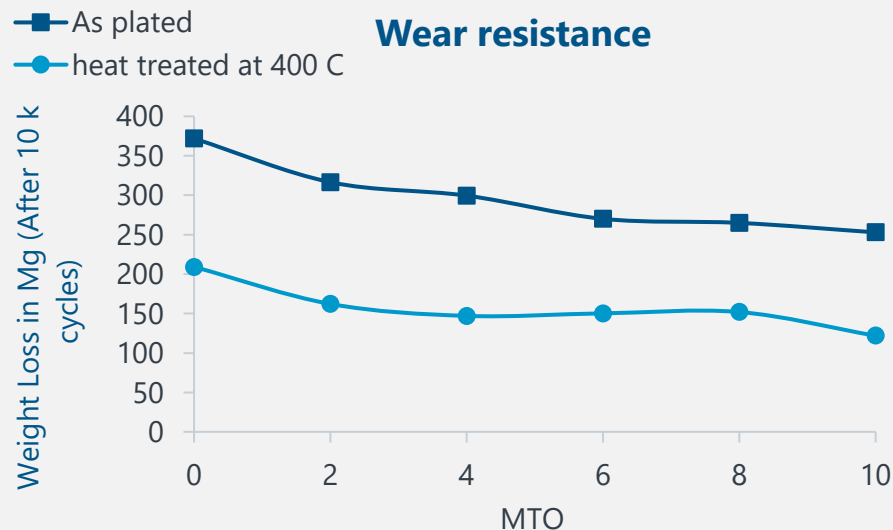


Wear resistance

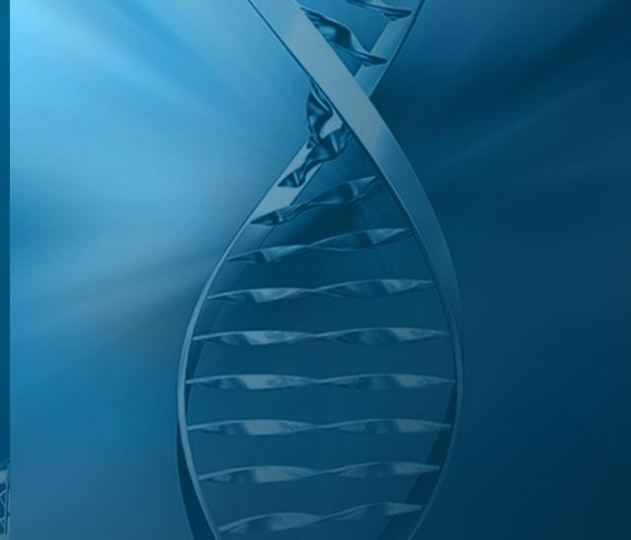
- Plated thickness: 40µm
- CS 10 wheel, 1 kg load

Hardness (Vickers)

- Plated thickness: 50 µm
- Hardness was measured at 100 mN load



Summary



Sustainable EN technology

- Pb and Cd-free (ELV, RoHS and WEEE compliant)

Technical benefits

- Ease of use – Single additive process
- Long bath life with consistent deposition rate (up to 10 MTO)
- Robust performance, suitable for job shops
- Process performance comparable to conventional mid-processes

Economic benefits

- Logistics, ordering and inventory

