BONDERITE®

An Introduction to the Autodeposition Coating Process

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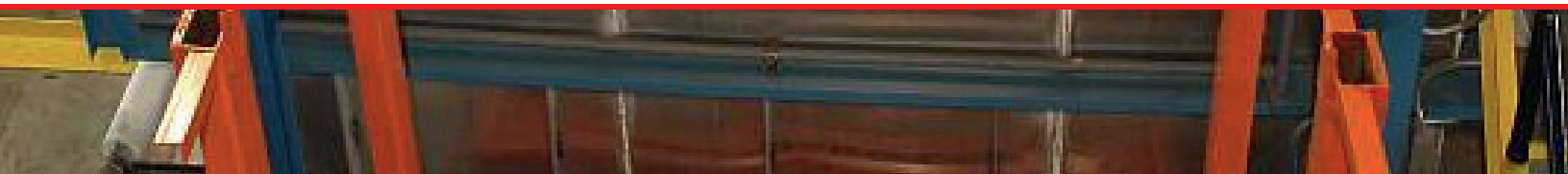

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BONDERITE®

What is autodeposition?

Autodeposition is a method of applying a layer of anti-corrosive paint directly to metal using a chemical reaction. Henkel provides autodeposition coating process products under the brand name of BONDERITE® (known as AQUENCE®). The autodeposition process has been in commercial use since 1975, and has grown to include more than 120 commercial paint shops in 20 countries. Since its inception, this simple and reliable industrial coating process has coated billions of square feet of surfaces worldwide for a wide variety of applications.

How does autodeposition work?

The process consists of four basic steps:
1. Clean the metal
2. Coating deposition
3. Rinse/seal wet coating
4. Oven dry

To explain the chemical reactions that occur with autodeposition, we focus on the interaction of metal ions with the paint particles. The unique step is the coating bath itself, where water-based paint emulsion at low solids (usually around 4-8% by weight) is combined with two other products. A "starter" solution of acidified ferric (Fe^3+) fluoride initiates the coating reaction and an oxidizing product stabilizes the metal ions in the solution. The coating emulsion is stable in the presence of ferric ions, but unstable in the presence of ferrous ions (Fe^2+). Therefore, if ferrous ions are liberated from the metal substrate, localized paint deposition will occur on the surface. This process is illustrated in *Figures 1* and *2*.

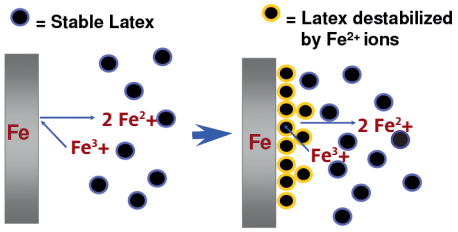


Figure 1 **Autodeposition Mechanism**

If a component made from ferrous metal (shown as the grey rectangle above) is immersed into an autodeposition bath, the acidic environment liberates ferrous ions, causing the coating emulsion to be deposited, forming a mono-layer of paint particles.

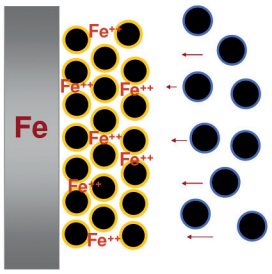


Figure 2 **Autodeposition Mechanism**

Figure 2 illustrates the same ferrous metal substrate after three mono-layers of paint have been deposited. It also illustrates that ferric ions become trapped within the deposited coating. This allows the wet coating to have "cohesive" strength which resists loss of paint solids in the post-paint rinse stages prior to the paint curing oven.

How do I control the coating thickness?

Because the autodeposition coating process is a chemical reaction, the deposition rate will be influenced by time, temperature, concentration, and agitation. The coating thickness will depend on the diffusion (movement) of ferric ions to the surface and ferrous ions from the surface. As the wet coating builds, the deposition rate slows down over time. Thus, the autodeposition process is a self-limiting and controlled reaction, as illustrated in *Figure 3*.

Autodeposition
Simple Process Control

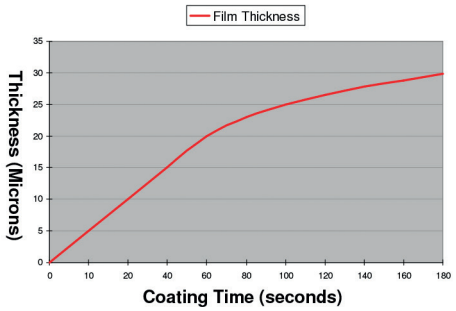


Figure 3

Mixers are used in the paint bath to agitate the bath and bring fresh chemistry to the surface.

An interesting feature of the process is the stability of the bath. There are no heavy anti-corrosive pigments in the bath to cause sedimentation. The acidic nature of the bath also means it is resistant to bacterial growth. The above conditions allow the autodeposition coatings bath to require only low agitation and little maintenance over weekends and shutdown periods.

The typical process

Autodeposition lends itself to production using chain conveyor systems, hoist systems, and “power and free” mechanisms.

A typical autodeposition coating process consists of seven stages plus oven curing:

1. Alkaline spray cleaner
2. Alkaline immersion cleaner
3. City water rinse
4. Deionized water rinse
5. Autodeposition immersion
6. City water rinse
7. Reaction/seal rinse

Final properties are achieved with an oven cure, depending on the BONDERITE® M-PP Coating product type.

A schematic and photograph of a typical programmable hoist line are shown in *Figure 6 (see page 6)* and *Figure 8 (see page 8)*. Please find a similar set of examples for conveyor systems in *Figure 7 (see page 7)* and *Figure 9 (see page 8)*.

What performance can I obtain?

Performance depends on the product type and requirements. For example, the BONDERITE® M-PP 800™ Series is a low-bake product widely used for metal, rubber, and plastic composites. The BONDERITE® M-PP 900™ Series is designed for use in areas subjected to higher operating temperatures, cyclic corrosion resistance, and is suited for use as a primer under powder coatings and liquid baking enamels.

Typical performance properties are listed in the next pages. Final coating performance is affected by multiple variables, including metal quality, surface cleanliness, process control, and dry coating thickness. However, autodeposition is known as the “simple solution” because there are fewer stages to control than conventional painting processes, with simple methods.

Please see *Figure 4* and *Figure 5 (see page 5)* for more information on typical performance characteristics.

Figure 4 **Typical BONDERITE® M-PP 800™ Series performance characteristics**

BONDERITE® M-PP 800™ Series Coatings
PVDC-Based Waterborne Autodeposition Coating

Test	Performance
Resin Type	PVDC
Film Thickness	0.8-1.0 mil (18-25µ)
Adhesion (X-Hatch)	5A – no failure
Pencil Hardness	4H-7H
Gloss Range	5-10 @ 60º angle
T-bend Flexibility	0T bend – no loss
Reverse Impact	> 80 in. - lbs.
Solvent Resistance	50+ DR MEK (no breakthrough)

Test	Performance
504 Hrs. NSS – ASTM B-117	≤ 3 mm creep
1,008 Hrs. NSS – ASTM B-117	< 5% face rust
20 Cycles SAE J-2334	≤ 3mm creep
240 Hrs. Humidity – ASTM D1735	< 5% face rust
Water Soak (240 Hrs.)	pass

Low Cure, No VOC, With Excellent Physical and Water Barrier Properties

The information contained herein is based on results Henkel believes to be accurate at the date of testing. No guarantee of performance is given. Additional information and testing specific to a substrate or process condition may be obtained by contacting Henkel.

Thermal resistance of BONDERITE® M-PP 800™ Coating is dependent upon the duration of exposure and other environmental conditions (such as air flow and presence of moisture). Life cycle testing for parts that will be exposed to operational temperatures about 200ºF or 90ºC is recommended prior to approval.

Figure 5 **Typical BONDERITE® M-PP 900™ Series performance characteristics**

BONDERITE® M-PP 900™ Series Coatings
Epoxy-Based Waterborne Autodeposition Coating

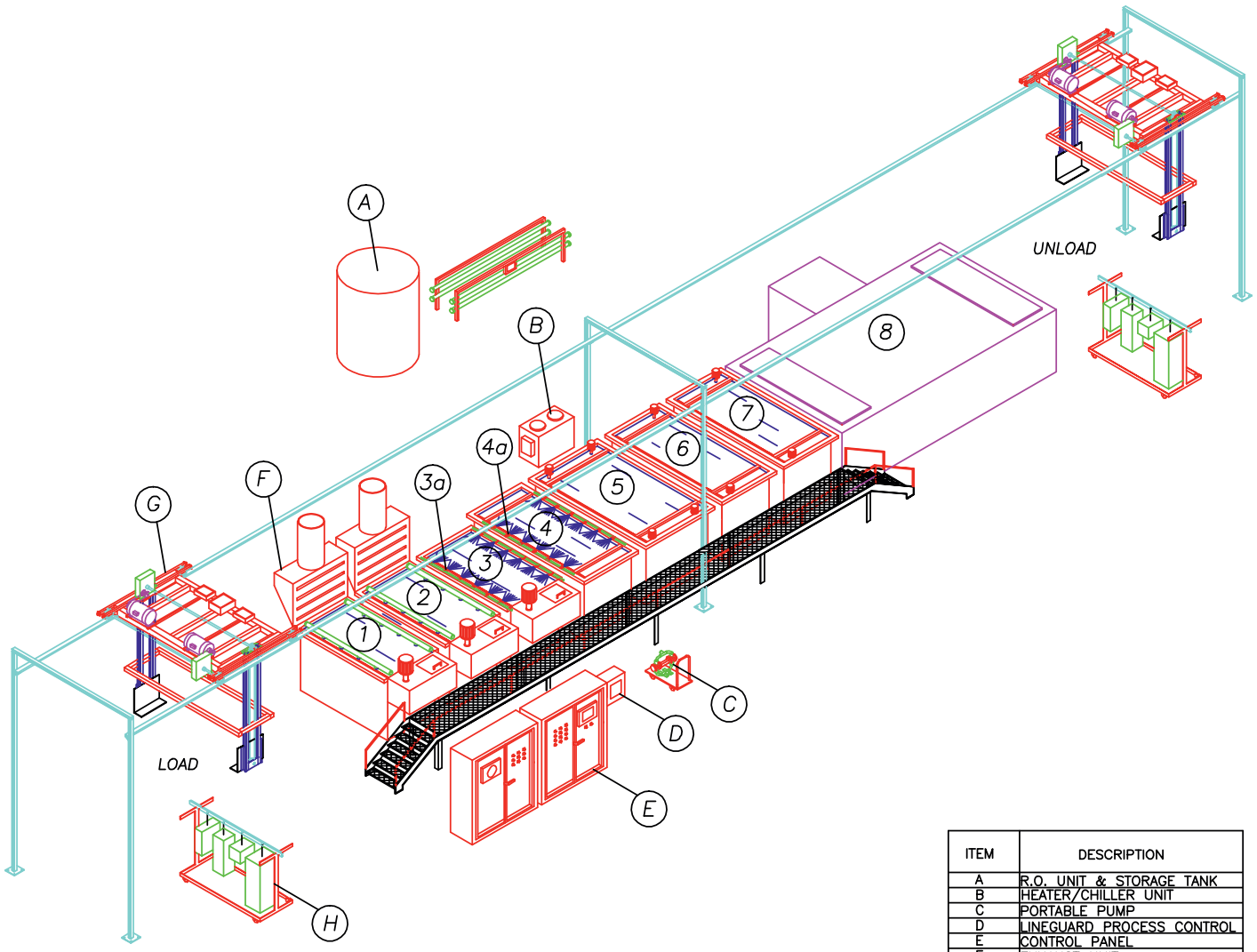
Test	Performance
Resin Type	Epoxy-Acrylic Urethane
Film Thickness	0.8-1.0 mil (18-25µ)
Adhesion (X-Hatch)	5A – no failure
Pencil Hardness	H-3H
Gloss Range	20-40 @ 60º angle
T-bend Flexibility	1T bend – no loss
Reverse Impact	> 80 in. - lbs.
Solvent Resistance	50+ DR MEK (no breakthrough)

Test	Performance
504 Hrs. NSS – ASTM B-117	≤ 3 mm creep
1,008 Hrs. NSS – ASTM B-117	≤ 5 mm creep
1,008 Hrs. NSS – ASTM B-117	< 5% face rust
40 Cycles SAE J-2334	≤ 3 mm creep
1,000 Hrs. Humidity – ASTM D1735	no face rust
Water Soak (240 Hrs.)	no adhesion loss
Thermal Stability	> 230ºC (446ºF)

Very Low VOC, With Excellent Physical and Chemical/Corrosion Resistance Properties

The information contained herein is based on results Henkel believes to be accurate at the date of testing. No guarantee of performance is given. Additional information and testing specific to a substrate or process condition may be obtained by contacting Henkel.

Figure 6 **Typical autodeposition equipment layout for hoist operations**



ITEM	DESCRIPTION
A	R.O. UNIT & STORAGE TANK
B	HEATER/CHILLER UNIT
C	PORTABLE PUMP
D	LINEGUARD PROCESS CONTROL
E	CONTROL PANEL
F	EXHAUST UNIT
G	CRANE
H	PORTABLE CART W/RACK

STAGE No.	PURPOSE	CHEMICAL	TIME (SEC.)	TEMP. (°F)
1	IMMERSION CLEAN	ALKALINE	60–120	200°
2	IMMERSION CLEAN	ALKALINE	120–180	200°
3	IMMERSION RINSE	WATER	60–90	120°
3a	EXIT SPRAYS	R.O. WATER FROM ST. No. 4	–	AMB.
4	IMMERSION RINSE	R.O. WATER	60–90	AMB.
4a	EXIT SPRAYS	VIRGIN R.O. WATER	–	
5	IMMERSION COAT	ACC	90–120	70°+/–2°
6	IMMERSION RINSE	WATER	60–90	AMB.
7	IMMERSION RINSE	REACTION RINSE	60–90	AMB.–125°
8	DRY–OFF OVEN – 30 MIN.			

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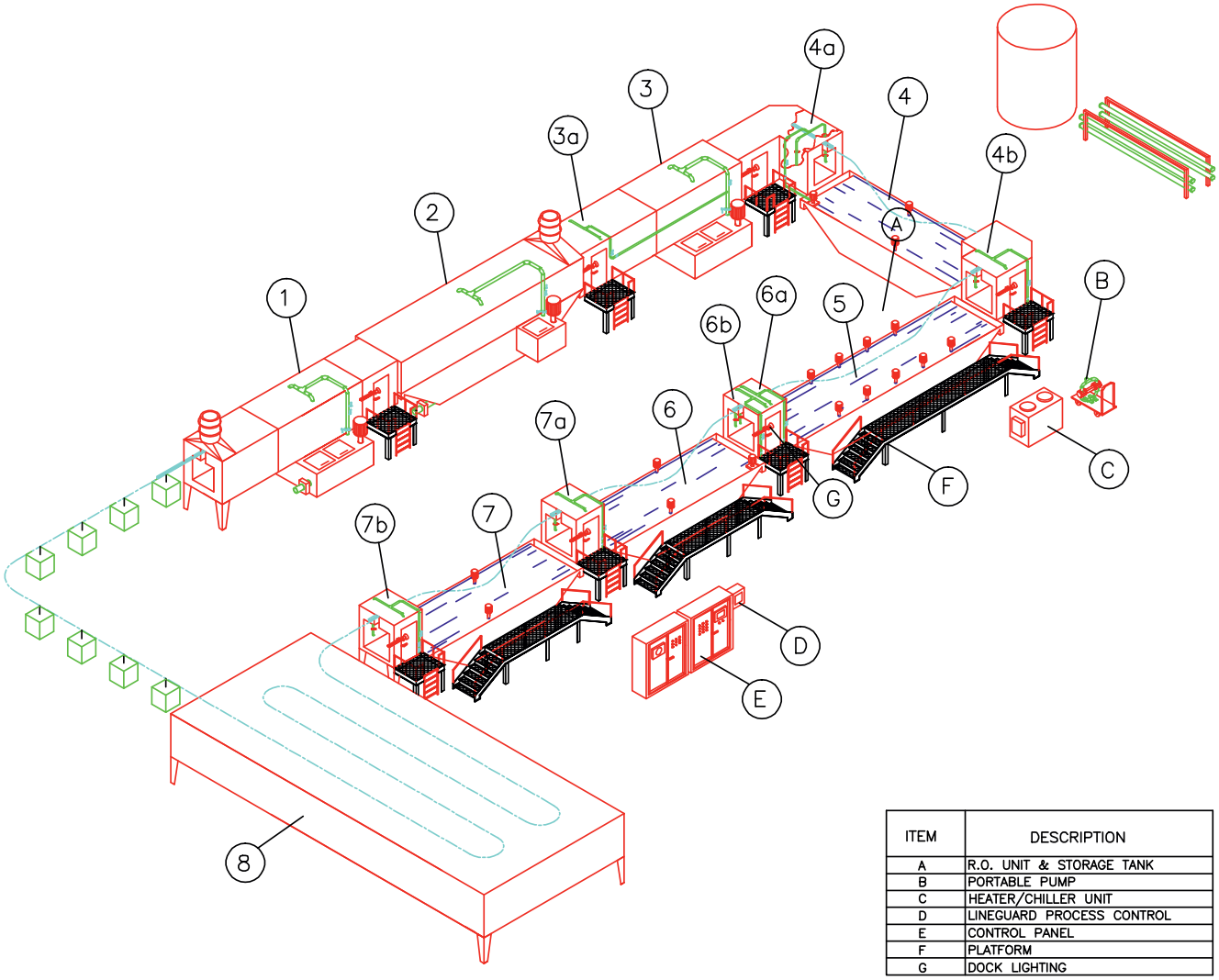
4–15–98	NONE	GPD	1–1

AUTODEPOSITION SYSTEM – RPOGRAM HOIST

CAD/REF. NAME:	APPROVED	REV.	DWG. #
			98–51

Figure 7 **Typical autodeposition equipment layout for conveyor operations**



ITEM	DESCRIPTION
A	R.O. UNIT & STORAGE TANK
B	PORTABLE PUMP
C	HEATER/CHILLER UNIT
D	LINEGUARD PROCESS CONTROL
E	CONTROL PANEL
F	PLATFORM
G	DOCK LIGHTING

STAGE No.	PURPOSE	CHEMICAL	TIME (SEC.)	TEMP. (°F)
1	SP CLEAN	ALKALINE	60	190°
2	IMMERSION CLEAN	ALKALINE	120	190°
3a	PRE-RINSE	WATER FROM ST.# 3	–	120°
3	SP. RINSE	WATER	60	
4a	PRE-RINSE	D.I. WATER FROM ST.# 4	–	AMB.
4	IMMERSION RINSE	D.I. WATER	60	
4b	POST RINSE	VIRGIN D.I. WATER	–	
5	IMMERSION COAT	ACC	120	70°+/-2°
6a	RINSE-OFF	WATER FROM ST.# 6+PLANT	–	AMB.
6b	MIST	D.I. WATER	–	
6	IMMERSION RINSE	WATER	60	AMB. > 65°F
7a	MIST	D.I. WATER	–	AMB.
7	IMMERSION RINSE	REACTION RINSE	60	AMB.-125°
7b	MIST	D.I. WATER	–	AMB.
8	DRY-OFF OVEN – 30 TO 40 MIN.			

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AUTODEPOSITION SYSTEM – CONVEYOR

CAD/REF. NAME:	APPROVED	REV.	DWG. #
			98-12

Figure 8 **Typical programmable hoist installation**

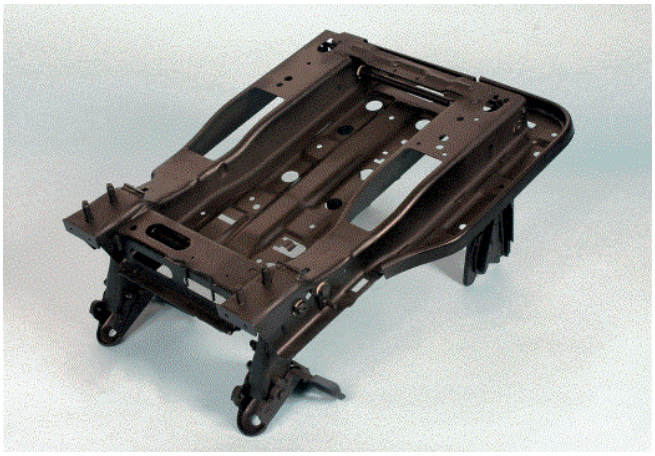
Figure 9 **Typical monorail conveyor installation**

Where is it used?

BONDERITE® M-PP Coatings provide the same level of functional performance experienced with baking enamels, electroplating, electrocoating and powder-coating technologies. Henkel directly maintains or licenses technical, manufacturing, and business development support for this unique technology in every region of the world. A sample of typical commercial applications is noted below.

Commercial market applications

Automotive Parts
- Shocks/Struts
- Suspension Components
- Brake Components
- Engine Components
- Engine Cradles
- Interior Components
- Steering Components
- Chassis/Frames
- Trailer Hitches/Tow Bars
- Window Brackets
- Seating Components
- Under Dash Brackets
- Safety Restraint Components
- Bumper Rails



Automotive seat frame assembly and automotive trailer hitch

Automotive suspension components

Agricultural/Construction Equipment
- Cabins
- Frames
- Wheels
- Track Rollers
- Various Components

Agricultural, construction, and commercial vehicle applications

What unique benefits will BONDERITE® M-PP Coatings provide?

The autodeposition coating process has a number of unique features and benefits:

1. No throwing power limitations
Autodeposition is not limited by electrical shielding – therefore, "wherever the liquid wets, it will coat." Frame and chassis suppliers have selected BONDERITE® M-PP Coatings to give long-term corrosion protection to the inside and outside of the steel frames.

Steel frames. Photo courtesy of Alf Engineering, India

For coaters of small parts, BONDERITE® M-PP Coatings can cope with much higher jig (rack) loading, as the process is not affected by electrical shielding or current density problems. Compared to sprayed processes, the benefits of higher jig loading can be extensive.

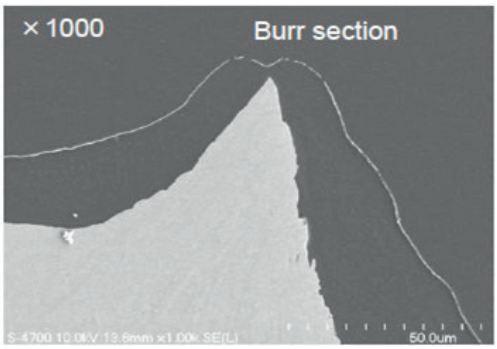
2. Ability to coat complex assemblies
The oven baking schedule for BONDERITE® M-PP 866™ Coating is 100-104°C (210–220°F), a temperature at which most rubber and plastics remain undamaged. This means rubber and metal anti-vibration mountings can be coated without damage to the rubber, and rubber seals remain undamaged. This benefit of BONDERITE® M-PP Coatings means that complex assemblies can be painted fully assembled rather than as components.

Rubber and metal suspension mountings coated with BONDERITE® M-PP 866™

The autodeposition coating process creates cost-reduction options for manufacturers coating metal components as assemblies. If product designs allow for an autodeposition coating process, the following opportunities are available:

- Lower freight impact (ability to direct ship to end-users)
- Decreased rack investment and maintenance
- Improved manufacturing cycle time
- Reduced packaging costs
- Decreased in-process inventory and indirect labor

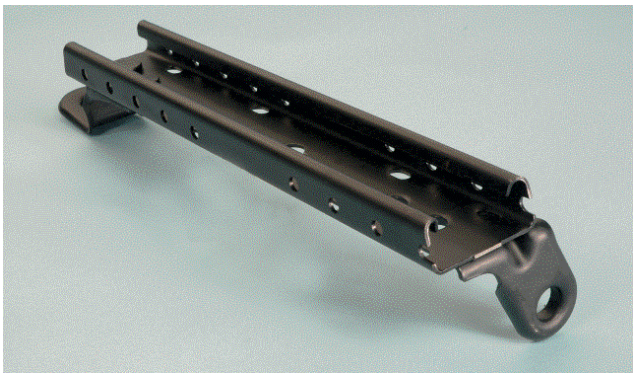
3. Metal profile reproduction
Scanning electron microscope (SEM) photos show a uniform, tight autodeposited wet film and consistent coating thickness around the machined edge of steel part.



Typical SEM photograph of a metal surface coated with BONDERITE® M-PP material.

Autodeposition coating conforms to the shape of the metal surface, and is not affected by variances in electrical energy at high and low areas of complex parts. This feature means BONDERITE® M-PP Coatings provide exceptional edge protection compared to other paint processes.

4. Abrasion resistance
Parts subject to heavy mechanical wear will benefit from the autodeposition coating process due to its exceptional hardness and ability to directly bond to the metal.



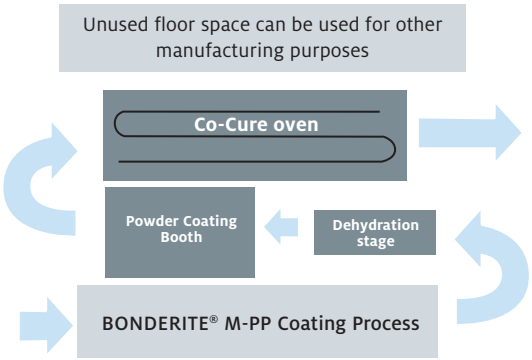
Automotive seat track slide coated with BONDERITE® M-PP 866™

Because of its exceptional wear resistance, BONDERITE® is used on automotive seat tracks, drawer slides and some applications traditionally served by electroplating.

5. Environmental benefits
BONDERITE® paint products are water-based, have very low or no Volatile Organic Compounds (VOC) and can meet all known clean air legislation requirements and various regulatory material disclosure directives around the world. BONDERITE® M-PP 800™ and 900™ Series products do not require toxic, heavy-metal based pre-treatments and therefore do not contain chromium, strontium, zinc, manganese, and/or nickel.

6. "Co-Cure" advantage
BONDERITE® M-PP 900™ Series Coatings not only offer epoxy urethane tough performance as a stand-alone coating, they also are excellent primers for two-coat topcoat systems. Henkel launched an exciting new process development in 2009 called "Co-Cure Process." The Co-Cure Process is an energy-saving process for processing autodeposition coatings primers and powder topcoat. It comprises a de-watering step for the autodeposition primer, followed by the application of powder coating and/or an adhesive sealer, and is completed with the chemical co-curing ("chemical fusion") of the primer and powder topcoat/adhesive.

BONDERITE® Co-Cure "Fusion" Process



Co-Cure advantages:
- Process simplification, reduce paint line footprint
- Handling flexibility; improved production through-put rates
- Energy-saving
- Unique two-coat system performance

7. Additional manufacturing benefits
Health and safety
- No flammable or explosive chemicals in process
- Less risk of employee exposure to process
- Fewer limitations on process location

Energy and cost savings
- Lower energy demands because no electricity is needed to drive the deposition of the coating
- No electrical contact needed
- Coating buildup on racks is very slow
- Decreased rack stripping costs

Conclusion

- The autodeposition coating process is a simple, uniform, and reliable industrial finishing system.
- BONDERITE® M-PP Coatings are exceptionally hard yet flexible films that compete in performance with baking enamels, electroplating, electrocoating and powder-coating technologies.
- BONDERITE® M-PP Coating Products provide unique energy, environmental, and worker-beneficial solutions to complex manufacturing operations.

BONDERITE®

North America
Henkel Adhesive Technologies
32100 Stephenson Highway
Madison Heights, MI 48071
United States
Tel: +1.248.583.9300
Fax: +1.248.583.2976

Latin America North
Henkel Mexicana, S.A. de C.V.
Boulevard Magnocentro No. 8, Piso 2
Centro Urbano Interlomas
52760 Huixquilucan Edo de Mex
Mexico
Tel: +52.55.3300.3000
Fax: +52.55.3300.3062

Europe-Middle East-Africa
Henkel AG & Co. KGaA
Henkelstraße 67
40589 Düsseldorf
Germany
Tel: +49.211.797.0
Fax: +49.211.798.4008

Asia Pacific Office
Henkel (China) Investment Co. Ltd.
No. 928 Zhang Heng Road
Pu Dong
201203 Shanghai
China
Tel: +86.21.2891.8000
Fax: +86.21.2891.8944

Latin America South
Henkel Technologies Ltda
Henkel Diadema
Rua Karl Huller, 136
CEP: 09941-410 - Diadema - SP
Brazil
Tel: +55.11.3205.8955
Fax: +55.11.3205.8766

India
Henkel Chembond Surface Technologies Ltd.
Chembond Centre
EL-71, MIDC Mahape
Maharashtra
Navi Mumbai - 400705
India
Tel: +91.22.392.130.00
Fax: +91.22.276.812.94

www.bonderitempp.com