

Metal Finishing Choices for Sheet Metal Fabrication

There are two types of finishing of metal fabricated parts: metal finishing and surface finishing. Metal finishing will be discussed in this chapter and surface finishing is covered in Chapter 8. Metal finishing is used to add a layer to the part while surface finishes remove a layer. Both are meant to improve appearance and functionality.



Choosing a finish to your sheet metal fabricated products and parts usually takes two key factors into account: function and aesthetic. Functional coatings are typically chosen to protect the sheet metal from corrosive elements in the environment or physical damage. However, coatings can also improve other factors like: weldability, electrical conductivity or resistance, and chemical resistance. Aesthetic choices are usually made based on a desired appearance or for branding purposes.



UNDERSTANDING GALVANIC CORROSION

Corrosion is the breakdown of metal (through chemical or electrochemical reactions) into oxide, hydroxide, or sulfide. We commonly associate corrosion with rust which is just one form of localized corrosion. There are several different types including galvanic corrosion which is of special interest for those involved in sheet metal fabrication finishes.

Galvanic corrosion is a result of two dissimilar metals with electrical or physical contact in a corrosive electrolyte – commonly water, salt, soluble acids, or bases. In these conditions, one of the metals becomes an anode and the other a cathode. The anode will corrode faster than it would have alone while corrosion to the cathode is slowed. The anode is often referred to as the "sacrificial" metal.

Galvanic corrosion creates a significant risk for metal fabricated products where multiple metals are used. Fasteners are a good example. Using metal bolts that act as a cathode to a frame will result in faster corrosion to the frame than you would normally expect from the metal used to make it.

Preventing galvanic corrosion involves three key things: choosing compatible metals whenever possible, prevent contact between incompatible metals through insulation or coating, or provide a coating to the connection to prevent exposure to the corrosion environment.

Some metal coatings take advantage of galvanic corrosion to enhance the corrosion resistant properties of a metal. Zinc plated and galvanized dipped metals, for example, use these principals to enhance the corrosion resistance of different types of steel. Zinc will take on the sacrificial anode role and corrode first, protecting the steel it is coating. Other finishes can help prevent galvanic corrosion without acting as a sacrificial anode. Ecoating, powder coating, Dacromet, and anodizing finishes can also provide protection by helping prevent contact between the two dissimilar metals or eliminating exposure to the corrosive environment.

DIFFERENTIATING METAL FINISHES FOR SHEET METAL FABRICATION

The three biggest reasons for finishing a surface is to improve corrosion and abrasion resistance. The thickness of the coating material is also a factor for many. The table below summarizes how popular finishes perform in each of these areas.

	Corrosion resistance	Coating thickness	Abrasion resistance
Powder coating	<ul style="list-style-type: none"> Corrosion resistance depend on type of material used and pre-treatment process Surface must follow pre-treatment process before powder coat or part will be at risk of corrosion and adhesion issues Chips or incomplete coverage adds to risk of corrosion 	<ul style="list-style-type: none"> Can range from 35 to 200µm Thicker than traditional liquid paint Improve appearance Various colors and textures available 	<ul style="list-style-type: none"> Heat cured finish Material composition and pre-treatment may have enhanced abrasion resistance Creates a hard finish that resists abrasion well
Ecoating	<ul style="list-style-type: none"> Good corrosion resistance Provides physical and chemical barrier to corrosion 	<ul style="list-style-type: none"> Typically 12 to 30 µm but can be more Often used to increase surface thickness Thickness of application is uniform 	<ul style="list-style-type: none"> Good durability Heat cured finish Good longevity
Zinc plating	<ul style="list-style-type: none"> Provides physical barrier to corrosion Acts as a sacrificial anode to prevent corrosion Parts can sustain minor damage and remain corrosion resistant 	<ul style="list-style-type: none"> Can range from 5 to 25 µm If use as an undercoat for other finishes, poor adhesion Best for detailed surfaces and not heavy-duty applications 	<ul style="list-style-type: none"> Very strong finish Highly durable to abrasion
Dacromet	<ul style="list-style-type: none"> Provides barrier resistance to corrosion Creates passivation effect on surface 	<ul style="list-style-type: none"> Between 5 to 7.6 µm Can be used under a painted finish 	<ul style="list-style-type: none"> Good abrasion resistance Electrically conductive finish Good resistance to chemicals, organics, heat, salt
Anodizing	<ul style="list-style-type: none"> Good corrosion resistance Commonly used for saltwater or marine environments 	<ul style="list-style-type: none"> Ranges from 0.5 to 150 µm 	<ul style="list-style-type: none"> Hard, wear resistant finish Often used for parts that come in frequent contact with other material
Passivation	<ul style="list-style-type: none"> Good corrosion resistance through an inert, oxide layer 	<ul style="list-style-type: none"> The process removes free iron from the surface leaving a thin and transparent oxide film 	<ul style="list-style-type: none"> Does not change durability or abrasion resistance
Galvanized dipped	<ul style="list-style-type: none"> Provides barrier resistance to corrosion Acts as a sacrificial anode to prevent corrosion 	<ul style="list-style-type: none"> At more than 254 µm the finish is prone to flaking Poor appearance Can adjust thickness of finish to accommodate needs 	<ul style="list-style-type: none"> Often used in harsh environments because of durability Good abrasion resistance Good durability and longevity Surface damage can result in corrosion

NOT ALL FINISHES WORK WITH ALL SHEET METAL

Not all finishes are suitable for all types of metal so finishing options should be part of your material decision making process.

	Cold rolled steel	Hot rolled steel	Spring steel	Aluminum	Stainless steel	Cold galvanized steel
Powder coating	x	x	x	x	x	x*
Ecoating	x	x	x			
Zinc plating	x	x	x			
Dacromet	x	x	x**			
Anodizing				x		
Passivation					x	
Galvanized dipped	x	x				

*Powder coating can be applied to cold galvanized steel but special pre-treatment is required for the powder coating to adhere

** Various type of Dacromet are available, including cold and hot processing. Choose your process carefully to ensure the Dacromet surface finishing modifies the mechanical property of the underlying material

Metal finishing options

This section outlines some of the most common choices for finishing sheet metal fabricated parts. The list is not exhaustive and there are other options available. Check with your custom fabricator to determine what they offer and what they recommend for your specific needs.

Powder coating

Powder coating applies a dry powder (instead of traditional liquid paint) electrostatically to the metal surface. After heat curing, the surface is harder and more durable than traditional paint.

Commonly used for: appliances, automotive components, outdoor equipment and furniture, outdoor signs, fencing, windows and doors



Powder coating finish

What you should know:

- Finish is thicker and more uniform than liquid paint
- No drips or running which is common with liquid paint
- Can accommodate unique finishes textures and custom colors
- Part must be completely clean for powder to adhere
- Great adhesion and corrosion performance require pre-treatment process to remove rust, degreasing, surface activation, and phosphating
- Fast curing time

Ecoating

Ecoating is also known as electrophoretic painting and is used to apply a thin coating of epoxy paint to a metal surface. A bath that includes paint, resins, or pigments in a water-based solution is used along with an electric current to encourage the coating particles to deposit on the metal surface. The coating is cured with heat.

Commonly used for: hardware, giftware, automotive parts, appliances, agricultural parts, marine components, metal furniture, outdoor furniture, outdoor tools and equipment, fixtures

What you should know:

- Offers corrosion resistance
- Can be used to increase surface thickness
- Usually not used for cosmetic/visual parts
- Can be a primer for other finishing
- Provides a more even coat than traditional painting or powder coating
- Application has a consistent thickness
- Good option for parts that have hard-to-reach spaces
- Good durability which makes it a good choice for parts that have prolonged exposure to water, sun, or outdoor environments



Mild steel with ecoating finish

Anodizing

Anodizing submerges an aluminum alloy into an acidic and electrolytic solution to create an aluminum oxide finish. While aluminum itself is corrosion and wear resistant, many of the metals used in aluminum alloys are not and anodizing offers a way to compensate.

Commonly used for: computer hardware, home appliances, building materials, marine part including ship hulls and docks, oil rig structures and components, roofing, construction materials, scientific instruments.

What you should know:

- Improves hardness
- Improves corrosion, abrasion, and wear resistance
- Gives a smooth finish
- Good wear resistance makes this an option for parts that are in frequent contact with other materials
- Dyes can be added to create a colored finish
- Common for aluminum alloys exposed to saltwater or marine environments
- Most commonly used for aluminum and aluminum alloys but can also be used on nonferrous metals like titanium, magnesium, stainless steel, zinc, and copper alloys

Zinc coating

Zinc coatings can be applied in two ways: electrolysis or with acid zinc. Acid applications are faster but don't always provide a uniform coating. Electroplating is slower but gives a more uniform coating. A fine zinc coating provides corrosion protection in 2 ways: as a physical barrier and as a sacrificial anode that will corrode faster than the steel its applied to. The nature of the zinc coating means that even if a part or piece incurs minor damage, it can remain protected from corrosion.



*Mild steel with
yellow zinc finish*

Commonly used for: small parts like nuts, bolts, and screws; automotive parts, military vehicles, wire, tube

What you should know:

- Improves corrosion resistance
- Well suited to detailed surfaces, less suited for heavy-duty applications
- High strength finish
- Finished metals have good formability
- Should not be used as an undercoat for other finishes due to adhesion risk
- Galvanized metals will have a silver-grey colored finish
- Galvannealed metals have a smooth, matte finish
- Zinc coated parts cannot be welded. Welding should occur prior to coating

Galvanized dipped

Galvanizing or hot-dip galvanizing involves submerging the metal into molten zinc to create a very tightly bonded alloy coating. This is one of the most common ways to protect metal from corrosion damage. Like zinc coating, it provides both a physical barrier and acts as a sacrificial anode.

Commonly used for: automotive and machinery parts, construction materials, electrical boxes, electronics equipment, prefab buildings, HVAC parts, appliances, light fixtures, playgrounds, toolboxes

What you should know:

- Improves corrosion resistance
- Creates a uniform finish but poor appearance
- Commonly use for heavy duty products where appearance is not critical
- Good resistance to mechanical or abrasion damage, good durability
- Good longevity of finish
- Can adjust thickness of finish but thicker finishes create a rougher surface and can create issues with weldability
- Economical alternative to more costly, corrosion resistant metals
- Fast application process
- Surface damage can expose metal and result in corrosion
- Must start with a clean surface for proper bonding

Dacromet

Dacromet combines zinc and aluminum flakes with a binder for cold-dipped or spray applications. Heat is applied to complete the process. It creates a type of passivation on the surface.

Commonly used for: large automotive parts, nuts and fasteners, wind turbines, marine parts, agricultural and construction equipment, aerospace

What you should know:

- Improves corrosion resistance
- Provides barrier protection with a very thin layer of protection
- Good resistance to mechanical and chemical damage
- Improved resistance to organics, heat, salt
- Creates an electrically conductive finish
- Finish can be painted
- Some Dacromet types may change metal mechanical properties



Q345 with Dacromet finish

Passivation

Passivation is the process of exposing stainless steel to an acid solution to remove free iron from the surface, creating a "passive" metal. The elements left behind change the reactivity of the metal's surface to create a more rust and corrosion resistant finish. Processes like welding, cutting, grinding etc can alter the surface of the metal, introducing foreign material, which may make passivation a good next step.

Commonly used for: pharmaceutical equipment, food manufacturing equipment

What you should know:

- Improves corrosion resistance
- Metal must be cleaned well before passivation or the process will be unsuccessful
- Surface damage can result in corrosion
- May need to be reapplied during life of the part
- Process can be used for descaling or cleaning stainless steel