Machining Science and Jigs and Fixtures (21ME42)

Module 3 Powder Coating and surface finishing

What is Powder Coating

Powder coating is a dry finishing process that has become extremely popular since its introduction in North America over in the 1960s. Representing over 15% of the total industrial finishing market, powder is used on a wide array of products. More and more companies specify powder coatings for a high-quality, durable finish, allowing for maximized production, improved efficiencies, and simplified environmental compliance. Used as functional (protective) and decorative finishes, powder coatings are available in an almost limitless range of colors and textures, and technological advancements have resulted in excellent performance properties.

How Powder Coating Works

Powder coatings are based on polymer resin systems, combined with curatives, pigments, leveling agents, flow modifiers, and other additives. These ingredients are melt mixed, cooled, and ground into a uniform powder similar to baking flour. A process called electrostatic spray deposition (ESD) is typically used to achieve the application of the powder coating to a metal substrate. This application method uses a spray gun, which applies an electrostatic charge to the powder particles, which are then attracted to the grounded part. After application of the powder coating, the parts enter a curing oven where, with the addition of heat, the coating chemically reacts to produce long molecular chains, resulting in high cross-link density. These molecular chains are very resistant to breakdown. This type of application is the most common method of applying powders. Powder coatings can also be applied to non-metallic substrates such as plastics and medium density fiberboard (MDF).

Sometimes a powder coating is applied during a fluidized bed application. Preheated parts are dipped in a hopper of fluidizing powder and the coating melts, and flows out on the part. Post cure may be needed depending on the mass and temperature of the part and the type of powder used. No matter which application process is utilized, powder coatings are easy to use, environmentally friendly, cost effective, and tough!

Durability of Powder Coating

Powder coating is a high-quality finish found on thousands of products you come in

contact with each day. Powder coating protects the roughest, toughest machinery as well as the household items you depend on daily. It provides a more durable finish than liquid paints can offer, while still providing an attractive finish. Powder coated products are more resistant to diminished coating quality as a result of impact, moisture, chemicals, ultraviolet light, and other extreme weather conditions. In turn, this reduces the risk of scratches, chipping, abrasions, corrosion, fading, and other wear issues.

It's tough. It looks great. And it lasts a long, long time. In addition to being durable, powder coating is an attractive choice due to environmental advantages.

What is the powder coating? Explain

1. Powder coatings don't require a carrier. The additives, pigments, and resins are formulated in a powder form. To apply the material to parts, the powder is electrostatically charged and conveyed via compressed air. The charged powder is attracted to a grounded part. The part is then taken through an oven, where the heat changes the powder from a solid to a liquid and then to a solid coating. Properly cured powder coatings can offer superior protection against chipping, scratching, UV rays, and corrosive elements. This is why powder coatings are often specified to coat metal products destined for outdoor use.
2. Advantage

There are several advantages of powder coating over conventional liquid coatings:

- Powder coatings emit zero or near zero volatile organic compounds (VOC).
- Powder coatings can produce much thicker coatings than conventional liquid coatings without running or sagging.
- Powder coating overspray can be recycled and thus it is possible to achieve nearly 100% use of the coating.
- Powder coating production lines produce less hazardous waste than conventional liquid coatings.
- Powder coated items generally have fewer appearance differences between horizontally coated surfaces and vertically coated surfaces than liquid coated items.
- A wide range of specialty effects is easily accomplished which would be impossible to achieve with other coating processes.

What is the liquid coating?

1. Introduction

   The basic raw materials comprising a liquid coating are additives, carriers, pigments, and resins. Additives make up the smallest portion of any liquid coating composition, but they impart special characteristics on the overall finish; for example, they might assist with rust prevention or UV protection. The carrier is the main liquid used to formulate the paint. The carrier can be water, solvent, or a combination of the two. Liquid coatings heavy in solvents traditionally have been the dominant form of liquid finish applied to metal parts over the years, but more interest has been directed to waterborne and high-solids coatings, which release a minimal amount of volatile organic compounds (VOCs) during application when compared to traditional solventborne coatings. Pigments play a role in final appearance and performance to some extent. As a rule, the volume of pigments influences the gloss of the film. The more pigment present, the lower the coating's gloss. Resins act as the base of the liquid coating. They primarily govern the overall performance of the coating, helping the paint to excel for particular applications.

   Liquid coating finishes can be applied in various thicknesses. Obviously, the more mils applied, the better the protection. In many instances, a manufacturer, such as an automaker, will seek to balance maximum protection with the minimum amount of paint mil thickness.

2. Advantage

- Economical: The first notable benefit for liquid coating is the fact that because the paint can be applied thinly so you need less of it, which in turn makes it an economic option. Less painting material means less money and an affordable option for you!
- Variety of Choice: Liquid coating also gives a vast variety of options in more ways than one. For starters, the liquid paint has a wide expanse of color choices, including both metallics and pearls, which can give your product the flair you've been looking for. Liquid also comes in various specialty coats. These specialty coats include glow-in-the-dark and teflon, which are ideal for specialty markets like military, medical, aerospace, and transportation needs.

- Lower Error

  When painting with a liquid spray, the occurrence of film builds lowers. More film builds means a higher chance of rejected parts and a longer production time, which isn't ideal for anyone. With consistent and effective coating, you and your team save a substantial amount of time and money.

- Easily Markable

  Sometimes, there will be sections of a piece that are not supposed to be painted and are taped off. Regular tape will not withstand the heat of the oven to keep a section paint-free on products that require baking. With liquid paint, because there is no need for an oven to set the paint, so sections can easily be marked off.

How Does the Coating Affect the Environment?

Solventborne coatings are often specified for a finish because of their dependable performance and ability to air-dry in a matter of minutes. Unfortunately, most of the traditional liquid paint formulations from yesteryear no longer are around because of the need to reduce VOCs emitted during application.

That has led to the development of more environmentally friendly coatings, such as new waterborne formulations and high-solids coatings, that emit low VOCs. The waterborne, which have come a long way from the early versions used 15 years ago, are slowly growing in acceptance. However, some manufacturers still have reservations about applying a water-based product directly to metal. High-solids are liquid coatings that have a solids content of at least 65 percent, which means minimal solvents are present. But fewer solvents also means that the coating is more viscous. That has led to the development of multipart application systems (referred to as 2K systems if two parts are mixed, 3K if three parts are mixed, etc.) that are formulated to be mixed only seconds before application.

All finishers that apply liquid coatings spray to waste. The overspray can't be reclaimed. If filters are used to capture the overspray, the finisher has to dispose of the filters according to regulations established by local authorities.

The powder booth does not require exhaust. As stated previously, if any VOCs are emitted during the powder coating process, they are typically very low.

Powder coatings can be recycled with the right reclamation equipment. Companies looking for Class A finishes have reclamation systems that depend on thorough cleaning and maintenance because any cross-contamination of reclaimed material ruins the original material's ability to deliver a specific color.

Again, the disposal of unreclaimed powder coating material is governed by local regulations. In some instances, local law may require disposal in sealed containers or require that the powder coating material be baked into the form of brick for disposal in a local landfill.

GALVANIZING

Prepared items are galvanized by immersion in molten zinc. On immersion in the galvanizing bath the steel surface is completely covered by the molten zinc, which reacts with the steel to form a series of zinc-iron alloy layers. The thickness of these layers is determined principally by the mass of the steel being galvanized. This is an important advantage of the galvanizing process – a standard minimum coating thickness is applied automatically regardless of the operator.

To allow formation of the coating the work remains in the bath until its temperature reaches that of the molten zinc, in the range of 445°C to 465°C. The work is then withdrawn at a controlled rate and carries with it an outer layer of molten zinc which solidifies to form the relatively pure outer zinc coating.

With proper venting and draining design, the molten zinc covers corners and welds, seals edges, and penetrates recesses to give complete protection to areas which are potential corrosion spots with other coating systems. The galvanized coating is usually slightly thicker at corners and narrow edges, giving greatly increased protection compared to organic coatings which thin out in these critical areas. Complex shapes and open vessels may be galvanized inside and out in one operation.

The period of immersion in the galvanizing bath varies from a few minutes for relatively light articles, or longer for very heavy structural members.

Upon extraction from the galvanizing bath the article is normally cooled via a quench solution, which usually contains an inhibitor to provide passivation of the zinc surface to prevent early oxidation.

The use of galvanizing for structural steel protection gives you ten major, measurable benefits.

- Lowest first cost. ...
- Less maintenance/Lowest long term cost. ...
- Long life. ...
- Reliability. ...
- Toughest coating. ...
- Automatic protection for damaged areas. ...
- Complete protection. ...
- Ease of inspection.

Anodizing

It is a key step in manufacturing aluminum CNC machined parts. An electrochemical process that involves coating a metal part with an oxide surface layer, anodizing gives the part additional sturdiness and a more attractive finish. While anodizing is most common with aluminum, other substrates can be anodized, including magnesium and titanium.

Anodizing ensures a part can resist corrosion and wear and tear from prolonged use, and that it retains its cosmetic appearance under any conditions. In many cases, manufacturers send parts to a third-party service provider specialized in anodizing, similar to when you need heat treatment, tempering or electroplating.

The most common types of anodizing are Type I (Chromic Acid Anodize), Type II (Sulfuric Acid Anodize) and Type III, also known as Hardcoat. Each type of anodizing is ideal for different materials and serves its own distinct manufacturing parameters. Despite each type's specific advantages and drawbacks, they all work relatively the same way.

The simplest way to understand how anodizing works is in the name. To anodize a part, you connect it to a positive terminal of an electrical circuit, also called an anode. You then submerge the part in an acidic electrolyte bath solution. This solution contains chemical compounds, such as sodium phosphate, which fill the bath with positive and negative ions.

Once the part is submerged and secured to a hanger so it doesn't move around, you apply the negative end of the circuit, or cathode, to a metal electrode in the bath. When you send voltage through the circuit, the negative electrode attracts positive

ions (cations) from the part, and the aluminum part attracts negative O2 ions (anions) from the solution.

When positive aluminum ions leave the part's surface, it becomes porous, reacting with the negative O_2 ions to grow a layer of aluminum oxide.

Let's break the process down into these simple steps:

- Turn the part into an anode with a positive charge
- Turn the metal plates into the cathode with a negative charge
- Submerge both in the acidic bath
- Apply voltage
- Subtract aluminum ions from the part, creating pores
- Attract oxygen ions to the part's surface
- The reaction forms a hard, corrosion-resistant aluminum oxide layer

What's the difference between anodizing and electroplating?

If you're familiar with electroplating, you may recognize that anodizing is similar in many ways. Comparing the two processes definitely helps to understand anodizing as a unique and important step in fabricating CNC aluminum parts.

Similar to anodizing, electroplating involves placing the part in an electrolyte bath and applying a charge to it. The key difference is that with electroplating, the part gets negatively charged, becoming the cathode instead of the anode.

The anode is applied to a piece of the desired plating material, such as gold. As with anodizing, this circuit allows positively charged ions to flow to the cathode (the part). These ions coat the part with a thin, even layer.