METAL FINISHES

Everything But Paint

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Except for a few parts on an automobile, most have some type of finish. Those that don’t include some castings of iron or aluminum, e.g., steering boxes and alternator cases and forged steel pieces, e.g., steering arms and roll bars This article will cover typical finishes except paint, including: electroplating, passivation, anodizing, and polishing. Most of these finishes are used on mild steel which comprise the bulk of automotive parts.

Electroplating

Eletroplating is used on many different parts and is used to apply chrome, nickel, copper, cadmium, zinc, and terne (a mixture of four parts lead to one part tin). All electroplating requires a clean, smooth surface. The piece to be plated is negatively-charged and the metal ions to be deposited on the subject piece, which are contained in an electrolyte (called a bath), are positively charged. An electrical DC current is passed through the bath causing the metal ions to be deposited on the part being plated.

Chrome Plating

Various automotive parts of steel and zinc die cast are chrome-plated. Of all the metal finishes chrome-plating is arguably the most misunderstood of the metal finishes. Most people associate chrome plating with *decorative chrome plating* such as used on car bumpers until they were replaced by plastic covers. However, there is also hard chrome plating which is used for wear resistance on some engine parts. It is called hard chrome because it is several thousandths of an inch thick and can be measured for hardness as opposed to decorative chrome which is only millionths of an inch thick and would easily break if subjected to a hardness test. This article will concentrate on decorative chrome plating only.

The subject of chrome plating is filled with many buzzwords that are essentially meaningless — “show chrome,” “triple chrome plating,” “double-nickel chrome,” tri-chrome” and more. Read the platers’ ads and probably more will surface. The following will demystify this process and provide some guidance to ensure a successful result.

Decorative chrome plating requires polishing of the piece to be plated, cleaning chemically and electrically, activating the surface, plating copper (may be omitted), plating two or three coats of nickel and then plating a final layer of chrome. Between each step, the piece must be thoroughly rinsed so as to not contaminate the succeeding plating bath. Cross contamination of the electrolytes will lead to peeling of the plating and a white appearing dust on the plated piece when exposed to the elements.

New metal pieces have minimal preparation as compared to restoration of a part for a collector car. A used piece being re-plated requires stripping of the existing chrome, the existing nickel, and the existing copper if present. Then, any rust must be removed, dents straightened and pits and scratches polished out. Next, a layer of copper is deposited and this layer buffed until a smooth surface is obtained. These restoration steps are essential to successful re-chroming of a part. If not carefully done, the original part dimensions will be changed and adjoining parts may not fit or details, such as those in zinc die cast parts will be obliterated. Some parts, such as chrome air cleaners, rocker arm covers, etc, are chrome plated without any copper, particular when new.

After the part is prepared, it is ready for final steps of chrome plating. First, a layer of semi-bright nickel is applied followed by a coating of bright nickel. The reason for two coatings of nickel is to provide a durable finish. The bright nickel is anodic to the semi-bright nickel and sacrificially protects it by spreading any corrosion forces laterally instead of allowing them to penetrate through to the steel leading to rust. Any rust showing on chrome is the underlying steel rusting because the overlying coatings have failed. The nickel layers are then topped with chrome. Typically, once he chrome plate step is complete the work is done. However, sometimes it is necessary to buff the part to remove any excess in high-current density areas which is function of how the part is connected to the electric current. Special connectors must often be fabricated to properly disperse the electrical current uniformly through the part.

As the foregoing description reveals, chrome-plating is a labor intensive process and this is the principal reason it is so expensive. There are also other factors. Chrome plating uses many hazardous chemicals and complying with environmental regulations has increased production costs. Finally, in recent years there has been a run-up in commodity prices for nickel and copper greatly increasing the cost of the platers' supplies.

Other Electroplated Metals

The other commonly applied metals in automotive use include cadmium, zinc and terne. Terne, a mixture of four parts lead and one part tin, was used for many years by GM to plate hydraulic tubing and gas tanks.

Cadmium is distinguished by its whitish hue. It was the preferred silver-appearing finish applied to small parts and fasteners in the automotive industry until the early 1970s. Then, environmental regulations were adopted that significantly increased the cost of cadmium plating to control the hazardous chemicals involved. Pieces such as relay covers, regulator bases, washer bottle holders and the like plus fasteners on cars before the mid-1970s are probably cadmium plated because of cadmium's superior (compared to zinc) durability.

Zinc plating was originally reserved for larger pieces, such as brake backing plates. It is distinguished by a bluish hue. Once the cost cadmium increased, zinc plating was also used for small silver-colored parts and fasteners. Most silver colored parts available today, either for new cars or reproduction parts, are zinc-plated. Often these zinc plated parts are further treated by passivation.

Each of these metals is applied in a layer of only a few thousandths of an inch thick or less. The coating is essentially transparent. Therefore, the degree of shine to the plated piece is determined by the surface preparation of the substrate material. For example, if a restored relay cover or fastener is media blasted and not polished, the resulting finish will have a matt appearance. Like chrome-plating, the part to be plated must be thoroughly cleaned and activated before it is placed in the plating bath.

Passivation

Passivation is a family of processes used to control corrosion by the spontaneous formation of a hard, non-reactive surface film, typically an oxide or nitride film that is a few molecules thick. Several different passivation processes are employed to protect automotive components and fasteners.

Chromate Conversion

Chromate conversion was developed during World War II to increase the corrosion resistance of zinc and cadmium-plated parts. The conversion coating uses a solution of various chromium compounds. Originally, only olive was available but soon there were more ranging from clear, to yellow, to gold, to olive drab; the darker the coating the more corrosion resistance. Sometimes parts that have a chromate conversion are dyed black for appearance purposes; this treatment is far more corrosion resistant than black oxides and iron phosphate discusses later. A key characteristic of all chromate conversion coatings, regardless of color, is an iridescent green, blue and red coloration. This coloration is a happenstance of the shape of the part and its natural reflectivity.

GM cadmium-plated parts were typically coated with a clear chromate conversion. Yellow is often commonly seen on such items as power brake boosters and some air pollution control parts.

Black Oxide

Black oxide is a caustic solution that colors the steel black. Typically used for fasteners and sometimes supplemented with oil, it is not long lasting. It can be identified by a dull finish and differentiated from other caustic treatments by its dark black color. Sometimes, black oxide treated fasteners are oiled to protect the finish during storage before application.

Black oxide is one of the earliest passivation processes dating to the 18th century. Its earliest uses were for bluing gun barrels, a use continuing to this day.

Iron Phosphate

Iron phosphate is another caustic-based solution used to apply a protective coating to steel. Few parts that are converted with iron phosphate are used without further treatment.

Iron phosphate provides an excellent substrate for paint and is often used for that purpose, e.g., iron phosphate followed by a thin coat of semi-gloss black paint.

Parkerizing is a proprietary process for passivating steel dating to 1912. It is now owned by Henkel Surface Technologies and produces a flat black appearance like iron phosphate and is slightly more durable.

Zinc Phosphate

Zinc phosphate is an iron phosphate bath enriched with zinc creating an iron-zinc alloy. It provides far greater protection than iron phosphate because of the sacrificial properties of zinc. It is recognizable by its dark gray, crystalline structure. The size and configuration of this crystalline structure is determined by the variables of time, temperature, and concentration of zinc in the bath at the time of deposition. There is no standard for this coating and, accordingly, appearance can vary. Zinc phosphate is typically used on hood latches and for a while in the 1960s and 1970s GM used zinc phosphate on hood hinges.

Anodizing

Anodizing is forced oxidation. This process combines some elements of electroplating and passivation to provide a more durable finish than the naturally formed oxide, alumina. The part to be anodized is submerged in a solution of sulfuric acid and charged with a positive current. Because the part is the anode, the process was called *anodize*. The oxygen molecules in the sulfuric acid break down and oxidize the surface of the aluminum which is then sealed in an extremely hot water rinse.

Window reveal moldings used in the 1960s and later and sill plates are aluminum parts that are typically anodized. This coating is very durable and lasts for years under all types of environments.

Other Finishes

Forged Pieces

GM used forged steel pieces for many suspension parts – tie rods, steering arms, anti-roll or sway bars, etc. Forging heats the steel and then presses it into the desired shape. A scaly-blue/teal surface appears during cooling. No paint or other preservatives were typically applied. The forging appearance degrades over time leaving a rusty surface unless coated with accumulations of grease as is often the case. Restorers use various techniques to attempt replication of this appearance where a high degree of authenticity is desired.

Polishing

A durable metal finish that is used on decorative stainless steel trim pieces is polishing. Left alone stainless steel resists corrosion and polishing provides a shine comparable to decorative chrome plating without the expense of electroplating.

Summary

Typically, the finish applied by the component manufacturer is specified by the car manufacturer. On the assembly line, these finishes are the ones remaining when the car leaves the assembly line unless the component is part of an assembly that is painted after assembly, such as the basic engine. When Buick painted its straight-8 engines, the rocker arm and spark covers were painted with the engine assembly. After painting was complete, these covers were removed for final valve adjustment and installation of spark plugs. The nuts holding these covers in place during painting of the engine were discarded and replaced with new cadmium plated nuts.

Determining the original finish is very difficult during restoration of collector cars because time and the elements have destroyed most of the original finish. Only by careful examination of the parts (often traces of the original finish can be observed) and having knowledge of typical practices can the correct original finishes be applied to all components and fasteners.

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