# Automotive Chrome ... It's Back

By Dr. Donald Snyder

"As General Motors goes, so goes the nation." It is not certain if GM has ever been large enough to have this much influence. However, during the 1950s and into the '60s, it certainly could be stated that: "As the automotive industry goes, so goes the plating industry." During this period, many captive and jobshop plating companies were busy plating every elaborate bumper, grill and trim style that the automotive designers conceived. The more glitter, the better. Chrome was "in."



At the height of chrome's popularity, if a plating shop had automotive business, times were good. Also, the use of chrome in other industries—such as kitchen appliances and furniture—was high, because their use of chrome traditionally follows the automotive industry.

During the late '60s and '70s, however, the reputation of chrome became tarnished. By the early 1980s, external bright decorative chrome on automobiles was essentially nonexistent. "Foreign styling," unacceptable rapid corrosion, overbearing use of chrome parts and aerodynamically designed vehicles each contributed to the disenchantment with chromium, at least to the automotive manufacturer.<sup>1</sup> Plating shops had to shift to other parts to survive—several were forced to close. Therefore, a non-OEM source of chrome automotive parts had to be found.

### Many Still Requested Bright Exterior Finishes

The desire for plated bright exterior parts did not completely die in North America. For those who continued to appreciate the quality appearance of chrome on their vehicles, an industry was nurtured, primarily in southern California, to produce after-market, brightchrome-plated automotive parts. During the '70s and '80s, this developed into a thriving business, particularly in plating steel, wire and, most recently, aluminum wheels. Glitzy after-market, bright-chromeplated bumpers, roll bars, emblems and bright trim were also produced. To many consumers, putting chrome on their vehicle was like hanging jewelry on their beloved "prideand-joy." To others, it appealed to their macho, sporty interest.

To satisfy customer demand, some new vehicle dealers offered aftermarket, bright-chrome-plated parts especially copper/nickel/chromium-plated aluminum wheels. It became common for upscale autos, sporty cars, light trucks and recreational vehicles to have chrome-plated after-market parts. The parts provided these vehicles with an unique look and an enhanced curb and drive-by-appeal.

The use of chromium on over-theroad trucks never died. Up-scale trucks continued to have chrome as standard equipment, and many chrome options were available for lower-level vehicles.

### Automotive Companies Respond to the Demand

It is hard to know for certain, but some cynical people believe that the after-market bright trim and wheel business grew so large and profitable that the automotive companies especially those in the U.S.—wanted to benefit directly. In 1997, it was reported that optional, plated alumi-

## Table 1

Micro-etching Surface

I tuting se	quence for aluminum wheel
Step	Action
Polish	Make surface reflective
Clean	Remove soils
Etch	Micro-roughen surface
Desmut	Remove residue

num wheels brought up to \$800 in profit per vehicle. This could be more profit than a car dealer received for the rest of the vehicle. Others thought that the automotive companies did not want the potential liability if these upscale vehicles failed as a result of the failure of an after-market part. There was a particular concern for aftermarket chromium parts supplied by authorized automotive dealers representing their respective OEM companies. In most cases, aftermarket decorative chrome parts would



Figure 1. Copper and Nickel over Aluminum - 500X Cross-Section



not meet the more severe service requirements of OEM parts.

A less controversial reason proposed was that the automotive dealers and manufacturers observed that the desire—and maybe even the demand—for bright work was great enough to redesign it back into the vehicle. Chrome parts make it easy

## Table 2 Making Surface Platable

Plating sequence for	or aluminum wheels
Step	Action
First zincate	"Clean" surface
Remove zincate	Remove debris
Second zincate	Adherent surface

and relatively inexpensive for U.S. designers to differentiate their vehicles and to distinguish themselves from foreign designs.

To the automotive buyer, chromeplated parts offer a unique, luxurious, prestigious, durable and expensive quality appearance. A late 1997 survey conducted by ABPA<sup>2</sup> found that "56 percent of automotive consumers say chrome enhances a vehicle's appearance." In the '80s, this percentage would have been much smaller. ABPA also reports that the increased use of bright trim should last at least to the year 2010.

Although not to the same extent as in North America, European automotive stylists are also adding more bright chrome trim to their designs. A style popular in Europe, as well as in other parts of the world, is toning down bright chrome parts by giving them a slightly dark, brushed or satin appearance. ,

## Popularity Outside the U.S. Has Remained High

In the Far East, exterior bright trim was never completely removed from vehicles produced there. They maintained an average of 1–1.5 ft<sup>2</sup> of bright chrome-plated parts. Today, a few years after the trend started in North America, Far East automotive companies (especially in Japan and Korea) are doubling the amount of bright trim on their high-end vehicles.

## Chrome Is Back

For whatever reason, the 1990s have seen a slow but consistent increase in the use of OEM bright exterior

## Table 3 Producing "Ideal" Substrate

Plating sequence	for aluminum wheels
Step	Action
Nickel strike	Conductivity
Acid copper	Leveling

automotive parts. It first started with top-of-the-line vehicles and has moved slowly into the lower-line vehicles. They are receiving more plated aluminum wheels, grills, door handles, window trim, side panels/ body molding, bumper strips and emblems.

In the late '90s, this trend became large enough for platers to observe the increased demand. Today, many plating companies are near capacity, and some are building new plating lines. Also, companies not originally in the plating business have started to plate automotive parts. This is especially true for companies that

### Table 4 Durable, Corrosion-resistant System

Plating sequence for aluminum wheels

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Step	Action	
Semi-bright nickel	Leveling & corrosion resistance	
High-potential nickel	Sacrificial layer	
Bright nickel	Appearance, leveling & corrosion resistance	
Nickel strike	Produce micro-porous chromium	
Chromium	Appearance/anti-tarnish	

manufacture the parts being plated.

In 1997, the Surface Finishing Market Research Board (SFMRB)<sup>3</sup> estimated that about 10,000 job and captive shops were involved in plating in the U.S. The SFMRB's 1997-98 report, states that more than 50 percent of all U.S. plating companies (in 1997 for captive shops and 1996 plus 1997 for jobshops) listed the automotive industry within their top three segments of parts plated. This includes OEM and after-market parts. Although not surveyed, the percentage of automotive platers is probably higher for Canadian plating shops. The percentage of companies plating for the automotive industry should continue to rise as a result of this increased use of bright automotive parts. Although the total surface area covered by decorative chrome automotive parts will not return to the level of the '50s and '60s, there is a significant increase over the '80sworthwhile for platers to pursue.

## Chrome-plated Aluminum Wheels Are the "In" Thing

Originating from the small and fashionable after-market business in southern California, the most glamorous and probably greatest increase in exterior bright plated parts is plated aluminum wheels. A dramatic increase in the production of OEM plated aluminum wheels has occurred over the last four to five years. Production that, five years ago, could be measured in a few thousand aftermarket wheels per year, is now estimated to have a worldwide capacity of more than four million per year. OEM wheels dominate this capacity. An estimated 50 plating shops worldwide plate aluminum wheels, primarily for the U.S. market. More than half the total capacity is in the top five shops.

This rapid increase in the use of plated aluminum wheels could be considered a fad, but it does offer one of the fastest and least expensive ways to change the curb and drive-by appearance of a vehicle. It also helps in the quest to remove vehicle weight. After the initial rapid growth in OEM plated aluminum wheels, the market has been growing at an average of about five percent each year. At this time, nothing appears to be adversely affecting growth for the future. Even the after-market business is increasing.

## Low Return Rate Requires Hard Work

Aluminum wheels are subjected to the most demanding service environment of any decorative part on a vehicle. Safety is also a major concern. For these reasons, there must be no question about the wheels' durability. The plating industry has learned a tremendous amount about producing decorative plated parts that can last 10 or more years in service.<sup>4</sup> The industry has also learned how to apply these electrodeposited coatings to aluminum-a very hard-to-plate substrate. Over the last four or five years, platers adapted this technology in order to consistently plate highpressure (squeeze) castings (> 50% of OEM) and low-pressure (atmospheric) cast wheels to OEM specifications. Throughout these years, the wheel's service performance has proven to be extremely good.

At a panel discussion addressing bright chrome on automobiles that was held early this year at the Detroit International Auto Show (NAIAS, January 1998), Dave Kuntz of Kuntz Electroplating Inc. reported that they had essentially no plated aluminum wheels returned for plating rejects. This was from a pool of 1.5 million plated aluminum wheels produced over a 4.5-yr time period. Kuntz Electroplating is now at the 900,000 plated aluminum wheels per year level (two million in service after five years), with essentially the same outstanding performance. This return

rate is actually smaller than the industry's average for OEM plated steel wheels. This is certainly one outstanding testimony to the durability of plated aluminum wheels.

It was not easy to obtain this low return rate. It was the result of a tremendous amount of hard work on the part of the platers with the cooperation of their suppliers and the auto companies. Because of the rapid, naturally occurring oxide formed on aluminum, aluminum requires the most involved preplate sequence of the commonly plated substrates. A typical, highly simplified plating sequence for aluminum wheels is reviewed in Tables 1 through 4. A more detailed description of the preplate steps can be found in the literature.5

The starting point for processing cast aluminum wheels prior to plating is outlined in Table 1. A thick, uneven aluminum oxide coating on the wheel is removed during these operations. To obtain the desired surface appearance, the wheel is subjected to machining, grinding and polishing. This is followed by a series of cleaning steps to remove the debris generated by these physical processes and any other shop/processing soils. The etch step removes the remaining aluminum oxide from the surface and leaves a micro-roughened surface. The desmut step cleans the surface of residual aluminum and aluminum alloying oxides and activates the surface, even the exposed silicon contained in the castings. The proper application of this series of processing steps determines the degree of adhesion of the electrodeposits. They are also very critical in determining the final appearance of the wheel.

A uniform, thin aluminum-oxide coating forms on the activated aluminum surface after the desmut operation. The process steps in Table 2 remove this film and replace it with a tenacious, less active zinc/zinc salt film dispersed with alloying metals. The first alloy zincate "encapsulates" any material remaining on the aluminum surface and removes it when it is stripped. The second zincate film has a more open structure and is more uniform and thinner than the first zincate. This film protects the aluminum surface from oxidation long enough to cover the platable surface with a nickel strike.

Table 3 lists the specially formulated nickel strike step that protects the aluminum surface and zincate film from the acid copper plating solution. An "ideal" substrate is next obtained by depositing a thick layer of acid copper over the thin nickel strike. Acid copper imparts leveling, thermal protection and adhesion. In addition to the normal metal-to-metal bonding, the cross section in the figure demonstrates how the combination of the nickel strike and the acid copper deposit can actually mechanically enhance the adhesion by plating down into a pit/void. The adhesion is so good that, when the deposits are pulled from the wheel, the aluminum substrate fractures and not the electrodeposits.

Even though acid copper electrodeposits have very good leveling properties, additional leveling of the casting can be obtained by polishing/ buffing the soft copper deposit. Lowpressure (atmospheric) castings typically contain enough porosity/ voids to require buffing of the acid copper deposit for maximum appearance. The acid copper deposits on high-pressure (squeeze) castings typically do not need polishing, because the castings are relatively free of pits/voids and perturbing silicon. The polished/buffed copper deposit shown in the figure demonstrates its leveling ability.

Table 4 lists a sequence of electroplating steps that many aluminum wheel platers utilize, depending upon the specifications followed. This combination of nickel layers that electrochemically interact with each other offers maximum corrosion resistance for the thickness of nickel used. If this sequence of deposits had been developed in the '50s and '60s, many of the corrosion failures during that time might have been avoided.

#### Competition and Costs

As with most large, successful products, competition and cost of production become significant. Weight reduction for the vehicle, design flexibility, established production capacity, engineering costs, durability and assembly factors all contribute to the cost and acceptability of potential competing products. The proven durability of a plated aluminum OEM wheel is now the standard to beat. A non-exclusive, non-prioritized list of potential replacements contains:

#### The Old Standard

• Steel wheels—painted or plated highest weight

## Newer Approaches

- Organic-coated aluminum wheels
- Organic-coated, micro-polished aluminum wheels
- Plated plastic or stainless steel centers
- Plated plastic or metal "glued-on" covers
- Organic/metal composite coatings
- Plated two- or three-piece wheels
- Plated or organic-coated magnesium wheels

All of these competing approaches, and others, are in use today. There is still enough demand for plated aluminum wheels, however, that the total number plated is still increasing.

#### Changing Technology

Even though the plated OEM aluminum wheel market is only about five years old, the plating technology is already mature. This is just another example of the rapid changes taking place within the traditional plating industry. The technology also contains some health/safety/environment issues. Some areas where changes are currently being made, in no particular order, are:

- Nitric acid free Etch—Table 1
- Reduced pore/void in castings— Table 1
- Improved plating sequence for other aluminum alloys—Tables 1 & 2
- Non-cyanide Zincate—Table 2
- Nitric-acid-free Zincate remover—Table 2
- High-throw Nickel Strike-Table 3
- High-throw Acid Copper—Table 3
- Higher leveling Copper and Nickel processes—Table 3 & 4
- Hexavalent Chromium free Chromium—Table 4

Costs, performance/durability, safety, and competition are a few driving forces to continuously improve upon the technology. The foundation was built over the last, very exciting, five years. Perhaps the next five years will be equally productive. No matter what the future brings for plated aluminum wheels or for plated bright automotive parts in general, the increase in their use is adding excitement to the automotive industry. And, as the automotive industry goes, so goes the plating industry. PESF

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