Electrocoating, FounderCoating alleanyDutyBumpers-ACaseHistory

This article is a quick journey through the transitions of coating processes related to heavy duty truck bumpers. It takes us from the early auto days to the processes used today and some of the new developments now in the works. It is an edited version of a paper delivered during SUR/FIN[®] '99—Cincinnati.







The development of federal regulations to protect the environment helped pave the way for organic finishes to be used on truck bumpers. Now they are finished to match or blend with other components.

Some History

From the time of the early "horseless carriage," automobile bumpers have been expected to take a lot of abuse. I remember when it was common for one car to push another in an effort to get the other one started. Bumpers have also been considered as part of the trim and, therefore, a decorative component, so bumpers were expected to have an attractive as well as tough finish. The finish was required to have good resistance against corrosion. It also had to have good resistance to impacts from road gravel or contact with bumpers of other vehicles.

The same standards were applied to the first trucks. As larger and more heavy-duty trucks came of age, the bumper became an important styling factor. Before the days of power steering, it took a lot of muscle power to effectively handle the steering of the big rigs. Part of the driver's job was to help with or completely handle the loading and unloading of cargo. The hardy men who operated these machines identified themselves with hardy-looking rigs. A major styling consideration was to design bumpers that would give those trucks a tough, "macho" image. Chrome plating was a natural finish and met the requirements quite nicely for decades.

How Things Change

Over the years, however, many things have changed. A new agency of the U.S. Federal Government was established that would have a major impact on bumper manufacturers. It was called the Environmental Protection Agency (EPA). After the Cuyahoga River caught on fire, a major focus area became the nation's water resource. The best place to start seemed to be with the chemical effluents from finishing and other chemical processes. New rules and regulations were passed. Expensive treatment facilities became a requirement to obtain operating permits for chrome plating shops. The cost of chrome plating began to increase.

The operating environment has also changed. The advent of the interstate highway system changed the role of the heavy-duty trucks. Tractor-trailer rigs and the interstate highways replaced railroads for the transportation of more time-sensitive freight. In

addition, power steering and other mechanical improvements made these big machines much easier to operate and maneuver. Motorized lift trucks and automated material handling equipment took the heavy labor out of loading and unloading cargo, so that operating personnel could totally focus on driving. The rigs could then be operated with less fatigue. Driver teams-in some cases, husband-wife teams-started to share the driving on continuous cross-country hauls. New cab-over-engine design made the sleeper cab practical, because the wheel base did not have to be lengthened as much. The cab became more of a "mobile apartment" than simply a control station. These changes were what paved the way for more acceptable styling changes for the bumpers, such as colors that blended with or matched other components.

Organic Coatings

The natural replacement finish for chrome was a straightforward liquid primer and liquid topcoat as used on other body components. Even with extensive surface preparation, however, this system fell short of the



Some truck bumpers are coated with polyester powder over electrocoat primer. Color changes are kept to a minimum and something less than ultimate in weatherability is acceptable.

corrosion and impact-resistance properties desired.

In the late 1960s, cathodic epoxy electrocoat process over a zinc phosphate-treated steel substrate was commercialized. This fusion-bonded, heat-cured plastic coating was introduced to industry as a highperformance priming process. Electrocoat represented a processing breakthrough. It provided a foundation coating with excellent adhesion and corrosion resistance properties that greatly enhanced the performance of almost all of the conventional liquid topcoat systems. Electrocoat had the heat resistance properties to accommodate powder coating topcoat systems with their high-cure temperature requirements. Now there were several options available for coating metal bumpers.

Requirements

Heavy-duty truck bumpers represent a challenging application for organic coating materials and processes. Here are some of the characteristics that truck makers evaluate when making a selection.

- Chip resistance
- Corrosion resistance
- Cost
- Gloss range capability
- Hardness
- Mar resistance
- Scratch resistance
- Smoothness
- Weatherability

Here are some of the characteristics that might be more important to the applicator.

- Application efficiency
- Color change availability
- Compatibility with other materials

The Auto Influence You may have noticed that, in recent

years, there has been a strong styling trend to the monochromatic look in automobile design. This means the bumpers and related components were required to match in color with other body components. Autos have essentially the same requirement for bumper coatings as trucks. The auto production volumes are, of course, many times higher. These high volumes are a strong incentive for the makers of coatings to conduct extensive research and product development programs to improve material performance.

Four general types of topcoat material were being considered for a recent bumper project. They were:

- Urethane liquid
- Polyester powder
- HFA acrylic powder
- GMA acrylic powder

Because of its incompatibility with other materials, the GMA acrylic was eliminated. We considered the data we had available, and consulted data from a study made by another company.*

The accompanying table shows the materials and the general findings of how each material measured up for each characteristic. They were applied over an electrocoat primer as a primer.

The excellent corrosion resistance performance was driven by the electrocoat as a primer for each material. Then the decision was based on characteristics in the order of their importance and cost justification.

*Ferro Corporation



In some shops, longer bumpers are hung in a horizontal position. The oven conveyor must be long enough to allow sufficient cure at a productive line speed.

Urethane Liquid

Chip resistance is very important. It tends to be a function of the elasticity of the material plus its adhesion to the substrate. Strange enough, our tests actually showed that some colors had better chip resistance than others because of the pigment systems used. Another factor seemed to be the substrate itself. Chip resistance seems to be more difficult to achieve over steel than aluminum. The coating system and cure parameters were also factors. If the electrocoat was cured at a higher-than-recommended temperature, the film was harder and the intercoat adhesion became a weak point.

The urethane liquid material had generally good chip resistance. It did not, however, perform as well in the important scratch and mar resistance areas.

Application efficiency of the urethane liquid material was rated lower because of the generally low transfer efficiency resulting from overspray.

The redeeming characteristic of liquid systems, however, is the ability to change colors. One truck maker told us they must meet so many custom colors for their customers that they now have more than 1,200 colors on their color chart. For custom colors, the liquid systems have a significant advantage.

Polyester Powder

Most of the applications today use polyester powder coating over electrocoat as a primer, where the color changes are few and far between and where something less than the ultimate in weatherability is acceptable.



Combining electrocoating with powder coating provides several options for finishing metal bumpers.

One of the best chip-resistance scenarios we tested for steel substrates was powder coating directly over a surface that had been blasted and treated with zinc phosphate. Without electrocoat to cover the sharp edges and recessed areas, however, there was an unacceptable amount of red rust bleed-out. The processing hazard of using polyester over electrocoat is again the close control of the curing of the electrocoat and the powder.

Polyester powder coating forms a tougher film than the urethane liquid. It has a higher degree of resistance to marring and scratching.

Weatherability tests, although not the ultimate, have been satisfactory in

Characteristic	Urethane <u>Liquid</u>	Polyester <u>Powder</u>	HFA Acrylic <u>Powder</u>
Material Characteristics			
Chip resistance	Higher	Average	Lower
Corrosion resistance	Excellent	Excellent	Excellent
Material Cost	Average	Average	Higher
Gloss range capability	Average	Lower	Higher
Hardness	Lower	Average	Higher
Mar resistance	Lower	Average	Higher
Scratch resistance	Lower	Average	Higher
Smoothness	Average	Lower	Higher
Weatherability	Average	Lower	Higher
Application Characteristics			
Application efficiency	Lower	Higher	Higher
Color change availability	Higher	Lower	Lower

the past. Product durability requirements continue to increase, however. The OEMs are looking closely at loss of gloss and variation of color in relation to weatherability. To improve on those properties, the makers of powder coating materials have worked hard to develop and market compatible acrylic powders.

Acrylic Powder

The primary properties desired by the OEMs are being met with the new HFA acrylic powders. These powders are compatible with other coating materials. This means they can be applied in the same plant with other polyester and epoxy powder coatings without causing quality problems.

These powders are harder, which has generally meant a reduction in chip resistance when compared to urethane liquid and polyester powder.

Acrylic powder is relatively new. It arrived on the market after the polyester powder had gone through the long approval processes and was well established. The original HFA acrylic powders were considerably more expensive than the polyester powders. Early chip resistance was thought to be less than desirable. However, the materials have been improved recently and the prices have gone down. There is resistance to changing some truck bumpers because of the lengthy approval process.

Other Processes

One automotive application uses a very conservative process to ensure success on all fronts. The process is: zinc plate, prime with a hybrid "antichip" powder, then an acrylic powder top coat.

Another new powder coating material being tested is called a "super durable" polyester. It has been formulated using two compatible coating technologies. They are designed to address the properties needed for successful applications with requirements similar to those of bumpers. Initially, these coatings were intended to be a rival of the HFA acrylics for many architectural applications. Some drawbacks are said to be the ability of the coating maker to control the manufacturing process consistently enough to meet automotive standards.

Yet another development in powder coatings is a process known as "engineered particle size" powders. In this process, the chemistry has been modified to provide a good charge for the fine particles. This means better transfer efficiency of the fine particles and less loss as a result of overspray. It also means the powder can be screened finer and will show fewer defects, which reduces rework of highly decorative components.

Equipment Overview

Coating large bumpers requires an electrocoating with a sufficient depth to accommodate the large parts in a well-racked format. The most efficient racking method is usually to hang the bumpers in the vertical position. Longer bumpers, however, may have to be hung in the horizontal position. The oven conveyor must be long enough to allow sufficient cure at a productive line speed.

The powder coating line needs essentially the same capabilities as the electrocoat line. There will be color variations, so provisions will be necessary for roll-in and roll-out selfcontained spray booths to minimize setup. Generally, the more commonly used colors have dedicated booths, and a "spray to waste" booth is maintained for small volume colors.

Material Handling

Bumpers come in various configurations. Some are essentially straight. Others have several bends and wraps at each end. Packaging for these components can be a challenge. The parts are sent to the coating operation in a container that can hold them in place effectively while providing ease of loading and unloading. As the parts are shipped to the coating source, it is not necessary to protect the bare metal and it is acceptable to have the bumpers touch each other.

When the bumpers are shipped from the coating source, however, they are finished components. Care must be taken to ensure that the coated surfaces do not touch each other or other container surfaces. In some cases, it is necessary to wrap the bumpers using a "bubble pack" layer. The containers are usually reusable. Many container designs are designed so they can be knocked down for "ship back."

Economic Factors

An appropriate coating process requires a "total systems approach." Factors bearing on the economics of the process start with the substrate itself. If the surface is rough or pitted, the coating can reflect that. The manufacturing process should address the fact that the bumpers are to be coated. Dies need to be maintained to prevent defects caused by gouging. The lube oil for the stamping dies should be of a chemistry that is removable with aqueous alkaline cleaner solutions. The amount of oil used should also be minimized to facilitate cleaning. The bumpers should not be stored for long periods of time, because doing so can cause processing oils to setup, harden and require expensive additional steps to remove.

Good handling systems design should consider rack configuration for container handling in and out of trucks and shipping docks. Maximizing the number of pallets per truck load can pay dividends in shipping costs. This needs to be coordinated with the handling of parts in and out of the container.

The pretreatment should be designed to handle the types of oil conditions expected to be found on the bumpers. Pretreatment should be in-line with the electrocoat process to minimize handling.

The topcoat process almost needs to be located on a different line. This is because of the variations in color requirements and the need to store bumpers in a primed condition until the final color is ordered.

Conclusion

Bumper designs and bumper finishing processes have come a long way over the years—from the good old days when bumpers were all chromeplated, to the straight paint jobs, to the extensive "high-performance" organic processes used today. The exciting thing about this coating challenge is the rapid pace of coating material developments and design changes now taking place in the industry. *PESF*

About the Author



Lyle E. Gilbert, MetoKote Corporation, 1340 Neubrecht Rd., Lima, OH 45801, holds a degree in engineering and a Master of Engineering Administration. He is a

registered "Certified Manufacturing Engineer (CMfgE) in the Field of Powder Coating" with the Society of Manufacturing Engineers (SME). During the last 25 years with MetoKote, Lyle has worked with the development of literally hundreds of coating applications. Among them were organic coating applications for various types of bumpers. Several of these applications are currently in production. MetoKote applies electrocoat, powder coat and liquid technologies.