Using plastic media blasting to remove powder coatings from parts

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MECHANICAL STRIPPING

Using plastic media blasting to remove powder coatings from parts

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An effective method for stripping all metal types, plastic media blasting (PMB) removes all or a portion of a cured powder coating from the surface of a part without causing damage. This article defines PMB and compares it to several other stripping methods used in powder coating. The article also discusses the environmental advantages of PMB, the types of plastic media and blasting equipment available, and the cost of operating a PMB system. Many application examples are included.

The advent of powder coatings has been both a blessing and a curse to the manufacturers of many commercial and industrial components. Although powder coatings have solved many coating problems and produced incredibly durable finishes, they can be difficult and costly to remove when a part needs recoating. Several stripping methods are used to remove powder coatings from parts, including the following:

Molten salt. This method involves dipping the part to be stripped into a pot of molten salt. The salt is kept in a liquid, or molten, state at temperatures that turn the powder coating to ash and vapor.

Burn-off oven. This method works essentially like the molten-salt method, except the part is put into an oven instead of a pot. The oven is kept at a temperature that turns the coating to ash (usually between 600°F and 900°F).

Glass bead blasting. This method involves the use of small glass beads in an abrasive blast process to remove a powder coating or to impart a nondirectional finish, or texture. When used to remove powder coatings from relatively soft substrates, such as aluminum, this method can produce unsatisfactory part appearance or performance from the surface stress and texture left by the impacting beads.

Unfortunately, many substrates currently coated with powder can't survive the coating removal process, or if they do, their structural properties are significantly diminished because of the extreme heat used to remove the coating. Fortunately, there is an alternative—plastic media blasting (PMB). Using recyclable plastic media, PMB removes powder coatings while generating only a small amount of dry residue. The plastic media are nonhazardous; therefore, if the powder itself doesn't pose an environmental problem, hazardous waste is nonexistent.

Applications for plastic media blasting

PMB technology has been in use for more than 8 years, principally for stripping aircraft and aerospace components. The technology was fostered by the US Department of Defense to replace the toxic chemical strippers previously used on strategic military aircraft and aerospace parts.

The US EPA's final rule prohibiting the disposal of certain chemical solvents in landfills throughout the country, including the most effective chemical strippers containing methylene chloride or phenols, stimulated the use of PMB. An alternative disposal method—incineration—can cost up to $1,000 for a 55-gallon drum of these chemical effluents.

Because the plastic particles used in PMB are harder than the coatings but softer than the substrates underneath, they can quickly remove primers and topcoats without harming the substrate, especially substrates sensitive to deformation, such as aluminum alloy.

For example, since 1989, PMB has been used to strip a particularly tough epoxy powder coating from aluminum alloy bobbins that hold missile guidance wires (see Figure 1). The soft plastic media don't affect the aluminum alloy or the very fine wires that can be rejected for even microscopic surface irregularities. Before PMB use in 1989, rejected bobbins were scrapped.

The aluminum missile airframe shown in Figure 2 is another example of a part that is suitable for PMB. In its assembled state, the airframe is impossible to strip using heat or hard abrasives. Although hand sanding is possible, it removes the chemical conversion coating, which can't be replaced economically to the assembled airframe. The plastic media remove the powder coating from the cracks, crevices, and rivet heads without damaging the substrate or removing the conversion coating.

FIGURE 1

Using plastic media blasting equipment, an operator removes epoxy powder coating from aluminum alloy bobbins that hold missile guidance wires.

FIGURE 2

Plastic media removes the powder coating from these aluminum missile airframes.

Before

After

Another example of the effectiveness of PMB involves a sophisticated naval torpedo casing. The casing requires a stripping method that removes the powder coating and leaves the aluminum conversion coating intact. Chemical strippers are ineffective. They also don't lend themselves to the semi-assembled configuration of the casing, which includes various fasteners and inserts that can be damaged by the chemicals. The casings are also on a very tight delivery schedule. As a result, the casing is sent on an aircraft to a company that does PMB and sent back the same day (see Figure 3).

With more environmental awareness and stricter environmental regulations in the coatings industry, PMB has matured into a technology suitable for a broad range of applications, including the aluminum alloy wheel in Figure 4.

Pot metal castings and the intricate cast-in artwork or text on them also are completely cleaned, which leaves contamination-free surfaces for recoating. For example, a set of cast-aluminum patio furniture requires stripping before powder coating. The original coating is resistant to chemical stripper, and the hours of hand cleaning required would be expensive. Hard-abrasive blasting would excessively profile the surface, requiring the use of a sanding primer. The design detail in the casting would also require a great deal of hand sanding. With PMB, the old coating is quickly removed and the casting detail is effectively cleaned without leaving a surface profile (see Figure 5).

In addition, PMB doesn't affect machined surfaces or metallurgical properties. As a result, parts look as if they've been coated for the first time. See Table 1 for more applications.

Variables in plastic media blasting

The PMB process is fast, economical, and safe. Although it resembles sandblasting, PMB doesn't use hard abra-

FIGURE 3

Plastic media blasting removes the powder coating from this naval torpedo casing and leaves the aluminum conversion coating intact.

FIGURE 4

Plastic media blasting removes the powder coating from this aluminum alloy wheel.

Before

After

FIGURE 5

Plastic media blasting strips the old coating from the design detail in this cast-aluminum patio furniture without damaging the substrate.

Before | After

sives, such as silica sand. Instead, it uses recyclable plastic particles that range in hardness from 3 (calcite) to 4 (fluorite) on the Mohs scale. Hard abrasives are around 7 (vitreous pure silica) on the Mohs scale.

The plastic media are pneumatically applied in a range between 200 and 400 pounds (depending on nozzle size) per hour at pressures of 20 to 40 pounds per square inch. Nozzle-to-part distance is typically ½ to 1½ feet. In contrast, the media used in sandblasting are conveyed at volumes of 1,000 pounds per hour and pressures normally at 100 pounds per square inch or more. Nozzle-to-part distance is typically 3 to 4 feet.

Sandblasting removes most coatings and a portion of the substrate to produce an anchor pattern or white metal finish before priming or powder coating. Often, sandblasting causes substantial damage to thin metal or sensitive substrates. On the other hand, PMB can be used to remove any coating from any substrate without damage.

TABLE 1

Examples of powder-coated products that can be stripped by plastic media blasting

Appliances
Industrial machinery
Tanks and containers
Vehicles
Vehicle parts
Aerospace parts
Military parts
Architectural parts
Shelves
Furniture
Vending machines

When using PMB, you need to consider certain variables for your application, including the following:

- Blasting pressure
- Blast nozzle angle to substrate

- Media flow rates
- Media dwell time
- Nozzle size
- Nozzle-to-part distance
- Coating type
- Substrate type and thickness
- Blast-media type and size
- Media contamination control, including part precleaning
- Consistent grit size distribution (media replenishment)
- Masking requirements
- Blasting equipment

The technical expertise necessary to make decisions about the variables involved in PMB comes from experience and hours of testing. Consequently, much of the initial success or failure in this technology is determined by how much support you receive from the equipment and media suppliers. Most suppliers will process sample parts at no charge so that you can determine whether or not the process will work for your application.

Equipment for plastic media blasting

In actual practice, the preceding variables aren't constantly and separately considered during the stripping process. Normally, the PMB operator, who has had proper training and experience, has predetermined the parameters for a given substrate. However, state-of-the-art equipment is available to apply the plastic media.

For example, electric remote controls at the blast nozzle adjust blasting air pressure and media flow to accommodate the rapid transition from one substrate to another. This feature is invaluable for stripping expensive, complex parts and allows the operator to go from steel to aluminum to fiberglass (on automobiles) or from magnesium to titanium to clad or anodized aluminum to advanced composites (on aircraft airframes).

The original PMB systems were little more than sandblast pressure vessels, modified with 60-degree cone bottoms to accommodate the flow characteristics of the plastic blast media. The reclaim systems for the media were typically the same type used for steel-shot reclaiming. Although they had tremendous recovery capability, they lacked the capability to properly clean the low-density plastic media.

Some of today's PMB systems offer features not even considered a few years ago. Media reclaim systems on some machines now use true cyclone separators with low-horsepower fans and motors. As a result, they efficiently remove all coating residue and plastic fines from the plastic media. This permits the recovery and reuse of the media, often for up to 30 cycles or more, which results in media use rates as low as 9 pounds per blast hour.

Large-area magnetic separators for the removal of ferrite particle contamination are also available now. Moreover, several PMB systems now offer compact and highly efficient cartridge-filter dust collectors with reverse pulse-jet cleaning systems for the removal of even submicron particles from the dust collector exhaust air.

Some PMB systems now provide nozzle-mounted, quartz halogen blast lamps to increase lighting of the part, which is crucial when working on sensitive substrates.

Advanced PMB blast cabinets (glove boxes) are available with operator controls to rapidly adjust blast air pressure and media flow to accommodate sensitive substrates. Conversion kits are available to retrofit existing open-blasting PMB systems and PMB blast cabinets with operator remote controls for adjusting blast air pressure and media flow.

Low-cost PMB blast rooms are now made of 18-gauge sheet metal, rather than the 10- to 12-gauge steel plate typical of sandblasting booths. Because PMB doesn't remove metal, these economical rooms are satisfactory for a variety of applications.

Advanced and highly efficient dust collectors that provide ventilation for blast rooms are also available now. Some compact, energy-efficient, modular systems provide automatic reverse pulse-jet cleaning on demand, with each module having a capacity of 6,000 to 16,000 cubic feet per minute.

High-density-particle separation (HDPS) systems are available to remove heavy particles, such as silica sand, from otherwise recyclable plastic media. Although this isn't a major concern for many stripping applications, military and aerospace manufacturers are very conscious of the damage that can occur by this type of contamination. Under current military specifications, media having a contamination level of 0.02 percent by weight (200 parts per million) must be taken out of service until they can be effectively cleaned. Airframe manufacturers require that the plastic media be free of contaminants to within 0.03 percent.

The low-profile HDPS equipment available today as on- or off-line systems exceed the requirements of the US military and airframe manufacturers.

Media types for plastic media blasting

The plastic media industry has changed tremendously in recent years. When the US military began using PMB, it authorized only three types of plastic media, all thermosets: Type I, polyester; Type II, urea formaldehyde; and Type III, melamine formaldehyde. By May 1988, the US Navy had approved two more media types per MIL-P-85891 (AS): Type IV, phenol formaldehyde, a thermoset; and Type V, acrylic, a thermoplastic. In March 1990, the Navy drafted a new specification, adding a sixth media type per MIL-P-85891A-0386DD: Type VI, poly allyl diglycol carbonate, a thermoset.

Because one media type won't work for all coating and substrate combinations, selecting the right plastic media for your application is critical to successful PMB. Figure 6 is a guide to selecting media candidates for testing. (Type IV is not listed because it isn't used much. It has many of the characteristics of Type II but has no advantages over less costly media types. It also is dirty and breaks down fast.) The x-axis in Figure 6 shows grit size from 60 (very fine) to 12 (very coarse) US Standard Mesh. The y-axis shows media types. In order of hardness, they are as follows:

Type I. Polyester is the softest plastic media and is rarely used today for paint removal because it's too slow. A frustrated operator has a tendency to dwell on the part too long, which damages the substrate.

Type VI. Poly allyl diglycol carbonate is significantly more aggressive on coatings than Type I but is very safe on most substrates. It has good removal rates when used on composites in particular. Although Type I has a lower removal rate from composites than that of harder abrasive from robust substrates, the fact that it's capable of stripping coatings from composites at all makes it very attractive to many composite coaters.

In the past, a composite part with an unacceptable coating was scrapped because there wasn't a safe way to remove the coating. For that reason, a removal rate of only ½ square foot per minute is considered economical because it saves the expensive part from the scrap bin. Removal rates of more than 1 square foot per minute aren't unusual, especially with coatings that are less than 5 mils thick.

Type V. Acrylic has proved to be the most popular plastic media for thin aluminum parts. It's less aggressive and has lower removal rates than Type II. Although it won't remove many primers, it's very long-lasting and can be a good choice if you only want to remove the topcoat.

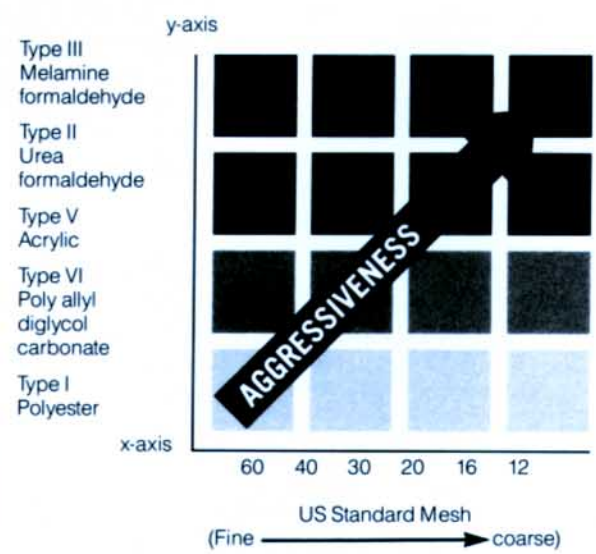
Type II. Urea formaldehyde is the most heavily used plastic media, accounting for more than 50 percent of today's media use. It's used on a variety of soft metals, some composites, and steel. Powder coatings usually come off easily with this plastic media.

Type III. Melamine is the hardest and most aggressive plastic media. Extremely tenacious powder coatings applied to hard metals respond to this media type.

You must consider both media type and grit size. As you increase the grit size or move up the y-axis to harder media, the action on the coating and substrate is more aggressive (see Figure 6). For example, a very fine Type III can cause less damage to the substrate than a coarse Type II and have the same or better removal rates. You

FIGURE 6

Plastic media guide



must also consider the action on both coating and substrate. For example, Type VI exhibits good removal rates (similar to Type II) on composites, yet is much kinder to the substrate than Type II.

Cost of plastic media blasting

The variable out-of-pocket costs (that is, excluding allocation of fixed expenses) of the PMB process per blast hour can fluctuate, depending on a number of factors, such as the following:

- Direct labor per hour
- Labor productivity rate per hour (typically 75 percent)
- Blast-media cost per hour (range is from $1.50 to $2 per pound, depending on media type and quantity)
- Energy use per hour
- Overhead (primarily masking supplies and indirect labor)
- Waste disposal (can be minor or up to $4 per blast hour if hazardous waste is generated by PMB, assuming the use of ½-inch nozzle)
- Removal rate in square feet per minute (depending on the coatings removed and the substrates, can range from 0.5 to 4 square feet per minute, assuming the use of ½-inch nozzle at 30 pounds per square inch)
- Media reclamation efficiency (in a highly efficient system that separates almost all coating dust and media fines, the blast media can be recycled up to 30 times and can effectively remove coatings even when the media has been broken down from 12 to 60 US Standard Mesh; in such a system, the media-use rate can be as low as 9 pounds per blast hour, using a ½-inch nozzle at 30 pounds per square inch)

Because of these factors, variable operating cost per blast hour can be as little as $45 to as much as $65. Removal cost per square foot can range from as low as 20 cents to as much as $2.15 when tenacious coatings must be removed from sensitive substrates that require extensive masking. Typically, the cost shouldn't exceed 50 cents per square foot.

Summary

No one coating removal method is best for all applications. For this reason, you should learn about the various methods to determine which one is best for your application. For a broad range of applications, however, it's hard to beat PMB for overall economics and high removal rates. The PMB process also allows you to clean fine details without any adverse effects from temperature extremes or coating type.

Because the plastic media are soft, they remove the coating from the substrate without the damage normally associated with hard abrasives. In addition, the recyclability of plastic media dramatically decreases waste compared with the waste generated by chemical stripping. Finally, PMB is fast. It can be done in seconds or minutes, not hours. **PC**

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