Anatomy of Metallized Plastic Application

Some customers know exactly what they need when they specify metal coatings onto plastic parts. They have prior experience using metallized plastics and are able to define the coating system, including specific metal coatings, thicknesses, surfaces to be coated and applicable industry and/or military specifications. They may also have experience in how to design their parts or assemblies to be compatible with the metallization process. While this situation may be true for the some companies and their engineering teams, a large number of engineers and designers do not have the background or experience with metal coatings on plastics.

Many engineers recognize the need for metal coating of plastics to meet specific design requirements but may not be sure what they need to do to meet their requirements and how to specify the coatings in their designs. This article is intended to provide engineers, seeking background information on metallized plastics, with more information to assist them in designing their products and specifying the metal coatings.

Key Factors in Specifying Metallized Plastics

1. What is the design objective that the metal coating on plastic needs to meet? Is there a functional requirement that the coating needs to fulfill, does the metal coating need to meet an appearance specification, or does the coating need to meet a combination of functional and decorative requirements?
2. On what surface is the coating to be applied? On what surfaces is the coating required, surfaces where the coating is prohibited, and/or are there surfaces where the coating is optional? FYI, in case of plating, coating all surfaces is virtually always lower cost than plating only on selected surfaces. The cost to mask surfaces is much more than the cost of the additional plating material.
3. What functional specifications does the coating need to meet?
    a. Electrical: this is usually specified in ohms/square or resistance in ohms from one specific location to another specific location on the coating. For example, the resistance measured from one end of the part to the other. This specification can be defined with the fabrication and testing of metallized prototype parts.
    b. Thickness: in some applications the metal coating thickness is a primary requirement, such as for antenna waveguides. The thickness is usually just specified as a minimum although some applications will also have a maximum thickness requirement driven by fit issues with mating parts, such as connectors.
    c. Environmental: are there any harsh chemicals, fumes and/or salt fog that the coating will be exposed to during use? Are there any specific environmental test requirements that the coating needs to meet, such as ASTM B117 salt spray standard? Environmental requirements may drive coating material thickness as well as coating material selection. Silver or nickel paints would be preferred over copper paints in harsh operating

environments. Increased nickel plating thickness to protect underlying copper plating may be needed in harsh operating environments.

d. Abrasion or Wear: will the coating be subjected to any abrasion or wear during use? Similar to environmental requirements, some paints offer superior wear resistance and increased nickel plating thickness can also address abrasion requirements.

e. Appearance: is the coating visible to the end user in the final assembly? Are there specific appearance requirements for the coating?

f. Plastic Resin: what plastic resin is being specified for the product? FYI, the ability to coat plastic resins is inversely related to the chemical resistance of the resin. For example, ABS is readily plateable as opposed to chemical resistant materials such as polyethylene or even PTFE that are unplateable.

Common Plateable Resins			
Acrylonitrile Butadiene Styrene (ABS)	Polycarbonate (PC)	PC/ABS	Polyether Imide (PEI)

Selected or Custom Blended Plateable Grades			
Polyphenylene Oxide (PPO) – selected grades	PC/Polyester – very limited plateability	Polystyrene – selected grades	Urethane – avoid silicone mold release
Polypropylene – custom blended grade only	PEEK – glass filled only	PPS – media blasting required	Liquid Crystal Polymer – glass filled only
Graphite – requires permanganate etch	Epoxy – avoid silicone mold release	Nylon – glass filled only	Polyphthalamide (PPA) – glass filled or custom blended grades only

Not Plateable		
Polyvinyl Chloride (PVC)	Polyethylene	Polybutylene Terephthalate (PBT)

g. The same general rule also applies to other coatings such as conductive paint. The greater the chemical resistance, the less able you are to coat the part with a metal coating. This is a critical design issue. Specifying a material where only marginal metal coating adhesion is achieved is fraught with risk over the lifetime of the final product in the field.

Paintable Plastic Resins

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ABS	Polycarbonate (PC)	Polybutylene Terephthalate (PBT)
PC/ABS	Poly Aryl Amide	Noryl Polyphenylene Oxide (PPO)
ASA	Polyphthalamide (PPA)	Ultem - Polyetherimide (PEI)
Nylon	Polystyrene (PS)	Xenoy (PC/PBT)
Difficult to Paint Resins (May Require Prime or not Paintable)		
PVC	Polyethylene	Liquid Crystal Polymer (LCP)
PEEK	Polyimide	Polypropylene (PP)
PPS	PES	Polyester

h. Thermal Exposure: what temperatures will the metallized plastic part see during assembly into the final product and what temperature range will the product see in the field? There are plateable plastic resins that can withstand soldering temperatures and exposure to temperatures of up to 250°C. Lower temperature resins such as ABS can soften and deform at as low as 85°C. Plating has also been shown to increase the temperature at which point the un-plated plastic part would begin to soften and deform. Plating can reflect a portion of the heat so that a plastic that might only survive up to 100°C might be able to function up to 250-300°C. Every application and plastic are different so it is recommended that high temperature metal coatings on plastic applications be thoroughly tested by the customer. Most conductive paints will function up to 100° C due to their thermoplastic resin. There are a few conductive paints that utilize the thermoset resin, which allows them to function in applications up to 200°C.

4. Mechanical Design: the design of the part to be coated can be a very critical factor in the overall success of the application. Design features such as small blind holes and/or deep crevices can make it very difficult to apply coating onto all specified surfaces. Additionally, design features that can trap plating solution and/or conductive paints can lead to the product failing to meet design requirements. Spraying paint into a closed end of a product can cause a significant portion of the paint to blow back out of the part and also create problems with the paint coating, specifically dry spray. Plating parts that have deep features without drain holes also presents risks for air entrapment and resulting plating voids. Inserts can be handles in the plating and painting process. If inserts installed prior to coating, the threads can be masked so that they are free of coating. Inserts can also be installed after plating as long as holes are sized for the insert and the coating thickness.
5. Prototype Parts: with ever expanding the use of 3D to printing and other rapid prototype manufacturing processes, prototype parts can be produced at a fraction of the cost of machining

or building prototype mold tools. It is important that prototype parts be compatible with either the plating process or conductive paint. Plating will expose parts to strong chemicals as well as temperatures of up 70° C, which is beyond the heat deflection temperature of many SLA materials and even some 3D materials. Also, many 3D materials are not compatible with the plating process. Consult with Cybershield on the current list of plateable 3D materials. Another issue with some 3D printed parts is that they can be porous, which can trap plating solution in the pores of the part. The trapped plating solution will leach out hours or even days later which can stain or etch the plating. 3D printed parts need to be printed at high resolution to avoid this problem. 3D printed parts and SLA's do not have significant limitations for conductive paint application. A final option for prototype parts is to machine the parts of a plateable plastic. There are several manufacturers across North America that are capable of machining plastic parts.

The observations in this article are meant to be general guidelines. If you have upcoming projects that may require metallization of plastics, always feel free to contact Cybershield to review your requirements and determine how to achieve your design objectives.

You can contact Cybershield to review your project.

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