The Art of Spraying Electrically Conductive Paints

Non-conductive spray painting experience is not enough to ensure success

BY JESSE HAGAR

Electrically conductive coatings for plastic enclosure electromagnetic shielding are growing in popularity as concerns over weight increase for a variety of EMI applications in the military, aerospace, automotive, telecom, medical, and semiconductor marketplaces.

Conductive coatings are generally applied by spraying a layer of electrically conductive paint, which is heavily filled with a conductive metal such as silver, nickel, copper, or a variety of coated or specialty powders and flakes. When one first attempts to use a conductive paint, the results can be disastrous if he or she is unprepared for the task. Conductive paints cannot be handled or applied in the same manner as conventional paints. Using this medium is something of an art form that takes equipment modifications, proper up-front part design, personnel training, experience, and practice. However, by following these simple guidelines, one can prepare oneself for a successful startup to spraying conductive paints.

CONTINUOUS AGITATION

All conductive paints are loaded with heavy metal fillers, sometimes as high as a 4:1 ratio of metal to resin by weight. These heavy particles will settle quickly, like sand in water. Even the most well-formulated paint, designed to minimize settling, will experience the conductive filler falling out of suspension. This is the number one issue that affects one's ability to spray these paints properly.

Care must be taken that the paint is under constant agitation during use. An air-driven mixer for the paint pot or a recirculation loop (or both) will keep the paint constantly moving and prevent particles from settling out. This is the only way to ensure the paint remains homogeneous throughout the entire spray process. For hand-held spray guns, the operator will need to aggressively shake the spray cup and gun between passes. In addition, it is also important to avoid magnetic-driven mixers when the paint contains ferromagnetic filler.

If one does not have a continuous recirculation loop, the paint will settle in the spray lines. If the paint in the lines is allowed to sit for more than a few seconds, the lines must be fully purged before spraying can resume. In high-volume spray applications, it is sometimes less expensive to modify equipment with a recirculation loop than to purge and dispose of expensive conductive paint between each part.

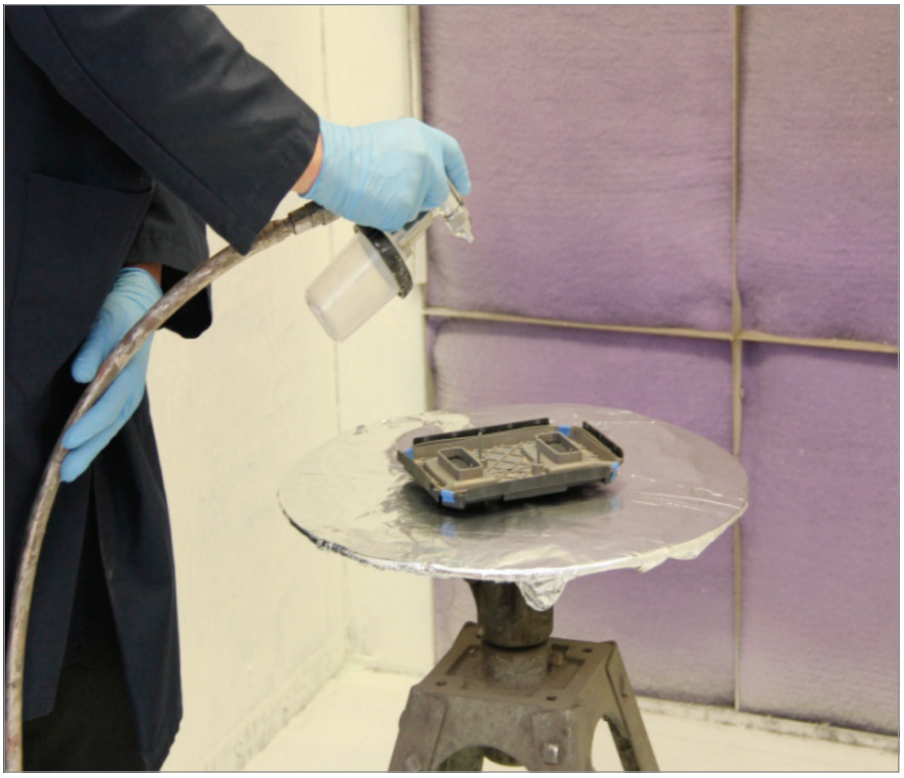

Figure 1: Prototype painting

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Storing conductive paints will cause the particles not only to settle but to also to hard-pack over time at the bottom of the container. Before each use, it is important to aggressively shake the container for several minutes. Also, always check to verify the paint is homogeneous by scraping a clean paint stirrer or spatula across the bottom of the container. If a viscous sludge of particles is found on the spatula, then the paint will require further mixing before use. See ASTM D869 (Standard Test Method for Evaluating Degree of Settling of Paint) for more direction on this procedure.

EQUIPMENT

Many hand-held, air-atomized spray guns will work for conductive paint application, including siphon-feed spray guns, gravity-feed guns, and high volume/lowpressure (HVLP) spray guns with pressure pots. Also, many manufacturers of automated high volume spray equipment are gaining experience with conductive paints and are now modifying their equipment with pot mixers and continuous recirculation to satisfy the growing demand.

One also has to consider the fluid nozzle diameter (Figure 2). For air-atomized spray guns, a fluid nozzle of 0.040" (1mm) or greater will work with most conductive paints. However, for smaller more detailed parts with automated equipment, one could possibly use a much smaller diameter. The equipment, particle size, and viscosity all play a factor. If the nozzle were undersized then clogging, spitting, resin rich or inconsistent spray can occur. One common fix when experiencing trouble spraying conductive paints is to increase your fluid nozzle diameter.

SOLVENT PACKAGE

Another issue in spraying conductive paints is "dry spray." Dry spray occurs when the paint does not level correctly, causing particles to not lay down. The goal of a conductive paint is to maximize filler particle contact, which is achieved by coating the surface with metal filler particles that effectively cover the surface like leaves on the ground in the fall. However, dry spray causes the particles to position themselves more perpendicular to the substrate and not fully submerged in resin. This will cause an extremely rough surface, conductivity loss, and cohesion issues.

There are a few potential causes of dry spray. One is that the percentage of solids is too high and another is that too much solvent is evaporating between atomization and contact with the substrate. Despite the cause, one common and easy fix is to decrease the distance between the spray nozzle and the substrate. Another fix is the addition of solvent to the paint. Most well-formulated conductive paints will contain a proper mixture of

fast, medium, and slow evaporating solvents. Therefore if considerable solvent addition is considered, contacting the paint's manufacture for recommendations is important. In fact, if equipment limitations require the need for a faster or slower solvent package for a spray application, most small or moderately sized paint manufacturers are willing to adjust the paint's formulation to fit a customer's needs.

THICKNESS

Coating thickness is also an important consideration when spraying conductive paints. The more conductive the filler, the thinner a coating required to achieve the paint's full shielding potential. For example, a very conductive filler such as silver only requires a 0.5 mil dry film thickness, whereas a significantly less conductive filler such as nickel requires as much as 3.0 mils. Moderately conductive fillers such as silver-coated copper fall somewhere in the middle.

It is a common misconception that if one significantly increases the paint's thickness, the shielding effectiveness also significantly increases. Going above the manufacturers recommended thickness provides little to no additional shielding in reality. In fact, tests show that doubling the manufacturer's thickness recommendations, only results in a 3-6 dB increase in shielding. If everything was done correctly during the painting process (including complete coverage, correct thickness, and confirmed conductivity) and more shielding is still required, then a paint with a more conductive filler is needed.

Uniform thickness for a conductive coating is significantly more important than with a conventional paint. To ensure uniform thickness and complete coverage, there should be a 50% overlap between paint strokes and each subsequent coat should be sprayed perpendicular to the previous coat.

If you are considering painting the inside of a complicated part, such as the inside of a housing, it is important to take into account up-front part design. Any 90-degree, sharp corners will never receive the proper coating thickness and will therefore produce a significant EMI leakage. The more curvature that exists in the corners, the greater the opportunity is to build up the proper coating thickness. It is very expensive to fail shielding tests and consequently require redesign of a mold; if the use of a conductive coating potentially will be potentially considered, sharp corners must be avoided during the initial design phase.

FINAL THOUGHT

Spraying conductive paints for the first time can leave you frustrated by the wasting of plenty of time and money. However, with the proper preparation you can ensure a successful smooth transition into spraying conductive paints. There are many high-volume spray equipment manufacturers and paint manufacturers willing to work with potential customers to ensure success.

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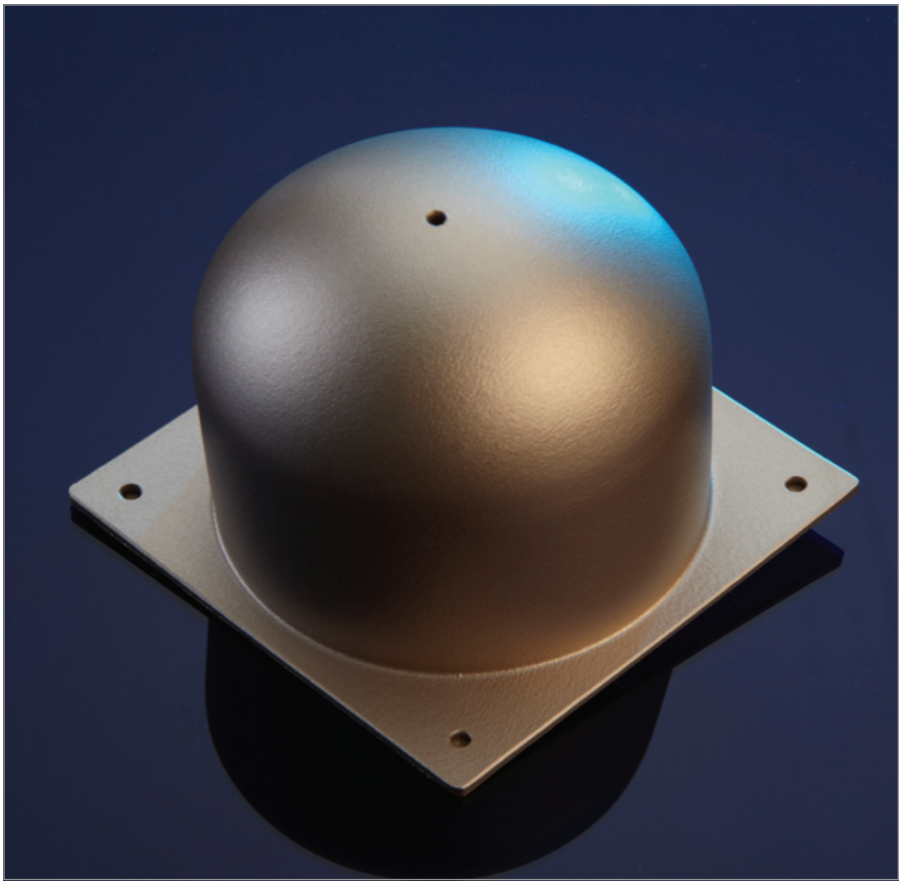

Figure 2: Commercial radome

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