Busbar Insulation
Epoxy Powder Coat Design Considerations

Design Tips - Standardized Colors - Proper Plating
Masking Efficiency - Fluidized Bed

First of all, why is insulation necessary?
Insulation prevents a number of critical design issues such as high-voltage arcing and current-induced magnetic fields, which could interfere with surrounding electronics. Proper management of these effects allows for tighter component design and the most efficient use of operating space. However, which type of insulation is most appropriate?

What are the options?
There are a myriad of options when it comes to insulating a busbar. Common alternatives range from shrink tubes, to dielectric films used in busbar lamination such as Mylar (PET), Kapton, and glass epoxy (FR-4). However, this article focuses on epoxy powder coating insulation, a highly customizable insulation which excels in dealing with complex geometries in single-layer busbars.

What is epoxy powder coating?
Epoxy is a dielectric, thermosetting dry powder that is "melted" to flow over the busbar to provide electrical insulation. This powder coating is available in many colors and can be applied in two ways. The first is the fluidizing process, the part is heated, then dipped into a bed of epoxy powder that has been fluidized with air. The epoxy powder flows around the part and then "melts" onto the heated surface. The part is then heated to cure the powder coating. The second method is electrostatic spray. In this method, the part is electrically grounded in a spray booth. As the powder is sprayed, the electrically charged powder adheres to the grounded part. Again, the part is heated to flow the powder over the metal conductor. Typically, manufacturers use this method to apply a thinner layer of insulation. However, Storm Power Components has developed a process that allows for multiple layers of insulation, achieving a higher dielectric value. Storm's ability to spray on thicker insulation passes on savings as well. Traditionally, the fluidized bed method has been used for thick layering of insulation, but this method can only be applied in relatively small batches of parts. Electrostatic spray allows for larger batches of parts to be coated at one time. The scalability of this method yields considerable cost savings.

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Design Tips & Tricks
Now that the background information is out of the way, time to discuss design tips for epoxy powder coating. Since epoxy coating insulation really shines as geometry becomes more complex, it is important to discuss certain aspects of design than can significantly influence the performance, reliability and cost of insulating a busbar.

Square vs. Radius Edges
Design specifications can prevent weak points in the powder coating insulation. Specifically, epoxy powder coating does not like sharp edges. In other words, sharp corners, usually around holes in the busbar or the busbar edges, result in thin spots in the insulation. To mitigate this, a designer can specify that radius edges be used and apply bevelling or "chamfers" in any necessary holes in the part.

Masking Efficiency
Masking is a necessary part of the insulation application process. Masking is basically blocking off any connection points on the busbar that need to be insulation-free. It is important for a designer to recognize that, for most production volumes, the masking process is done manually and needs to be treated with the appropriate tolerance expectations. Tight tolerances can impact the fabrication cost, but while a machine-made cut can be treated with a tolerance of +/- a few thousandths, the manual process of masking typically deserves a slightly wider tolerance. By designing a part with the masking process and appropriate tolerances in mind, a designer can save significantly on time and labor costs.

Proper Plating
Plating is a great way to reduce corrosion risk of copper and aluminum busbars. However, designers should recognize that not all plating works in tandem with epoxy powder coating insulation. Tin is a popular plating option that does not play well with epoxy. The problem is that both bright and matte tin have a high lubricity factor, meaning it creates a slick surface and does not allow the powder coating to properly adhere as well as other finishes. Good alternatives when combining plating and epoxy powder coat insulation to busbar are silver and electroless nickel finishes.

Standardized Color
Occasionally, designers try to match the color of the insulation to a certain palette, whether it be their logo, marketing considerations, etc. Having components that perform well and look good to boot is nice. However, most colors for powder coated parts are selected from a limited palette. If a batch of unique color parts are up next to be sprayed, it takes significant time to completely clean the spray booth, switch out the spray nozzles, and load up the new color. Moreover, special order colors often have long lead times. Moreover, epoxy powder has a self life and requires temperature controlled storage. Bottom line, both time and money can be saved by using one of our standard colors. For powder the standards are Red, Black, Blue, Gray and for fluidized applications Tan.

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