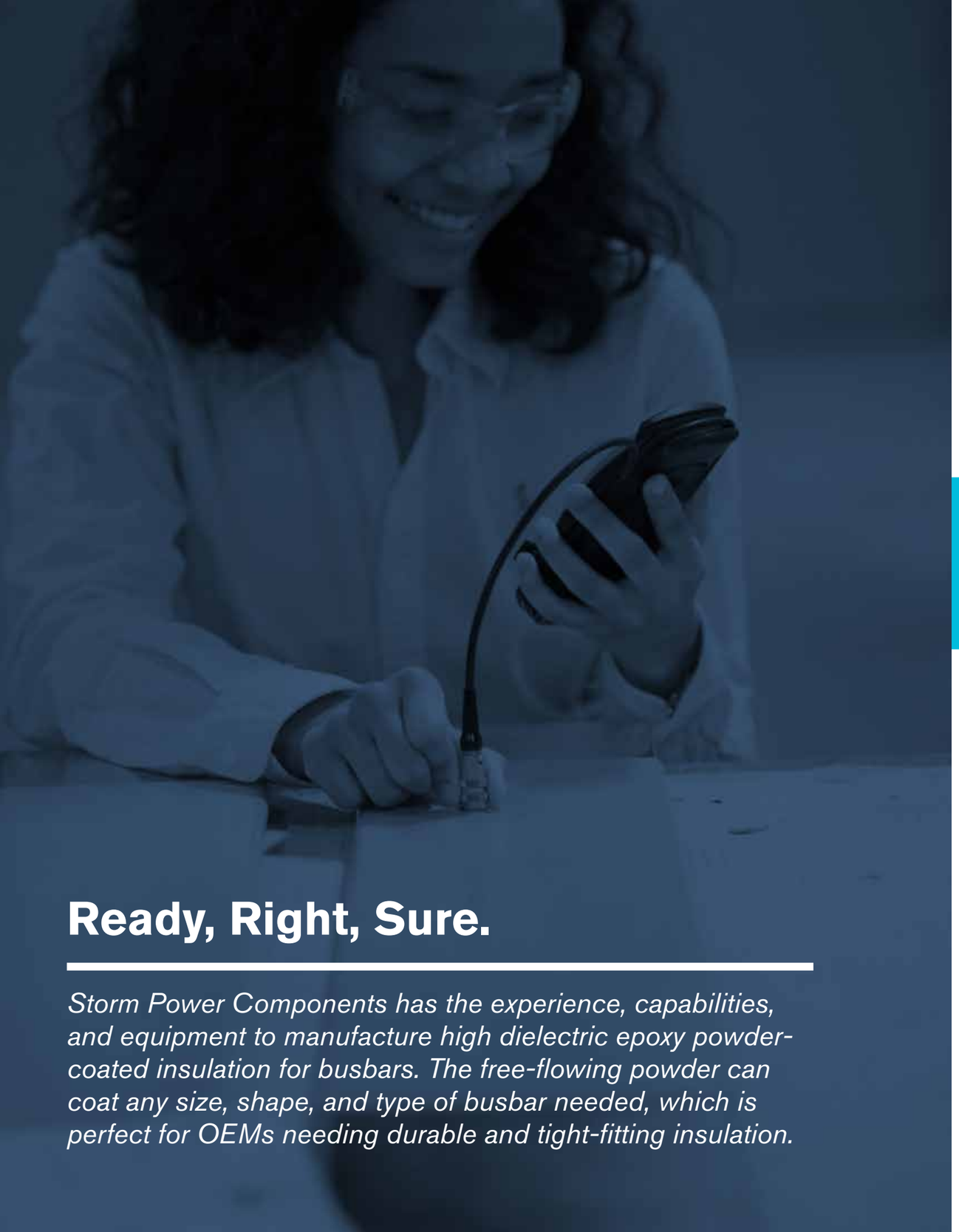
STORM™
POWER COMPONENTS

DESIGN GUIDE

Epoxy Powder-Coated Busbar Insulation

Everything you need to know...



Ready, Right, Sure.

Storm Power Components has the experience, capabilities, and equipment to manufacture high dielectric epoxy powder-coated insulation for busbars. The free-flowing powder can coat any size, shape, and type of busbar needed, which is perfect for OEMs needing durable and tight-fitting insulation.

STORM POWER COMPONENTS

Storm – The Premiere Dielectric Finishing Service

Improve Product Footprint with Epoxy Powder Coating Insulation.

In today's power-hungry and ever-shrinking environment, equipment footprint has become more critical than ever. As well, the complexity and volume of other mechanical and electrical components within the overall cabinet structure demand maximum flexibility in part placement. Applying epoxy powder-coated insulation can substantially reduce overall design constraints, potentially leading to more cost-effective designs with improved assembly protocols.

Consider the Benefits of Epoxy Powder Coating

1 Reduced Flash-Over

Epoxy powder-coated insulation decreases the risk of flash-overs. The insulation is essentially directly bonded to the conductor leaving no air gap. As a result, the likelihood of partial discharges between the conductor surface and the insulation barrier is decreased.

2 Reduced Insulation Failure

When cables or pre-insulated busbar are bent to conform to the required routing path, the insulation undergoes compression and tension at all locations where the conductor was changed. These forces manipulate the insulation, which can lead to premature insulation failure. The smooth coverage epoxy powder coating provides, eliminates these stresses, thereby reducing the chances of insulation failure.

3 Reduced Operating Temperature

Although this has not been independently verified, some customers have found that epoxy powder-coated busbars have reduced operating temperatures. Because there is no air gap between the conductor and the insulation, heat transfers smoothly through the epoxy powder insulation, and the increased surface area versus a bare conductor provides efficient heat dissipation.

4 Increased Versatility

Epoxy powder coating is the perfect insulation for conductors that are oddly shaped, have unique sizes, or those which may be known to undergo stress during installation. Unlike most other types of insulation, the epoxy powder is applied after all required bending, contouring, punching and milling is complete. In doing so, the insulation will be consistent throughout the entire conductor run.

Material Characteristics

How It Works

Epoxy is a dielectric insulation material with a manufacturer's insulation rating of ~800 volts/mil (.001"), at a minimum of 10 mils (.010").

The powder used in this process is a thermosetting dry powder that, once heated, flows uniformly over the copper substrate (plated or un-plated). This coating can be applied in thicknesses ranging from 6 mil (.006") to 120 mil (.120"). When the epoxy powder cures, a cross-link occurs increasing the molecular weight and insulation capability. Reference the graph below to compare Epoxy powder to other polymers.

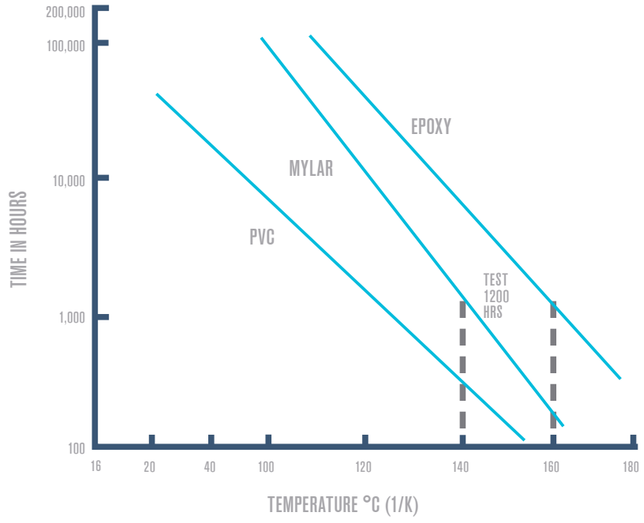


Figure 4. Insulation life curves plotted according to the Arrhenius reaction theory

Epoxy powder not only protects against corrosion, but also carries a high manufacturer's insulation rating of ~800 volts/mil (0.001") at a minimum of 10 mils (0.01 inches). Due to safety consideration, it is recommended that a High-Pot (High Potential) test is performed, rather than rely on film thickness.

Tensile strength of the coating applied on raw and plated copper bar is in the range of 7500 PSI, and has a thermal UL rating of 130 degrees C. Epoxy powder coating's high dielectric strength can be varied based on the application process and component preparation.

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Two Methods in Coating

Electrostatic Spray or Fluidized Bed?

The choice between electrostatic spray or fluidized bed powder coating is determined by the dielectric strength requirement of insulation application. The general rule of thumb is that a high-voltage busbar should be fluid dipped to achieve a thickness greater than 0.12 inches. Complicated shapes should also be fluid dipped for even, thick coating on bends and turns. Copper busbars or other components with flat, open geometry are more suitable for spraying.

Standard Variety Colors

Blue *Gray* *Red* *Green* *Brown* *Pink* *Black*

Electrostatic Spray

Before the epoxy powder is applied to the substrate, application technicians should determine how much powder is to be applied to meet the desired dielectric characteristics of each part. This is typically accomplished by varying the ratio of voltage, airflow, and powder. Components should be treated to an optimum temperature prior to applying the powder, then placed in a curing oven. As the thermo-set powder is heated, it will begin to melt and flow out, enabling it to form a higher molecular weight polymer, fusing both to itself and the substrate.

Fluidized Bed

Parts are "dipped" into epoxy powder that is suspended in an air contained, aerated hopper. This is accomplished by releasing compressed air through a porous plate located in the bottom of the hopper. As result, the epoxy powder "floats" in the hopper in a fluidized state. This creates a smooth, continuous epoxy powder coating over the substrate as it is "dipped." Greater thicknesses of epoxy powder can be achieved with this method of application than with electrostatic spray. As with sprayed components, the coated parts are then sent to a curing oven.

Design Considerations

Storm Power Components specializes in applying insulation at extreme thicknesses, up to 100 mil or more.

Epoxy powder insulation is significantly denser than other spray-on applications, and unlike the powder coating often used for aesthetic purposes, the total application thickness is typically greater than 10 mils. This capability allows for medium and high voltage applications up to 35,000 volts, allowing for drastic changes in the design of your medium and high voltage switchgear. Moreover, the versatility of the process and insulation allows it to be used in areas that are not normally considered. OEMs utilizing this insulation technology can produce more competitive products - achieving a leg up on their competition.

When designing a busbar to be epoxy powder-coated or evaluating a manufacturer, make sure to:

1. When possible utilize full round edge bar profiles:

The contoured edge of this profile allows for better adhesion of the epoxy powder as it "wraps" the edge of the busbar.

2. Avoid small cut-outs or holes in the conductor:

Small profile cut-outs or holes are difficult to edge condition and could create weak areas prone to premature failure.

3. Carefully consider design dimensions and labels:

Always dimension designs to the substrate, not the powder surface. Carefully consider masking location tolerances. Extremely tight tolerances on masking locations are difficult and expensive to achieve. Consider allowing masking tolerances of +/- .0625. For thru holes that will be coated on the interior, be sure to allow increased tolerances for the thickness of the powder to be applied. Allow for the largest reasonable bend radius. This will help the powder flow more smoothly without build-up or thinning.

4. Expertise applying extraordinary thicknesses:

Choose a provider who can perform a variety of thicknesses. If the provider isn't an expert in the process, you may end up with non-conforming components, holes excessively filled, poor edge conditions, and premature failures.

Epoxy powder insulation allows for drastic changes in the design of your medium- and high-voltage switchgear

5. Multi-process capability:

Can the manufacturer execute both fluidized bed and electrostatic spray methods? Does the manufacturer control the full process, from cutting, bending, and punching, to electroplating, and finally, insulating? This helps ensure clean execution of all steps in the process and a better finished product with the shortest possible lead times.

6. Avoid contact between the surrounding environment and your busbar.

Contact between the insulation and surrounding components could cause wear in the epoxy powder due to vibration or thermal cycling of the components.

7. Don't be afraid to use two or more insulated busbar conductors to connect one.

Does the manufacturer have the in-house engineering expertise to advice you of the options possible to make these type of applications safe and reliable?

OEMs using epoxy powder insulation can produce more competitive products – achieving a leg up on their competition

Testing Criteria

Epoxy powder coating's high dielectric strength can be varied based on the application process and component preparation. That's just one reason it's recommended to perform at least two types of testing procedures on finished parts, Hi-Pot (High Potential) and Partial Discharge, to ensure the component meets or exceeds the appropriate standards to ensure that the product will operate as designed. Moreover, rigorous testing will ensure the epoxy powder has properly adhered to the conductor surface itself.

1. A Hi-Pot (High Potential) test should be performed on all finished parts to ensure the finished product is a completely homogenous insulation surface, capable of maintaining its integrity throughout the product life cycle. Hi-Pot testing at Storm Power Components is carried out in accordance with section §6.2.1 of the ANSI/IEEE C37.20.2-1999 standard, which is the standard for bussing of metal-clad switchgear.

2. Impact Testing – Sample parts are impact tested utilizing a ball drop tester to ensure the insulation meets its specifications.

In addition to testing the finished parts, you'll also want to make sure the actual insulation products used are certified through both ASTM and Underwriters Laboratories (UL©).

Your Application is likely an Epoxy Powder Insulation Candidate

Epoxy powder-coated busbar is readily used in almost all outdoor applications.

Higher Energy Densities for Energy Storage

Space is a major issue when it comes to battery systems for hybrid commercial and industrial vehicles. By designing the battery layouts to accommodate closer packing the overall space can be reduced. Using thinner and more closely packed epoxy powder-coated copper busbars, the conductors will contribute to the space savings design.

Reduced Characteristic Impedance for IGBT Applications

Variable frequency drives are used almost exclusively now as induction motor starter and drivers. With insulated gate bipolar transistor (IGBT) drives becoming larger and larger, the current carrying capacity of the DC link and inverter busbars are also increasing.

Utilizing epoxy powder-coated copper busbars can provide increased ampacity per cross sectional area due to better thermal conductivity of the insulation. This translates into less required copper and more reliable inverter banks.

Gate drive signal integrity is an absolute necessity for reducing harmonics and to keep the inverter stacks from failing. By reducing the characteristic impedance of the drive circuit by using epoxy powder-coated copper busbars, the gate current is less likely to be attenuated. This ensures firing of the transistors when the microprocessor intends them to.

Reduced Footprint of MV Switchgear

Due to the very wide range of voltages the epoxy powder insulation is rated for, it can be used in a variety of medium voltage switchgear applications. This can provide large reductions in the footprint of conventional medium voltage gear. As most of the space requirements in MV switchgear is in providing adequate conductor spacing, epoxy powder-coated busbar is the most advantageous solution. By also using epoxy powder coating, difficult shapes and bends are easily insulated and installed, which cannot be accomplished by any other insulating method.

Homogeneous Insulation Layer

A homogenous insulation reduces the likelihood of weak points in the insulation which can lead to “insulation treeing” resulting in flashovers to ground and other phases. Insulation mediums that have less non-homogeneity are gas insulating, which is very expensive.

Powder-coated busbars can be found in almost all industries and applications, such as:

- Petrochemical plants
- Nuclear facilities
- Marine and offshore installations
- Sustainable energy applications
- Inverter drive applications
- Alternative energy
- Transportation

Trust the Experts for Premiere Dielectric Finishing

For more than two decades, Storm Power Components has provided “Under One Roof” electrical component manufacturing.

For more than twenty-five years, Storm Power Components has been a responsive manufacturer of electrical conductors—bare, plated, insulated and laminated. Our power components are processed through a number of finishes for a wide range of industries and applications. That’s just one of the many reasons OEMs around the world trust Team Storm to execute complex finishing processes like epoxy powder coating.

Our engineering team provides invaluable insight and services throughout the design and manufacturing process. From end-to-end product development to audits of existing copper busbar designs, our expert insight can help you shorten lead times, lower costs, and improve product performance.

Regardless of where you are in your design process, our engineers and designers can assist you. Whether you have a comprehensive written scope of work, a napkin sketch, a photo, or just idea, our knowledgeable and talented engineers and designers can develop a solution to help you optimize costs and manufacturability.

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Epoxy powder insulation allows for drastic changes in the design of your medium- and high-voltage switchgear

We've heard it all, and can help!

Our team of engineering experts are constantly refining production methods associated with epoxy powder-coated busbars assemblies. Over the years we've come across a variety of issues which has helped us refine the intricate process of dielectric finishing. So, sit back and relax while our astute team of engineers put their years of practical experience to work for you.

Top 10 Common Epoxy Powder Insulation Questions OEM Engineers Ask Us (And the Answers We Provide)

1. **What is the minimum conductor spacing that is required at each voltage level using this product?**
   Spacing can very close and even touching. However if the insulated conductors are we recommend they be bonded together.
2. **What kind of temperature rises are seen as a function of current for this product?**
   Generally, the insulation does not contribute to additional heatrise and many customers have reported it lowers heatrise.
3. **I am requiring busbar for an inverter drive; which coating method should I choose?**
   Coating method is a direct relation to the voltage requirements of your bus. The voltages generally seen in invertor applications would lend itself to electrostatic spray.
4. **I am requiring busbar for a low voltage high current switchgear application; which coating method should I choose?**
   Coating method is a direct relation to the voltage requirements (not current) of your bus. The voltages generally seen in low voltage switchgear applications would lend itself to electrostatic spray.
5. **I am requiring busbar for a medium voltage application; which coating method should I choose?**
   Medium voltage applications would require fluidized bed.
6. **How resilient is the coating to mechanical damage, as well as to the outdoor elements?**
   Very, it has a tensile strength of the coating applied on raw and plated copper bar is in the range of 7500 PSI.
7. **How well does this type of insulation hold up under heavy fault conditions?**
   The adhesion characteristics of the powder when properly applied should withstand the fault conditions of the conductor itself.
8. **Should I powder coat my ground conductors?**
   Every application is different but it is not a detriment to coat a ground conductor.
9. **Can I drill holes through the insulation for terminations without compromising the insulating integrity?**
   No, we recommend that holes be added prior to the insulation being applied.
10. **What method does Storm Power Components use?**
    The method by which Storm produces epoxy powder-coated busbar provides an extremely homogeneous insulation layer. We offer both electrostatic spray and fluidized bed processes.
11. **Are there different color options available?**
    Yes, in fact many customers color code their bars for easy identification.

Got More Questions? Speak to an Expert.

Call Us at 1-800-394-4804

About Storm Power Components

Storm Power Components is a fabricator of custom copper components. From back-up power systems, cell towers, and sub stations, to earth-moving equipment, motive power, and alternative energy applications, our industrial-strength parts are trusted by original equipment manufacturers around the world to power, connect, and protect their products.

As an industry veteran for more than 25 years, the company is squarely focused on delivering improved responsiveness, price advantage, and shorter distribution channels. The result is its ability to manufacture superior-quality parts with speed and accuracy, while providing customers a delightfully uncommon experience. Storm Power Components, a privately held company, is an AS9100:D and ISO 9001:2015 certified organization headquartered in Decatur, Tennessee. For more information, please visit www.stormpowercomponents.com.

Request a Quote Today!

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