

## DEVELOPMENT COMPANY

*Manufacturers of Ceramic Capacitors, Varistors and Thermistors  
Established 1947*

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### Phenolic vs. Epoxy Coating

This white paper is designed to compare the advantages versus the disadvantages of using a phenolic coating instead of the typical epoxy coating of Metal Oxide Varistors (MOV's). It should be noted that Maida utilizes a phenolic distinctly different from most varistor manufacturers in the industry. Maida uses a true phenolic while most others use a phenolic-epoxy hybrid.

#### Definitions:

**Metal Oxide Varistor (MOV):** Typically a zinc oxide ceramic based electronic component which has a non-linear voltage-current characteristic. A MOV is used in applications that require protection against transients. These transients can be created by: lightning – conducted or induced, by the switching of inductive loads (transformers, relays, or coils), by Electromagnetic Pulses (EMP), and ESD.

**Epoxy:** A basic component and cured end product of epoxy resins. Used as an electrical insulator for electronic components.

**Phenolic:** A basic component of phenolic resins. Used as an electrical insulator for electronic components.

A MOV is typically conformal coated with an insulating material (see Figure 1). The insulating material is typically an epoxy or phenolic material. A MOV will operate and perform its designed function without the need for conformal coatings. The typical purpose of such coatings allow for reduced creepage and clearance distances required, on end product Surge Protective Devices (SPD's) for example, by numerous safety standards – such as UL840.

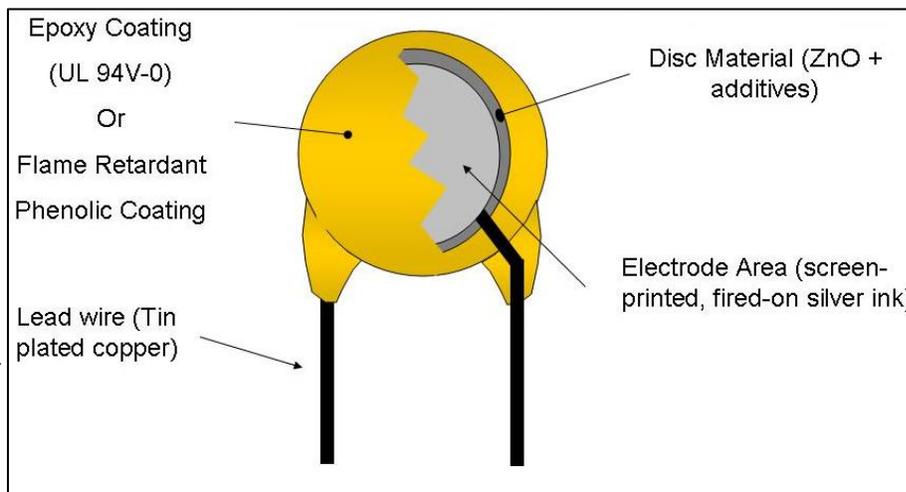


Figure 1



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There are advantages for using either epoxy or phenolic coatings. The use of either coating is dependant on the end application:

### Epoxy Advantages:

- High Dielectric Withstand
- Moderate to High Moisture Resistivity
- Moderate to High Chemical Resistivity
- High abrasion and wear resistance

### Epoxy Disadvantages:

- Less resistant to burning

### Phenolic Advantages:

- High Resistance to Flame
- Moderate to High Thermal Conductivity (useful for Thermal Cut-Off devices)
- Moderate Moisture Resistivity
- Moderate Chemical Resistivity

### Phenolic Disadvantages:

- Low to Moderate Dielectric Withstand
- Higher Cost

As listed above the main disadvantage for using an epoxy coating is that it burns under flame test and will burn during out-of-specification overvoltage conditions if appropriate disconnects are not installed in the application. The burnt epoxy can result in debris on printed circuit boards causing additional complications in the circuit. The main disadvantage for using a phenolic coating is its lower dielectric withstand voltage. Maida's phenolic coating requires much thicker coating, relative to the epoxy, to obtain the required dielectric withstand ratings.

The most important characteristic of the phenolic coating used by the Maida Development Company is the high resistance to flame. As seen in Figure 2 the image on the left is the phenolic coated varistor while the image on the right is the epoxy coated varistor. This is the result of a Flame Test, which is the application of a propane torch blue flame for 60 seconds. The flames continued to burn on the standard MOV even after the propane torch was removed. There were no flames on the phenolic varistor even under the propane torch. Similar results are obtained during limited current abnormal overvoltage testing (UL1449 3<sup>rd</sup> Edition).



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Figure 2

The most important characteristic of the epoxy coating is its high dielectric withstand voltage rating. The epoxy coated varistor can pass the requirements of various standards, such as UL1449 4<sup>th</sup> Edition and MIL-STD-202, with as little as 0.020" coating thickness. The phenolic coating, in comparison, typically requires at least twice the coating thickness as the epoxy. The reduced epoxy thickness can be beneficial for designs where space is a premium.

While the Maida Development Company uses only epoxy and phenolic coatings, it should be noted that other varistor manufacturers use epoxy and phenolic-epoxy hybrids. The phenolic-epoxy hybrids do not exhibit the same burn properties as Maida's phenolic coating. The phenolic-epoxy hybrid coatings do have an increased time to burn compared with the epoxy, but they will burn similarly to the epoxy and will typically result in debris on the printed circuit board upon failure.

In summary, the end user must decide the most important characteristics of a varistor's coating material. Breakers, fuses, thermal cut-off devices, and creepage and clearance requirements used in a circuit can force the necessity of one coating versus another. Additional information and details can be obtained by contacting the Engineering Department at Maida.

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