Conformal Coatings Guide & Overview

Engineered to protect circuit boards and other electronic components from adverse environmental conditions, conformal coatings adhere to irregular surfaces to ensure dielectric resistance and operation integrity.

Conformal Coating Resin Types

There are five main categories of conformal coatings:

- AR – Acrylic Resin
- SR – Silicone Resin
- UR – Polyurethane (Urethane) Resin
- ER – Epoxy Resin
- XY – Parylene

AR – Designed for moderate elasticity and general protection, this one-part system offers high dielectric strength, high abrasion resistance, and easy application and removal.

SR – With an extensive temperature range and good chemical resistance, silicone resin offers excellent protection and flexibility but may require longer soaking times or special solvents for removal.

UR – Known for moisture, abrasion and chemical resistance, polyurethane coatings are also resistant to many solvents and are therefore difficult to remove.

ER – Engineered for high resistance to chemicals, abrasion and humidity, two-part epoxy resin compounds are not generally flexible and are very difficult to remove once cured.

XY – Highly resistant to solvents and temperatures, this uniquely durable coating is applied through vapor phase deposition.

Specialty Materials

Fluorocarbon Conformal Coatings – Formulated of conformal coating dissolved in a fluorocarbon-based carrier solvent, this material offers good moisture resistance but is easily rubbed off.

Varnish and Alkyd Coatings – Generally hard and moisture-resistant, these types of coatings tend to lack flexibility.

Conformal Coating Cure Types

Conformal coatings are also classified by cure mechanism. While some methods are foolproof, others leave room for error in an uncontrolled application process.

Evaporative Cure – To achieve this cure, a liquid carrier evaporates to leave a conformal coating behind. Although simple in theory, a surface must generally be dipped two or more times to accumulate adequate coating.

Moisture Cure – Generally employed with silicone and urethane materials, this process involves a reaction with ambient moisture to form a coating and is often used in conjunction with an evaporative cure.

Heat Cure – Typically used as a secondary mechanism for a UV, moisture or evaporative cure, the addition of heat speeds up the cure of a system.

Two-Part Systems – Designed for use with epoxy systems, this method begins to cure when two substances are mixed and ratios are strictly observed.

UV Cure – Coatings that are cured by ultraviolet light deliver fast production results and do not contain carrier solvents. While the need for a secondary curing system is eliminated, UV cured coatings can be difficult to repair and require protective considerations for workers exposed to UV radiation.

Conformal Coating Application Techniques

Six primary methods are used to apply conformal coatings to circuit board surfaces:

- Manual Spraying
- Automated Spraying
- Selective Coating
- Dipping
- Brushing
- Vapor Deposition

Manual Spraying – For low volume applications, conformal coatings can be manually applied using an aerosol can or spray gun.

Automated Spraying – This application method involves a programmed spray system that moves the board on a conveyer to very specific areas of the board.

Selective Coating – Using programmed robotic spray nozzles, this automated process is used in high volume applications to apply conformal coating to very specific areas of the board.

Dipping – This is the process of immersing a circuit board in conformal coating solution then withdrawing, commonly used in high volume applications.

Brushing – Typically used in rework and repair, in this method conformal coating is applied with a brush to specific areas of the board – a simple technique that is low cost but labor intensive.

Chemical Vapor Deposition – Specific to Parylene conformal coatings, in this technique the Parylene is heated and transformed to a gaseous state. Once cooled it is introduced to a vacuum chamber where is becomes a film to be deposited on the board.

Conformal Coating Removal

Conformal coatings must occasionally be removed to allow for repair or rework processes. The removal methods used are dependent upon the coating itself as well as the size of the area, and include:

- Solvent
- Peeling
- Thermal/Burn-Through
- Grinding/Scraping
- Micro-Blasting

Solvent – While effective on most conformal coatings, care is advised as various solvents may cause damage to circuit board components. Most effective on acrylics, solvents cannot remove Parylene and are far less effective on epoxies, urethanes and silicones.

Peeling – Typically characteristic of flexible or silicone solutions, in this method of removal the conformal coating is simply peeled away from the circuit board.

Thermal/Burn-Through – Coating is commonly removed by burning through it during the rework process, a method which works well with most types of coating.

Grinding/Scraping – Most effective on harder conformal coatings, this process involves abrading the circuit board as a method of last resort, as serious damage to components may occur.

Micro-Blasting – Using a concentrated mix of soft abrasive and compressed air, this process removes conformal coating from small areas and is most commonly employed with Parylene and epoxy abrasives.

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