



Conformal Coating Overview

Conformal coatings are specialty film forming products that protect circuit boards and other electronic components from adverse environmental conditions. These coatings 'conform' to the irregular landscape of the circuit board, providing increased dielectric resistance, operational integrity, and protection from corrosive elements, moisture, heat, fungus, and airborne contaminants such as dirt and dust. With continued miniaturization of electronics, the necessity of conformal coating has increased because the additional insulative coating layer between circuits can prevent arcing or current bleed.



Conformal Coating Resin Types

Conformal coatings can be classified in five main categories:

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

These categories are based on the basic resin of each coating. The chemistry determines the major attributes and functions of the conformal coating. Choosing the proper conformal coating for your application is determined by operational requirements of the electronics.

AR – Acrylic conformal coatings provide fair elasticity and general protection. As one-part systems, they are easy to apply and remove. Acrylic conformal coatings are recognized for their high dielectric strength, abrasion resistance and ease of removal.

SR – Silicone conformal coatings provide excellent protection in a very wide temperature range. They provide good chemical resistance, salt spray resistance and are very flexible. Removal can be challenging, requiring specialized solvents and long soak time.

UR – Polyurethane conformal coatings are known for their excellent moisture and chemical resistance. They are also very abrasion resistant. Due to this and their solvent resistance, they are also very difficult to remove.

ER – Epoxy systems are usually available as two-part compounds. These conformal coatings provide good humidity resistance, high abrasion and chemical resistance. Typically, they are very difficult to remove once they are cured, and are not as flexible as the other materials.

XY – Parylene conformal coatings are a unique type of coating applied through vapor phase deposition. They provide excellent dielectric strength and superior resistance to solvents and extreme



temperatures. Because of the vapor deposition method, parylene can be applied very thin and still provide excellent circuit board protection. Removal for rework is very difficult, requiring abrasion techniques, and without access to vapor phase deposition equipment, recoating with parylene is impossible.

Specialty Materials

Fluorocarbon Conformal Coatings – Coating is dissolved in a fluorocarbon-based carrier solvent and applied with a spray or dip method to create a very thin coat. They provide good moisture resistance, fair chemical resistance, but can be easily rubbed off.

Varnish and Alkyd Coatings - These coatings can be anything from natural-based resins that form tough coatings to synthetic urethane, acrylic or epoxy-based coatings. They are typically hard, moisture resistant materials that lack the flexibility of the above materials, and also have greater variations in insulative properties and stability. These products are usually made of lower molecular weight polymers which affect the performance properties and quality of the product.

Conformal Coating Cure Types

Conformal coatings can also be categorized by cure mechanism. Some mechanisms are relatively fool-proof, while others are very complex and leave room for application errors when used in an uncontrolled process.

Evaporative Cure Mechanism – The liquid carrier evaporates, and what is left behind is the coating. Although very simple in theory, circuit boards usually need to be dipped at least two times to build up adequate coating on component edges. Whether the liquid carrier is solvent or water-based, humidity affects application parameters. Solvent systems tend to be easy to process, provide consistent coverage due to good wetting, and fast cure times. However, solvents are often flammable, so adequate ventilation and fume extraction methods are required. Using water as a carrier can eliminate the flammability concern, although they tend to take much longer to cure, and can be very sensitive to ambient humidity.

Moisture Cure – Primarily found in silicone and some urethane systems. These materials will react with ambient moisture to form the polymer coating. This type of curing mechanism is often coupled with evaporative cure. As carrier solvents evaporate, moisture reacts with resin to initiate final curing.

Heat Cure – Heat cure mechanisms can be used with one or multicomponent systems, as a secondary cure mechanism for UV cure, moisture cure, or evaporative cure. The addition of heat will cause the system to polymerize, or speed the cure of the system. This can be advantageous when one cure mechanism is insufficient to gain the cure properties required or expected. However, thermal sensitivity of circuit boards and components must be taken into consideration when curing in elevated temperatures.

Two-Part Systems – Typically found in epoxy systems, two component materials begin their cure schedule when mixed together. Two-part materials are 100% solids, solvent and moisture free systems, and can be viewed as a “no waste” system. Mix ratios must be followed strictly or expected physical properties will not be attained.



UV Cure – Coatings that are cured by ultraviolet light offer very fast production throughputs. They are 100% solid systems with no carrier solvents. UV curing is line-of-site, so a secondary curing mechanism is needed under components and in shadow areas. UV cured coatings are more difficult to repair and rework, and require UV curing equipment and UV radiation protection for workers.

Conformal Coating Application Techniques

There are six main methods used to apply conformal coatings to circuit boards:

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

Manual Spraying - Conformal coating can be applied by an aerosol can or handheld spray gun. It is generally used for low volume production when capital equipment is not available. This method can be time consuming because areas not requiring coating need to be masked. It is also operator dependent, so variations are common from board to board.

Automated Spraying - Programmed spray system that moves the board on a conveyor under a reciprocating spray head that applies conformal coating. Coating application is usually followed by an oven that accelerates the curing so the boards can be handled quickly.

Selective Coating - An automated process that uses programmable robotic spray nozzles to apply the conformal coating to very specific areas on the circuit board. This process is used in high volume processes and can eliminate the need for masking.

Dipping - The circuit board is immersed then withdrawn from the conformal coating solution. Immersion speed, withdrawal speed, immersion time and viscosity determine the resulting film formation. It is a common conformal coating technique for high volume processing.

Brushing - Brushing is a simple application technique used mainly in repair and rework applications. The conformal coating is applied with a brush to specific areas on the board. It is a low cost but labor intensive and highly variable method, best suited for small production runs.

Chemical Vapor Deposition - Application procedure specific to parylene conformal coatings. When heated, parylene is transformed into a gaseous state. It is then cooled, and introduced to a vacuum chamber where it polymerizes and becomes a film, which is deposited on the entire circuit board. The process requires specialized equipment and training, so is often out-sourced.



Conformal Coating Removal

On occasion it is necessary to remove a conformal coating from the circuit board to replace damaged components or perform other reworking procedures. The methods and materials used to remove coatings are determined by the coating resins as well as the size of the area, and can impact the time required. The basic methods as cited by IPC are:

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

Solvent Removal - Most conformal coating are susceptible to solvent removal, however it must be determined if the solvent will damage parts or components on the circuit board. Acrylics are the most sensitive to solvents hence their easy removal; epoxies, urethanes and silicones are the least sensitive. Parylene cannot be removed with solvent.

Peeling - Some conformal coatings can be peeled from the circuit board. This is mainly a characteristic of some silicone conformal coatings and some flexible conformal coatings.

Thermal/Burn-through – A common technique of coating removal is to simply burn through the coating with a soldering iron as the board is reworked. This method works well with most forms of conformal coatings.

Microblasting - Microblasting removes the conformal coating by using a concentrated mix of soft abrasive and compressed air to abrade the coating. The process can be used to remove small areas of conformal coating. It is most commonly used when removing Parylene and epoxy coatings.

Grinding/Scraping - In this method the conformal coating is removed by abrading the circuit board. This method is more effective with harder conformal coatings, such as parylene, epoxy and polyurethane. This method is only used as a method of last resort, as serious damage can be incurred.

Konform® Conformal Coatings

The different types of conformal coatings provided by Chemtronics include silicone (Konform® SR and HV) Acrylic (Konform® AR, Konform® Ultra), Urethane (Konform® UR-A), and two unique products; urethane/acrylic water based conformal coating (Konform® Hybrid), and a unique polymeric based flexible coating (Konform® Flexcoat).

Product	Type	Properties
Konform® AR	Acrylic	High Dielectric Strength,
Konform® Ultra	Acrylic	High Dielectric Strength, Fast drying
Konform® SR	Silicone	Wide Temperature Range, Flexibility
Konform® SR High Viscosity	Silicone	Wide Temperature Range, maximum coverage
Konform® UR-A	Urethane	Water-based, high solvent resistance, high abrasion resistance
Konform® Hybrid	Urethane/Acrylic	Enhanced dielectric strength and abrasion resistance



Konform® Flexcoat	Polymeric blend	High dielectric strength, extremely flexible.
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Chemtronics Acrylic Conformal Coatings

Konform® AR - Konform® AR is an acrylic based conformal coating designed to provide insulation against high-voltage arcing and corona shorts. This extremely effective acrylic conformal coating provides a hard, durable protective barrier against humidity, salt, corrosive vapors and fungus for printed circuit board and electronic assemblies. This material is an evaporation cure coating. Konform® AR resin meets MIL-I-46058C, Type AR, IPC-CC-830B, and is UL recognized. Konform AR is best removed by solvent. For small areas, use Circuitworks® Conformal Coating Remover Pen (CW2500). For removing from the entire board our Electro-Wash® Two Step is recommended.

Konform® Ultra - Konform® Ultra-Fast Dry Acrylic Conformal Coating is formulated to provide maximum process throughput while also maximizing insulation protection against high-voltage arcing and corona shorts. The product dries to the touch rapidly allowing for fast and easy application and handling. This extremely effective acrylic conformal coating provides a hard, durable protective barrier against humidity, salt, corrosive vapors and fungus for printed circuit board and electronic assemblies. This material is an evaporation cure coating. Konform® Ultra meets IPC-CC-830B and sections of MIL-I-46058C, Type AR. To remove Konform Ultra from small areas, use Circuitworks® Conformal Coating Remover Pen (CW2500). For removing from the entire board our Electro-Wash® Two Step is recommended.

Chemtronics Silicone Conformal Coatings

Konform® SR - Konform® SR provides maximum flexibility for extreme temperatures. This transparent coating provides ideal protection for both rigid and flexible printed circuit boards. Cured coatings are hydrolytically stable and retain their physical and electrical properties after high temperature and humidity exposure. They are alkoxy cure materials (one component cure mechanism that releases small amounts of alcohol as it cures) that cure with ambient moisture. Konform® SR will not stress delicate circuit components due to thermal expansion and compression. Konform® SR resin meets MIL-I-46058C, Type SR and IPC-CC-830B, and is UL recognized. Konform SR can be removed with Circuitworks® Conformal Coating Remover and Electro-Wash® Two Step.

Konform® SR High Viscosity - Konform® SR High Viscosity offers maximum coverage where good flexibility is required, or where extreme temperatures can be encountered. This transparent coating provides ideal protection for both rigid and flexible printed circuit boards. Cured coatings are hydrolytically stable and retain their physical electrical properties after high temperature and humidity exposure, and are moisture, alkoxy cure materials that cure with ambient moisture. Konform® SR High Viscosity will not stress delicate circuit components, and meets MIL-I-46058C, Type SR and IPC-CC-830B. Konform SR High Viscosity can be removed with Circuitworks® Conformal Coating Remover and Electro-Wash® Two Step.



Chemtronics Specialty Conformal Coatings

In addition to our Konform® SR silicone conformal coating and Konform® AR acrylic based conformal coating; ITW Chemtronics offers three specialty conformal coatings that provide the proper protection for circuit boards while exhibiting unique properties that apply to customers' specific needs.

Konform® Flexcoat - Konform® Flexcoat Conformal Coating is designed for applications where flexibility and protection are paramount. This material is as flexible as an RTV silicone, but without the disadvantages of a silicone. Providing a soft, rubbery protective coating, this material will coat evenly and provide a flexible and durable protective barrier against humidity, salt, corrosive vapors and fungus for printed circuit board and electronic assemblies. This material is an evaporation cure coating. Konform® Flexcoat can be removed by cutting a small section and peeling the coating away from the surface, or by solvent immersion of the whole board. Konform® Flexcoat can be removed by peeling or by Electro-Wash® Two Step.

Konform® UR-A - Konform® UR-A water-based urethane conformal coating is designed to deliver outstanding conformal coating protection using a water-based carrier. It is engineered for applications where durability and environmental protection against moisture and air-borne contaminants are required, while minimizing the use and impact of VOC's. This extremely effective conformal coating provides protective barrier against humidity, salt, corrosive vapors and fungus for printed circuit board and electronic assemblies. Konform UR-A meets MIL-I-46058C, Type UR and IPC-CC-830B.

Konform® Hybrid - Konform® Hybrid Conformal Coating is a unique protective coating offering the insulating dielectric advantages of an acrylic coating with the chemical resistance of a urethane system. Formulated with a unique acrylic / urethane backbone, this resin system offers effective circuit board protection with a water based carrier. Konform® Hybrid Conformal Coating provides an effective protective barrier against humidity, salt, corrosive vapors and fungus for printed circuit board and electronic assemblies. This material is an evaporation cure coating. Konform Hybrid meets IPC-CC-830B. Konform® Hybrid can be removed with Circuitworks® Conformal Coating Remover and Electro-Wash® Two Step.

Chemtronics® is the acknowledged industry leader in solutions for the electronics, telecommunications and critical environments markets. Their products are engineered to meet a full array of cleaning, protecting and repairing needs. Products include degreasers, defluxers, conformal coatings, Static-Free products, desoldering braid, board repair pens, swabs, wipes, and fiber optic cleaners. For more information, go to www.chemtronics.com.