3M™ Novec™ 1700 and 1702 Electronic Grade Coatings

Process Guidelines for Printed Circuit Board Coating

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3M™ Novec™ 1700 and 1702 Electronic Grade Coatings can be outstanding choices for protecting printed circuit boards (PCBs) in today's demanding electronic applications. They both provide protection against moisture and other environmental concerns that could shorten a device's age life. They are also nonflammable and have low toxicity.

Novec 1700 and 1702 coatings are clear, low viscosity solutions of a fluorochemical acrylate polymer coating carried in a hydrofluoroether solvent. This solvent, 3M™ Novec™ 7100DL Engineered Fluid, is VOC-exempt per U.S. EPA guidelines. When applied to clean, moisture-free surfaces such as PCB laminates, flexible polyimide films, copper, aluminum, ceramic, steel or plastic substrates, Novec 1700 and 1702 coatings dry to thin transparent films. These coatings can then provide excellent anti-wetting, anti-stiction, anti-migration, and anti-corrosion properties required in many diverse assemblies. These low surface energy films repel, and are insoluble in, non-fluorinated liquids such as water, most hydrocarbon oils, and photoresist solutions. They can also endure up to 175°C for prolonged periods and still maintain good repellency. This makes them very versatile in the types of applications they can be used for.

Novec 1700 and 1702 coatings are easy to apply with a variety of methods. They do not require high curing temperatures and are removable if need be. The procedures below highlight the different recommended methods for applying these coatings. Additional support and information for your specific process can be provided by contacting the authors of this paper.

The Process of Coating Printed Circuit Boards

Printed circuit boards come in an endless array of shapes and sizes ranging from small, single-function boards, to flex circuits with complicated geometry to large, complex multi-PCB assemblies. As a result, coating these boards can present significant challenges.

Coating with Novec 1700 coating: Whereas conformal coatings are often used for moisture and environmental protection on circuit boards, often a thinner coating that is quick and easy to apply without curing is more than sufficient. Novec 1700 coating is one such material and is used by many for this type of protection. 3M has developed a number of easy processing methods for this coating that result in accuracy of placement, repeatability and selectivity.

The Novec 1700 coating process depends on several criteria. PCB geometry, production volume, budget, throughput speed and coating coverage are just some of the considerations. The five most common application processes for applying Novec 1700 coatings are dip, spray, drip, capillary and brush methods. In all of these, the key is controlling the flow of the Novec 1700 coating solution. The reason for this is because it has a lower viscosity and lower surface tension than most other coating solutions delivered out of aqueous or hydrocarbon-based solvents. The solvent in Novec 1700 coating is nonflammable and low in toxicity. Following good industrial hygiene practices, however, plus having ventilation and a local exhaust fan is always recommended.

Dip coating is a simple and effective coating process for full coverage. The low viscosity and low surface tension of Novec 1700 coating will wet virtually any substrate and penetrate very small spaces. The design layout of the PCB must be considered to avoid pooling and drag-out loses of the coating solution. Dip coating tanks for the Novec 1700 coating are commonly constructed of stainless steel or transparent materials like glass or clear acrylic plastic (PMMA). Dip coating processes can be manual or automatic. Maintaining a minimum tank volume, enough to just cover the assembly, with automatic dispensing of coating solution can help to minimize cross contamination. A deep tank with high freeboard for evaporation control is recommended. Different rates will provide different coating thicknesses and the optimal conditions will be based on the board size, layout and density placement of components.

Spray coating can be done manually or selectively with robotic spray equipment. Using a pre-programmed control system, a robotic sprayer can effectively and consistently spray complex geometric components, reducing the amount of time and effort spent manually applying a coating. Manual spraying may require less equipment but is inherently more variable and may lead to over application and coating waste.

Drip coating by selective semi-automatic drop/line dispensing of Novec 1700 coating with a programmable peristaltic pump is common at assembly lines where labor cost is low and a budget is not available for automation scale up. With this method, the flow rate and volume can be precisely controlled while maintaining manual control of where the coating is applied.

Capillary coating with boundary control can be effective for better control of the coating. The coating solution can be controlled by creating a shaped mold that barely comes into contact with the PCB selective coating area. The Novec 1700 coating is a low viscosity liquid and very effective in penetrating capillary gaps and wetting the area where the mold and substrate meet. The low surface tension of the coating solution wets most surfaces including difficult to wet, low surface energy substrates like silicones and fluoropolymers.

Brushing is usually not recommended for production. Brush tips can pick up debris from the substrate leading to cross-contamination of the coating solution. Controlling the amount of coating applied is difficult. Excessive waste and variations in the actual amount of coating applied are major concerns.

Coating with 3M™ Novec™ 1702 Electronic Grade Coating: Small, fine pitch connectors can very easily wick up coating material. This is caused by the capillary flow of a low viscosity coating solution. Applying Novec 1702 coating, which is a lower concentration version of the Novec 1700 coating, around these fine pitch connectors is then recommended. With proper control of volume and application area flooding, the mating surfaces of connectors can be avoided. A small amount of Novec 1702 coating wicked up at the connector boundary usually does not affect connector continuity. Evaluation of the coating and the application process on connectors on the production line is recommended.

Process Control and Quality Control Recommendations

The dispensing rate of Novec 1700 coating can be measured with a simple electronic balance. Measuring the liquid dispense weight per minute at the beginning of every four hour shift, for example, has been found to be an effective process control method at production sites.

For identification of a coated PCB on the assembly line, small dots of the coating solution can be put on black surface mount components (see Figure 1). The Novec 1700 coating marks on dark surfaces are obvious to the naked eye.

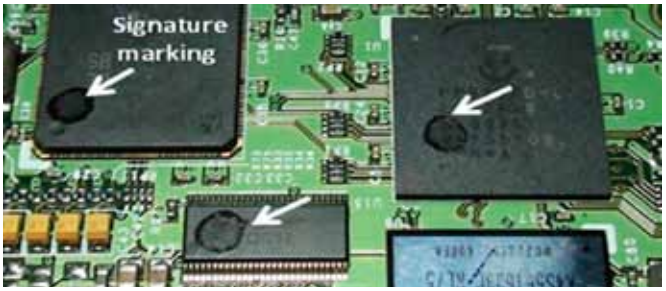


Figure 1. Examples of marking dark components with drops of Novec 1700 coating for identification of coated assemblies

On lighter colored PCB substrates or components, the boundary of polymer film on uncoated areas and on areas where the Novec 1700 coating has been applied can be seen under a microscope with proper lighting. It is much easier to see the coating by comparing PCB assemblies with and without the coating side by side (see Figure 2).

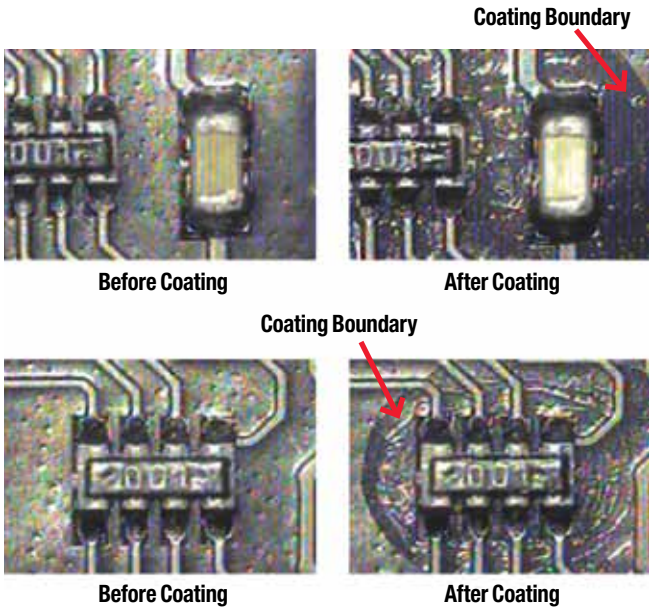
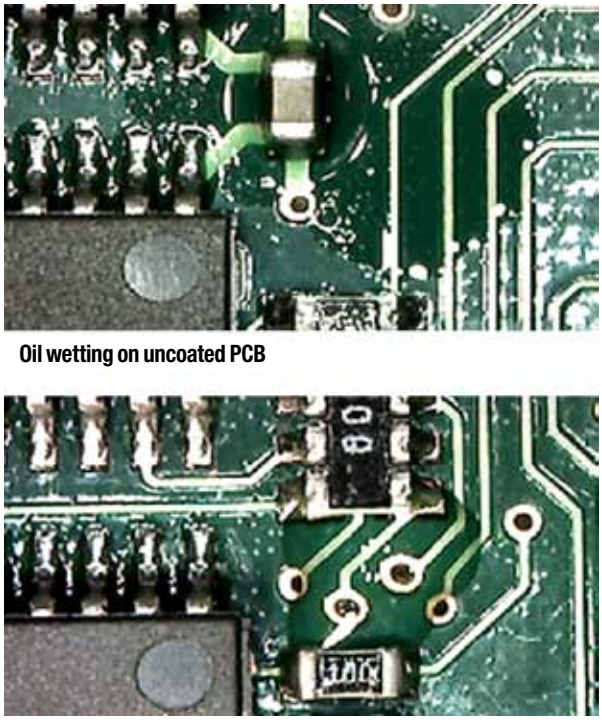


Figure 2. Side-by-side comparison of uncoated and coated components under magnification.

An oil wetting test can also help to identify the Novec 1700 coating on a PCB. Dried films of this coating repel liquids such as mineral oil, paraffin oil and hexadecane. The non-wetting of the mineral oil or paraffin oil on the Novec 1700 coated areas is a simple method for coating verification in the inspection process. (see Figure 3).



Oil wetting on uncoated PCB

Oil non-wetting on Novec 1700 coated PCB

Figure 3. Using oil wetting/non-wetting to inspect uncoated and Novec 1700 coated areas on PCB substrate.

The recommended environment for applying 3M™ Novec™ 1700 coating is 20-27°C and 40-70 % relative humidity (RH). Humidity control helps to prevent moisture condensation on the polymer film due to evaporative cooling of the coating solvent. Temperature control helps to keep a reasonable drying time in the production process. At 25°C, a 50 microns thick wet film (polymer and solvent) of Novec 1700 coating can be dried within 5 seconds.

In spray and drip application systems, the nozzle and dispenser tip may become clogged with the Novec 1700 coating polymer when the coating process is idle over 30 minutes. The clogging problem can be fixed by simply dipping the nozzle and dispenser tip into Novec 1700 coating liquid or 3M™ Novec™ 7100 Engineered Fluid as a solvent for 3 seconds. This will dissolve the polymer residue and should return the nozzle and dispenser tip to proper working order.

Rework

Dried films of Novec 1700 coating can be dissolved and stripped from coated assemblies with Novec 7100 fluid as a solvent. Because the thin polymer film has a minimal affect on heat transfer, soldering and de-soldering directly on Novec 1700-coated printed circuit board assemblies is possible. An exhaust fan and ventilation are always necessary during soldering and de-soldering processes.

Questions and comments about the information in this Application Note may be directed to the authors:

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