Methods of Masking Components for Parylene and Liquid Conformal Coatings

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Different Types of Masking for Conformal Coatings

Types of Masking Systems

Printed circuit boards (PCBs) and related electrical assemblies benefit from the protection of conformal coatings. However, because the films are insulative when dry, they can disrupt operation of the assemblies' electrical components, items like capacitors, connector contacts, diodes, operational amplifiers, resistors, or transistors. Conformal coating masking protects specified regions of PCBs and related assemblies from being conformally coated during film application. These components must remain uncoated to function as designed. Consisting of masking appliances constructed with appropriate materials, masking systems prevent migration of conformal coatings into designated keep-out areas. Masking processes enacted prior to coating application assure the conformal materials DO NOT invade designated keep-out areas.

Masking boots, dots, tape and liquid latex configurations represent the basic physical equipment used when protecting assembly components from conformal coating. The list of components not normally coated by conformal films is extensive and includes:

- actuators and similar electromechanical components,
- batteries,
- connectors,
- EMI shields
- glass-bodied diodes,
- grounding points,
- mating pins/sockets,
- mounting holes/surfaces/hardware,
- photodiodes, sensors, and other optical devices,
- potentiometers and variable capacitors,
- RF boards/filters or related components sensitive to the additional capacitance of conformal coating,
- spacers and fasteners,

- switches/relays and other unsealed components, and
- test points.

The key issue is recognizing what masking systems are best applicable to the component and its operational environment. Improper selection and use can lead to masking failures and compromised board function. Fortunately, techniques for masking assembly components have been developed and standardized over the years, permitting considerable consistency for masking success.

However, it remains essential to match the correct method/material mix to the specific masking job, to ensure coatings are kept out of designated areas, protecting reliable, longer-term assembly performance.

Matching Equipment with Material

Masking equipment is optimally effective when manufactured with materials appropriate to the masking task at hand. Common masking materials include:

- seldom recommended water soluble masks,
- latex peel-able masks, wherein ammonia emissions are a concern for the operator,
- hot-melt masks,

- frequently used paper, polyimide, or polyester masking tapes, and
- polymeric covers/plugs; typically quick and easy to use, they peel off accumulated coating after application.

Application of these materials must be monitored for various outputs occurring during manufacturing process, including:

- Electrostatic discharge (ESD), a buildup of static electricity, wherein the dielectric between differently-charged objects breaks down; visible sparks develop. For control, an ionized air blower is suggested for all masking and demasking procedures, to limit ESD generation.
- Fixturing, can also an issue that requires management.
- Residue from masking materials; development of undesirable residues can contribute to either coating dewetting during application or loss of coating adhesion during thermal cycling.
- Timing; improperly timed production/coating processes can generate demasking.

Several variables are involved in the masking process. Most prominent are the type of coating being applied, the PCB's surface geometry, the part to-be-masked, and overall production volume. Monitoring of masking processes should assess these outcome variables for various masking materials, tested in relation to masking processes/outcomes.

General Masking Requirements

Optimal management of the masking process identifies differences between conformal coating materials, before masking is initiated. Liquid conformal coatings – acrylic, epoxy, silicone and urethane – are applied by fluid methods, where the wet-coating substance is brushed, dipped or sprayed onto the substrate. Unless otherwise specified on the drawing or specification, what follows are general guidelines for applying the masking. Centering of the masking materials over the specified keep-out areas is essential, regardless of its size or location; masking should extend no more than 1/8 inch beyond its outer limits. As important, all component edges must be entirely masked; smooth seals throughout ensure the PCB's board and shell surfaces are completely encapsulated and tear-free. The objective is to remove any surface breaches, eliminating coating leakage into the component.

Because it is applied differently than liquid coatings, masking for parylene requires a separate approach. Parylene's chemical vapor deposition (CVD) uses gaseous, rather than liquid, application processes, a significantly more complicated technique necessitating specialized masking procedures. While coatings are uniform, pinhole free and durable, there is a need to mask more than just typical keep-out locations.

Ultraviolet curable masking compounds are increasingly common. Before use, the operator must determine if the selected compound will leave a harmful residue and is compatible with the proposed solvent system. Ion chromatography is helpful. Surface insulation resistance (SIR) testing checks the electrical resistance of an insulating material between a pair of contacts, conductors, or grounding devices. Determining a component's capacity for resisting current leakage or dendritic growth (electrical short) is also recommended.

Masking for conformal coating differs according to the type of assembly, the type of coating, and the materials comprising the masking appliance. Costly and time-consuming, a wide range of custom reusable boots, tapes and dots accommodate virtually any masking job. Explicit operator care is necessary to make appropriate materials' selections and assure processes are correctly implemented. A confirmed confluence between masking appliance and material type assures the optimal level of system performance.

Conformal Coating Masking Boots

Masking is necessary because conformal films like parylene and liquid coatings become insulative after drying, disturbing the performance of such critical components as connector contacts. Custom reusable boots – also called caps or plugs -- protect assembly parts in those keep-out areas that must not be coated. In comparison to masking materials like tapes and dots, boots are used for processes demanding an explicit volume of repeat-masking. Reusable boots are designed to quickly cover an entire region-to-be-masked, in a reliably efficient manner. Boots' return on investment (RoI) is typically achieved much faster, compared to tape and dots.

Different Types of Masking Boot Formats

Boots are typically categorized according to two types: A and C type Cups:

- A Cups are the simplest form, used to cover vertical connectors and components, including masking covers for both d-type and molex connectors.

- C Cups are more complex in design, providing masking for horizontal connectors, wrapping around the component from both sides of the assembly; they can be customized to accommodate complex or irregular surfaces and edges.
- Both A and C Cup boots provide reliable protection of any static-sensitive components they cover.
- These formats can be created in a wide range of custom sizes and shapes to accommodate most relevant masking and production requirements.

Boots are available in different sizes and colors; their precise composition varies according to the

- function, shape and size of the component, and
- application requirements of the coating material.

Silicone rubber and alternative low hardness elastomers are the most common boot materials, due to their resilience when in use and increased sealing properties. ESD-safe masking boots are always available, although their cost is generally higher.

Advantages of Masking Boots: Their Diversity and Versatility

Conformal coating masking boots fasten over such assembly components as connectors, header pins, plugs and sockets. Boots provide dependable security from the incursion of applied conformal coating, prohibiting coating seepage onto the component, which could disrupt its function. Well designed and applied boots can be used with most conformal coating materials. including wet substances like acrylic, epoxy, silicone, and urethane, and CVD parylene.

While the effectiveness of other masking solutions – liquid latex, tapes and dots – is undeniable for many purposes, their application can be costly, labor-intensive and time-consuming, extending production schedules while limiting RoI. In comparison, boots generate a labor-saving alternative for both masking components prior to conformal film application and demasking, once coatings have dried.

Properly applied, masking boots typically save as much as 75% of operating costs, compared to tape and dots, because of the reduction in both masking and demasking time/labor. In addition, boots don't leak as frequently as tapes or dots can, eliminating the need for masking (and coating) re-work.

Although there is an initial expense of constructing custom-made boots, its cost is quickly recovered by continual reuse; there is no need to constantly purchase new materials, as is the case with tapes and dots. These conditions remain true even for small volumes of repeat processing, saving you time and money in comparison to hand-masking. Appropriately constructed and maintained, masking boots can be reused as many as 200(+) times, and are applicable to both parylene and liquid conformal coating processes.

However, although safely used for parylene CVD and liquid spray applications, boot masking is not recommended for dip applications. The boot resting atop the keep-out area does not form an adequate seal during dipping; conformal coating may seep under the boot, corrupting the contacts or related components. This disadvantage is minimal compared to boots' cost-effectiveness and rapid production capacities for other coating application methods.

Covering whole areas of an assembly rapidly and effectively, boots are very adaptable, providing component protection during dipping, spraying, CVD and wave-soldering of the printed circuit board. Much of their functional versatility stems from the variety of boot types available for masking purposes.

Selecting Conformal Coating Masking Boots

The precise typology of masking boots is complicated by the ongoing development of PCBs and related electrical assemblies. Their ever-changing configurations and increasing sophistication demand a similar evolution in boots, to accommodate changes in the physical topography of the boards and their sensitive components.

For instance, header pin masking boots come in standardized or custom configurations and sizes, varying in such component categories as:

- the diameter, depth, height, pitch, width of the boot hole,
- the number of holes/strip, and
- whether the component is single- or double-rowed.

Similarly, such items as D Sub boots, Mag A or B boots, rectangular boots, slotted strips, custom edge strips and plugs are available in standardized sizes or can be customized, varying according to such component-specific factors as its size and shape or the number of holes/strip, as well as in differences in external and internal length.

As a simple spray shield for liquid conformal coatings, a boot can be used multiple times. The same is true for molex boots when applied for spray-shielding purposes, but over time these boots may begin to deteriorate after multiple liquid dipping or parylene CVD uses, potentially allowing coating-seepage into the component. Then boots need to be replaced.

Ultimately, boot design and type is a function of:

- the size/shape of the component being masked,
- its location on the PCB assembly,
- the kind of conformal coating covering the assembly, and
- its application methodology.

These factors largely determine its ultimate type, whether standard or customized.

Tapes or Boots(?): Making the Right Choice

Masking tapes and boots both protect components for a selected range of masking functions. Choosing between the two is crucial to achieving optimal masking protection. Conductivity needs to be maintained in all cases. In addition, such operational factors as the:

- assembly's production volume,
- surface geometry of the component/assembly, and
- type of coating applied to the assembly substrate
- influence whether tape or boot masking material is the best choice.

Masking Tapes

Masking tapes, and smaller dots, represent a highly accepted and standardized method of masking, successfully used from the outset of conformal coating processing. Since their hand-application is labor intensive and time consuming, they are mostly used for masking low volumes of assembly components. Tapes are also very efficient protecting such flat assembly areas as the edges of PCBs or conductive pads. Their counterpart, masking dots, are optimally used to safeguard smaller, specified keep-out sites like mounting holes. Tapes and dots are available in different colors, sizes, levels of adhesion and material type, expanding their range of application. As with all masking, the key is to choose the right tape or dot for the assembly and its coating process

There are, however, some problems masking conformal coating with adhesive tapes; these issues include:

- Adverse reactions between the tape and conformal coating can generate de-wetting effects on the PCB. Assuring compatibility with such conformal film materials as solvent-based acrylic, silicone and polyurethane safeguards the tape from responding unfavorably to the solvents.
- Conformal coating can seep under the tape because of bleeding/leaking during film application, if masking is poorly implemented. Consequent failure to stop the coating penetration into keep-out areas may necessitate such costly, time-consuming repairs as fixing the leak, removing the conformal coating from the

assembly, replacing the improperly masked component, or scrapping the entire assembly.

- Difficult removal during de-masking can leave adhesive residues that require additional labor (cost/time) to be removed, potentially leading to longer-term performance issues.
- Unwrapping occurs when the mask does not remain sealed during processing, so the tape cannot adequately protect the assembly from intrusion by the coating.

Masking Boots

In comparison, recyclable masking boots provide a cost-effective and labor-saving option to taping processes. They are far more efficient for large-batch component masking, and can be custom-made to accommodate an exceptional range of component alternatives. In this respect, boots are advantageous for assignments requiring repeat masking of high volume production, effectively covering entire components in some cases. After the initial expense, boots' RoI easily surpasses hand-masked tapes.

Unlike tapes, masking boots generate dependable defense for a wide range of assembly components for ALL conformal coating types and application techniques. Included processes are:

- batch/selective robotic spraying of PCBs and related assemblies,
- dipping processes, either horizontal or vertical, and
- parylene CVD.

To add to their versatility, boots can be custom-made to clients' precise assembly/component specifications. Utilization is simple, with boots being fastened over the selected components (connectors, plugs, sockets, etc.) needing protection from conformal coating application.

Correctly choosing between masking tapes and boots is critical to implementing efficient conformal coating procedures. Failure to do so often leaves electrical components exposed to conformal coating, a development that can lead to component dysfunction. In general, tapes are most effective for flatter surfaces and smaller production runs. Reusable masking boots are a more efficient and cost-effective option for masking larger production volumes, better adapted to a wide range of component shapes and sizes.

Parylene Masking: Materials and Methods

Parylene deposition takes place at the molecular level. Applied at room temperature through CVD processing, the typical thickness of parylene conformal film is in the microns-range.

Advantages of parylene coatings include:

- Excellent material properties, adhering to a wide range of substrate surfaces, biocompatibility, chemical/corrosion resistance, reliable dielectric performance and thermal stability.
- Uniform, pinhole free coverage of all surfaces regardless of position or place on the assembly (component sides, lead surfaces).
- No harmful vapors during processing.

Despite its benefits, parylene has several major disadvantages. Among these are:

- Limited, batch-mode production volume.
- Expensive processing equipment/materials.

- Difficulty reworking ineffective coating.

A further disadvantage is the need for costly, time-consuming masking of selected assembly components. The parylene masking process is necessary to protect designated areas of an assembly that could impede performance if coated.

Masking

Masking assures selected assembly components are NOT covered by the applied parylene film, which would inhibit their functionality. Integral to surface preparation, the masking process protects designated assembly components from the encapsulating effects of the parylene itself, which would suspend their operational capacities.

For instance, parylene's excellent dielectric properties simultaneously disable a PCB's contacts, rendering the unit inoperable, even as the substrate is protected from electrical interference. Masking contacts resolves this issue, coating only those PCB parts that aren't distressed by conformal protection. Components retain their capacity to accept an electrical charge and/or move as designed.

Masking Materials

Masking requires different materials such as peel-able masking dots, tapes/contact pads, boots and either non-ammoniated or water-soluble liquid latex. It is important to recognize:

- the properties of the various materials,
- how they are used in parylene processing separately or in combination,
- to ensure that masking failures do not occur.

Parylene masking dots and tapes generally use polyester or polyimide backings. In the vast majority of cases (90%+), properties like conformability and cost-effectiveness are as necessary to the masking process as strength and stability.

Essentially, masking dots are small stickers fastened over the contact before coating is initiated.

For masking tapes and contact pads, there are two widely used solutions:

- Polyester or Kapton tape
- Liquid peel-able latex masking materials effectively prevent coating ingress into the component; they peel easily from contacts after coating

Unless a popular part like a Molex connector is being used, masking boots are typically custom-made, specific to the physical configuration of the component to-be-covered. Recyclable, boots' capacity for repeat processing is a labor-saving initiative that also generates considerable cost-effectiveness during re-use, recouping the initial investment in short order.

Masking Methods

Generally, the most labor intensive part of the coating process, masking is done in accordance with the customer's drawings and requests for coating keep-out areas. Because CVD causes parylene molecules:

- to penetrate any surface area accessible to air,
- considerable attention to adequately sealing every connector is mandatory
- to assure all coating keep-out areas will resist and reject the parylene film application.

Basic to the process is accurately identifying those sections of the assembly NOT to be covered during CVD. A general methodological outline includes these steps:

- Sizing boots, tapes and dots to the precise configurations of the masked regions.
- Preparing parylene masking materials per instructions.
- Applying materials to selected areas, effectively covering contact points that need to remain uncovered during the assembly's operation.
- Allowing peel-able masking compounds to fully dry, before commencing parylene CVD.
- Applying the parylene, coating the entire substrate.
- Due to masking, the parylene covers the masking materials, rather than the contacts or other protected areas of the substrate surface.
- After Parylene application, the masking is carefully peeled or otherwise removed.
- The peel-able mask is subsequently removed, as soon as possible after the parylene has dried, to prevent tearing the film, exposing the contacts or other masked regions.

These processes are exceptionally labor-intensive and can be costly. Nevertheless, they are essential to parylene film administration. Touching up the periphery of the masked region with a small quantity of urethane after removing the masked materials lessens the threat of tears.

For most applications, use of conventional masking materials and techniques obstructs parylene deposition on designated PCB keep-out regions. However, masking for MEMS/nano medical devices is more challenging. Laser ablation provides better options for these more difficult applications, enhancing adaptability to assembly's alternate geometries, while providing greater precision during mask application.

Masked regions are protected from coating, assuring they function as designed to generate appropriate assembly performance. Masking materials must thoroughly shelter the keep-out regions, without gaps, crevices or similar surface breaches, to provide reliable connector function after coating. Effective masking of each PCB connector demands concerted operator attention, to appropriately seal it from contact with gaseous parylene molecules during CVD. Masking preserves an assembly's operational integrity and performance.

A Final Word

Integral to a complete masking solution for PCB conformal coating, masking boots protect selected components located in keep-out areas, to assure they remain operative after coating. Reusable boots provide a strong, cost-effective alternative to such materials as masking tape and dots. Masking boots can be custom configured into all forms, shapes and sizes to protect an extreme variety of assembly components from coverage for most conformal coating application techniques.

Diamond-MT has been providing conformal coating services to the aerospace, defense, electronics, life sciences, and MEMS/nano markets since 2001. In addition, we provide both standard and custom boot solutions for customers who perform conformal coating in-house, designed to their explicit masking needs. We recognize customers experience significant cost savings utilizing masking boots, instead of relying on manual labor to apply dots and tape, and are glad to help you lower your final in-house coating costs.

As such, Diamond offers a wide range of in stock custom boots and designs; we can also manufacture boots to your specific needs, including stand-offs and header pins. We can quickly match these to your needs or help develop a custom solution through our design services, to ensure you get the required protection from your conformal coating process. Our masking boots can be used with acrylic, epoxy, silicone and urethane under brush or spray conditions, or with parylene conformal coatings for CVD application with no compatibility issues.

Contact Diamond MT for Unsurpassed Masking Boot Solutions

Diamond MT is well positioned to offer clients either standardized or custom-designed masking boots, or both, if the customer solution requires such masking diversity. We can develop customized solutions according to your precise specifications. In either case, you'll be assured the necessary degree of component protection for all your in-house conformal coating processes.

About Diamond MT

DIAMOND-MT

Diamond MT was founded in 2001 as a firm specializing in contract applications of conformal coatings for Department of Defense and Commercial Electronic Systems. Since our beginning, Diamond MT has established a reputation for providing the highest quality services in the industry. Our commitment to quality, integrity, and customer satisfaction combined with an unmatched expertise in applications and processes has provided every one of our customers with superior results.

Diamond MT operates out of a freestanding 12,000 square foot building in Johnstown, Pennsylvania, which is located 60 miles southeast of Pittsburgh. Diamond MT is located near three major interstates and is supported by the Cambria County Airport, which serves as a primary freight terminal for south central Pennsylvania. Diamond MT maintains a strict program per NSI ANSI Standard 20.20 for ESD protection. All work areas are safeguarded with the latest in protection devices including wrist straps, garments, and workstations.

Quality Assurance: Diamond MT's quality manual ensures every employee is focused on continuous improvement and service excellence. Our ESD safe facilities stretch over 12,000 square feet dedicated to your conformal coating requirements. We are continually researching and updating our equipment to make sure we are providing the best ESD protection available.

All employees have been trained in proper ESD procedures. We operate at a class 3 level to ensure the job is done right the first time and to the highest quality standards set forth in accordance with the MIL-STDs, IPC, J-STDs as well as having our biomedical and ITAR certification. Furthermore, all assemblies are tracked through every step of the process with documentation/serialization spreadsheets as well as each assembly going through a 100% visual inspection.

Diamond MT has a strong organization consisting of highly motivated personnel, modern facilities, and diverse capabilities. Diamond MT represents one of the most modern, well-equipped facilities in the region. Diamond MT offers a highly skilled workforce, rapid turnaround manufacturing and high reliability through an established quality program, along with experience of commercial manufacturing requirements, competitive pricing and on-time delivery.

Rapid Turnaround: Diamond MT understands that oftentimes conformal coating is overlooked because it's the last step in the process. We are committed to serving the industry with rapid turn times for parylene, (normally 10 business days) with expedited service in as little as 2-5 business days depending upon the complexity and quantity.

For liquid coatings, our normal turnaround time is five business days; again with expedited service in as little as 2-3 business day turns. We understand that there are times you'll need a project completed FASTER. We will accommodate your needs in a budget friendly manner. This service is offered on a FIFO basis.

To learn more about Diamond MT, please contact us today!

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