



Plasma Ruggedized Solutions

***USING CONFORMAL COATINGS IN
DESIGN FOR
RUGGEDIZATION***

Protecting Your Investment

By the time you reach the conformal coating process stage, you have invested a lot of time and money into your product. It is critical that you find a reliable way to protect your investment and insure confidence that you will be delivering to your highest performance standards.

New technologies are making a tremendous impact on conformal coating operations. Design for manufacturing and assembly plays an important role in conformal coating's reliability, as well as the input from the manufacturers of the many different types of components and materials used to create the product. Conformal coating decisions must be made at the design level.

The purpose of the coatings is to act as an electrical and environmental insulating barrier for the electronics. There are five types of conformal coatings. Acrylics, Silicones, Polyurethanes and Epoxies are liquid coatings that are sprayed, dipped or selectively applied. They may be applied through automation, semi-automation or a controlled manual process. Parylene is a vacuum deposited material. References are found in Mil-I-46058 Material Specifications, as well as IPC-CC-830 Qualification and Performance of Electrical Insulating Compound for Printed Board Assemblies.

Our objective is to help you identify the issues regarding coating compatibilities or incompatibilities. The main areas of concern are: Masking, Adhesion, Coverage, Curing and Reworkability.

MASKING

Whether a manual, semi-automatic or fully automatic process is to be used, try to minimize the areas that are to remain coating free. Components such as connectors, sockets, switches, heatsinks, testpoints, ground planes, hardware or any point where coating may interfere with the functionality of the board are typical "masked" areas.

Spacing between components can limit masking and coating capabilities. Masking must insure that no coating wicks up onto components, while allowing as much exposed conductors to be coated as possible for maximum coverage of assembly.

Whenever possible, test points that need to be used after coating should be in rows, rather than scattered throughout the board. Not all coating material can be probed through and the test points may require masking. Components such as simple block or cylinder shapes are easier to mask, resulting in lower labor costs.

Components requiring mask should not have "hard to seal" properties, such as many terminal blocks and right angle connectors or surface mount camlok connectors. Use hermetically sealed components whenever the option is available.

Component selection must also be reviewed for material compatibility. If using solvent based coatings, be aware that solvents can dissolve or partially dissolve components, as well as labels used to mark boards or components.

ADHESION/COVERAGE

The level of adhesion between conformal coatings and substrates varies greatly. Today's soldermasks, new flux chemistries, soldering processes and alternative cleaning methods have greatly complicated the path toward compatibility.

From the base material of the board you may see such issues as exposed laminate after soldermask application. Soldermask artwork which exposes solder attachment points, groundshield areas or exposed laminate creates areas on the board where coating can break or fracture if not compatible. The most important aspect of the soldermask is the degree of cure. If not cured completely or improperly applied, the soldermask can actually contaminate an otherwise good process. Leaching contaminates into your process can ultimately effect the wetting characteristics and adhesion of the conformal coating, creating long term problems including premature corrosion and coating defects.

There are four main soldermask types: Thermal Cure Epoxy, UV Curable, Dry Film and Liquid Photo Imagible. Compatibility issues will have to be reviewed from first articles or documented test results supplied by the material manufacturers.

Fluxes activate solder surfaces during the assembly process and will leave contaminates on the boards. It is extremely important that the assemblies be cleaned. Of the three types of fluxes, (water soluble, No Clean and Rosin) water soluble seems to be the most forgiving, presenting very few problems. Most water soluble clean lines should produce an adequately clean surface for coating. All No Clean fluxes leave a residue. The type and amount of residue remaining can affect the adhesion of the conformal coatings. The coating may not show a reaction to the No Clean flux at the time of application, however entrapment of the ionic and corrosive species may cause a variety of problems over time. No Clean flux cleaners have been used with some success, but these can present additional issues that may result in more serious problems if not "tested-out" first.. Rosin flux is difficult to clean and EPA requirements have forced the discontinuing use of many of the chemicals previously used.

One option for testing cleanliness, although limited, is ionic testing. Ionic testing will pick up conductive contaminant such as : sodium, tin, lead, copper, etc. It will not detect organic- non conductive contaminants (i.e. oils, grease, fingerprints, etc.) or non-chloride contaminants, which can have an effect on coating adhesion.

Another solution may be plasma cleaning and/or etching, which can be used to promote adhesion as well. Under vacuum, gases are delivered into a chamber. When pressures have stabilized, RF energy is applied to electrodes. Gas passing through the electrodes will ionize. There are several types of gases used for this process. Oxygen is the most effective gas to use for general cleaning, wetting or decarbonization. If etching is required to alter the surface topography, a more aggressive gas will be introduced, normally a CF4 or Halocarbon 14 in small concentrations such as 5-10%. The effects on the parts will vary based on pressure, power and type of gas or gases used. The amount of RF frequency should be carefully considered. Two common types are 13.56 MHz or 40khz. The lower the frequency, the safer for the PWA. The higher frequency has difficulty adjusting itself if an impedance mismatch occurs and can damage assemblies very easily and very quickly. Low frequency will automatically shut down and will not destroy the parts. Plasma will only clean or etch organic materials, it will not attack metals.

CURING

Curing methods includes air, UV, thermal and moisture-laden atmospheres. Time required will vary between coating types and methods applied. When evaluating material specification cure schedules, you may find information regarding tack free, recommended curing conditions and time required to reach optimum properties. It is important to have a clear understanding of the differences. If using ultra violet curable materials, you may need to select a material that has a secondary cure mechanism for areas under components that are not irradiated by UV exposure. Solvent or solvent free materials requiring UV or thermal curing can be affected by temperature during cure process. Maximum temperature during UV curing should not exceed 100' C. If thermal curing is used, the boards may require several hours of air cure for outgassing, depending on the material, before being placed in an oven. On first articles, the material will have to be cured to full properties before subjecting the assembly to any type of environmental or thermal cycling tests. Testing of conformal coating in the premature stage of cure may result in a failed test or provide misleading results.

Inspection requirements are currently found in IPC-A-610 for commercial applications and MIL-I-46058C for military applications. These requirements should be reviewed by the Quality Assurance personnel at both the end user and the conformal coating contractor to highlight any gray areas.

REWORKABILITY

It is important to establish a rework procedure for coating removal. Removal procedures must be carefully considered during the coating selection process. One of the most common myths is that you cannot rework conformal coating. Not true, however there may be some limitations, and having an understanding of those limitations will allow the product to be reworked properly. Typical methods of removing a coating range from the use of solvents, micro-abrasives, excimer lasers and oxygen/argon plasmas, as well as soldering right through the material. Testing should be performed on a first article sample to determine most effective and economical process for the particular assembly. Whichever method proves to be the most effective, without damage to the assembly, will dictate the rework process.

SUMMARY

Conformal Coating application is a cost-effective way of increasing reliability and longevity to a printed circuit board assembly. Tighter lead spacing and increased component density have increased the use of conformal coating simply because of arcing and current leakage in higher humidity environments. Providing that logical choices are made in the selection process, it can be a simple solution to a variety of performance problems related to end use or miniaturization to the design. Design for manufacturing and assembly guidelines should be followed at the design level.

CONCLUSION

Compatibility factors will continue to emerge as new products and processes are developed to address environmental concerns. Responsibility for compatibility assessment is shifting to material suppliers, so choosing a conformal coating product should incorporate a high level of process, analytical and technical background information. It is also critical that a “partnership” approach between the contractor/end user/end material supplier be exercised to support and correct technical issues and questions that will arise in the application of the coating. The importance of performing compatibility testing of chosen conformal coating to every other individual process step and material the coating will cover, cannot be overstressed.

References

- 1. Ritchie, B. “In Flux: Conformal Coatings”, Circuit Assembly, Jan. 1993***
- 2. Markstein, H. “Coatings Conform To New Regulations”, Electronic Packaging & Production, Feb. 1995***
- 3. DeBiase, J., LaCroze, S., Lancelot, R. “Compatibility of PWB Coatings with Assembly Processes and Materials”, Electronic Packaging & Production, Feb. 1995***
- 4. Ritchie, B. “Adhesives in Electronics 96”, Second International Conference on Adhesive Joining and Coating Technology In Electronics Manufacturing”, Stockholm, Sweden, June 1996***
- 5. Crum, S. “Solvent-Free Conformal Coating Impact Application Techniques”, Electronic Packaging & Production, June 1997***
- 6. Tautscher, C. “A Focus on Conformal Coating”, Circuit Assembly, May 1997***