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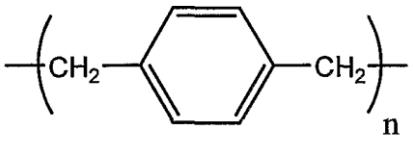
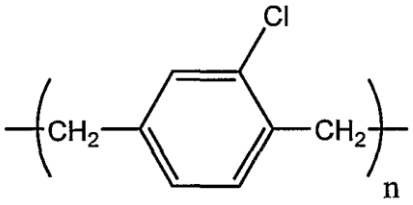
Parylene: The Truly Conformal Thin Film Coating

Parylene is the trade name for para-xylylene which is benzene ring with two para-substituted CH_2 groups (positioned on opposite sides of the aromatic ring). There are many variants of Parylene, three most common variants are Parylene-N, Parylene-C, and Parylene-D. Parylene-N is comprised of only carbons and hydrogens. Parylene-C adds a chlorine group to its benzene ring. Parylene-D adds two chlorine groups to its benzene ring which are also para-substituted. Parylene-C is the most versatile, cost effective, and utilized across all industries.

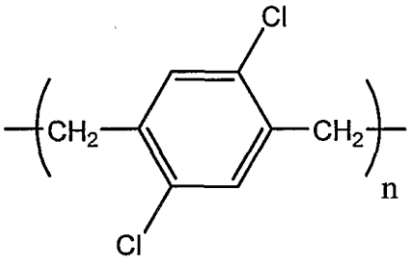
Parylene-N



Parylene-C



Parylene-D



Advantages of Parylene

Parylene is an outstanding material because of its unrivaled chemical resistance, dielectric characteristics, and moisture barrier properties. It is chemically resistant to virtually all solvents and room temperature corrosive acids. The dielectric strength of traditional conformal coatings (acrylics, epoxies, urethanes, and silicones) can range from 500 volts per mil to 1000 volts per mil, whereas Parylene can exceed 6000 volts per mil. Moisture absorption is less than 0.1% after 24 hours.

Chemical Vapor Deposition

Parylene is applied via chemical vapor deposition in a slow and controlled process. As a vapor process, it will deposit on every exposed surface and crevasse whether it is desired or not. That is where precision masking is needed. Another benefit of Parylene being truly conformal is that there is no loss in material thickness at edges of components that would normally be an issue with wet coatings. Product that is sensitive to heat will have no issue with Parylene's CVD process because the chamber where deposition occurs is done at 25°C.

Solving the issue with Parylene: Adhesion and Reworkability

Parylene's adhesion to substrates is one of its few weak points, it is mechanically bonded with a substrate rather than chemically bonded. In electronics, Parylene is conformally coated over organic (i.e. solder mask) and inorganic (i.e. metals) areas of the board. Since adhesion can be a high-risk factor, PRS has two

methodologies to improve Parylene adhesion to various types of substrates. To promote adhesion to organic substrates, a surface treatment of plasma is utilized to alter the topography of the substrate and allow for better mechanical adhesion. Mixtures of oxygen, nitrogen, argon, helium, and tetrafluoromethane gases are used depending on the level of adhesion promotion required and what elemental constituents are on the PCB. Organosilane coupling agents are used to promote adhesion to inorganic substrates on the PCB. The coupling agent can be applied via vapor phase or wet chemistry.

As a truly conformal coating, Parylene's ability to deposit everywhere is a blessing and a curse. Historically when Parylene leaks into keep out areas and inside of connectors, the entire printed circuit board is thrown out and taken as a loss. There are two ways to remove Parylene, soaking the board in boiling corrosive acid or subjecting the item to temperatures exceeding 400°C. However, PRS has developed micro-abrasion techniques that can completely remove unwanted Parylene without causing any damage to the printed circuit board or whatever product is being coated. Since most customers decide to go with Parylene for the need of a thin film, putting the unit back in the chamber for another full coating for rework will defeat the purpose. When rework is desired a compatible urethane material is used to ensure there are no pathways for the delamination.

Layered Approach

Of all the great properties Parylene has, abrasion resistance is not one of them. The biggest risk to satellite components coated with Parylene is not the hostile environment of space, but rather the operator handling of putting electronics in the satellite. To protect Parylene from an environment where abrasive contact is inevitable, it is advisable to use a layered approach and conformally coat the Parylene with urethane. The urethane has enough resilience that it will protect the Parylene so that it can perform to its desired properties.

Conclusion

Parylene has been around for decades but its capabilities to solve issues throughout all industries is not yet widely known. Parylene can provide the best dielectric insulating properties, moisture barrier, and chemical resistance a thin film can offer. With the world's electronics use growing exponentially, Parylene can offer piece of mind in any application.