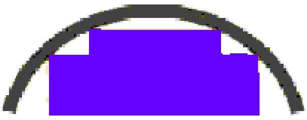
Parylene: what is it?

Parylene is a protective polymer material, which is transparent and colourless. It is a MIL-I-46058C and UL approved conformal coating listed as Type XY.

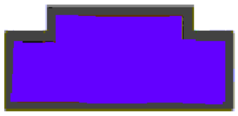
Parylene is applied by a vacuum process at room temperature and, in some respects, resembles vacuum metalising.

Vacuum metallization is conducted at pressure of 10^{-5} torr or below

Parylene is formed at around 0.1 torr.



Normal Coating



Parylene Coating

As it is not "line-of-sight" as in vacuum metallizing, the vapour coats evenly - over the edges, points and internal areas.

Types of Conformal Coating

Conformal coating alternatives are typically applied using a dipping or spraying method.

Dipping

- Creates uneven coating thickness during curing
- Traps air bubbles

Spraying

- Shadow masking
- Cannot achieve complete coating coverage in hidden areas

Both the above coating methods are applied in a liquid form that will follow gravity and expose sharp areas and edges.

Why use Conformal Coating?

Conformal coating is a protective dielectric coating that offers:

☑ **Protection**: circuitry shielded from moisture, fungi, dust and corrosion caused by extreme environments

☑ **Performance enhancement**: allows greater component density due to increased dielectric strength between conductors

☑ **Board handling damage prevention**: reduces mechanical stress on components and protects from thermal shock

The 5 types of Conformal Coating

Acrylic (Type AR) Epoxy (Type ER) Silicone (Type SR)
Parylene (Type XY) Polyurethane (Type UR)

Disadvantages of Other Conformal Coatings

Acrylics (Type AR)

- ✘ Are solvent sensitive even to alcohol
- ✘ Waterborne acrylics are difficult to repair

Epoxy (Type ER)

- ✘ Difficult, or impossible to remove as epoxy is a two components compound.
- ✘ Coating shrinks during curing, leaving hard, difficult to repair film
- ✘ Epoxy strippers will attack the printed circuit board assembly.
- ✘ May stress components

Silicone (Type SR)

- ✘ Trapped air bubbles
- ✘ Adhesion properties of silicone coatings
- ✘ Difficult to repair, possibility of trapped residue from the coating stripper beneath the recoated area

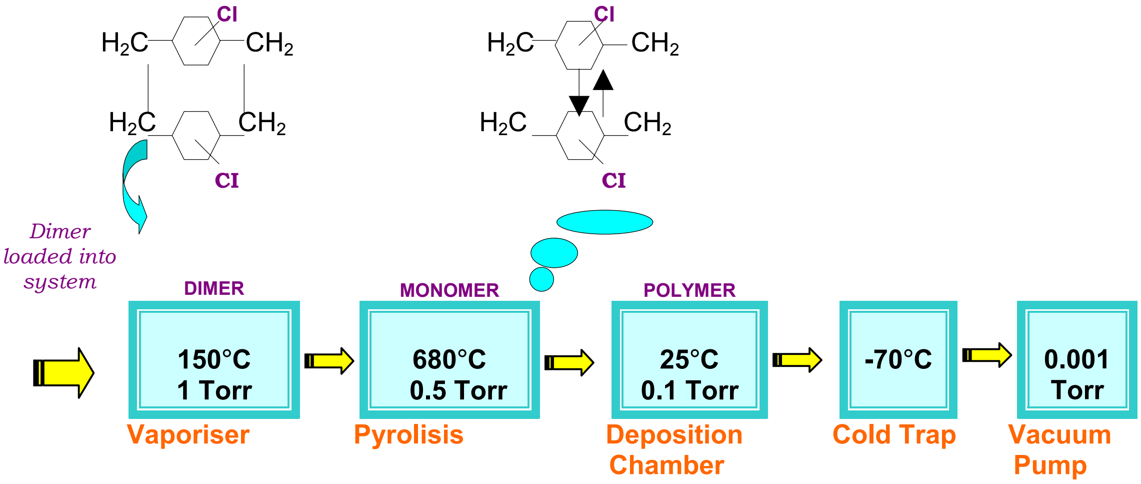
Polyurethane (Type UR)

- ✘ Require precise application techniques, and a tightly controlled curing environment
- ✘ A thick application of polyurethane coating will crack
- ✘ Poor wetting characteristics, and will trap air bubbles

Additional weaknesses on the above 4 types of coatings are:

- ✘ Special handling requirement and lengthy cure times dramatically increase production cycle time and production cost
- ✘ Shelf life and pot life are very limited, resulting in substantial material waste
- ✘ Health, Safety and environmental hazard concerns – increase the production cost

Parylene Coating Process



Process Flow of Parylene Coating

The Parylene process involves several aspects as shown in the diagram above.

After proper cleaning, activation and masking, the product is placed in the deposition chamber. A standard masking technique is used to keep the coating off the areas where it is not desired.

As the whole process is done in an enclosed chamber, it will not damage sensitive electronic components and, as the parylene polymers are deposited in a gas phase in a vacuum, the coating is completely uniform.

DIMER (di-para-xylene) is the chemical precursor used in the parylene polymer deposition process. This stable, granular white powder is available in three forms: N, C and D, each of which has its own properties and application advantages.

The dimer is heated to approximately 150°C, resulting in conversion to a gaseous monomer. This allows the parylene to penetrate and coat the parts that are unreachable by liquid coating. Coating thickness and uniformity are both controlled by the amount and the purity of the dimer used.

Benefits of Parylene Coating

High Reliability

Since parylene is non-liquid, it does not pool, bridge or exhibit meniscus properties during application. The whole process is done in an enclosed chamber, thus it will not damage sensitive electronic components.

The vacuum process removes moisture and impurities before deposition of parylene coating thereby ensuring it will not introduce any foreign substances to contaminate the coated specimens/products.

The dimer is over 99% pure, resulting in more truly conformal coating. It has less product failure, and provides better protection for the substrate

Uniformity

Parylene is a uniform polymer film, which is pinhole free and extremely thin. It provides complete and even thickness coverage on all hidden or exposed surfaces.

Repair Option

Parylene coated electronics are capable of being repaired. The removed parylene areas can be recoated to their original tolerances by reapplying the parylene.

Economical and Clean

The coating thickness can be controlled from 1 to 100 microns in a single operation, and many parts can be coated simultaneously, making the process extremely practical as well as economically attractive.

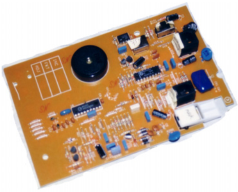
Hazardous waste is an added cost to the business and environment. Parylene coating eliminates the high costs of toxic waste disposal and Occupational Heath and Safety Management problems.

Low Stress Process

The entire process is accomplished at room temperature, thus stresses that might be induced by differential thermal expansion between the temperature of cure and room temperature are avoided. Any object that can be exposed to medium vacuum can be parylene coated.

Parylene Applications

Electronic and Circuit Board Coatings

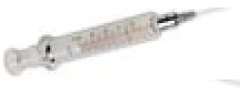


Strong, stable and secure, Parylene is a pure maximum barrier protection and total surface conformity solution. Parylene provides dielectric protection for resistors, thermocouples and other components. Fully coats fine lead wires and ends.

Parylene is used on electronics ranging from advanced military and aerospace electronics to general-purpose industrial products. (Military and aerospace organisations often use Parylene due to its reduced mass, weight and cost.

Reliable application to circuit board assemblies. Qualified under Mil-I-46058C Type XY, it will not alter resistor functions, thermocouples or other components.

Medical Devices



Parylene coating provides a non-reactive, inert, pinhole-free barriers, it is perfect for use on biomedical instrumentation, ranging from silicone tubes to advanced coronary stents.

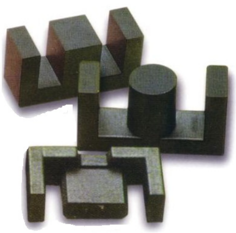
Its strength and purity allows for functional utilization with body implant devices.

Silicone Rubber Keypads

Improved chemical and moisture resistance

Increases the life of the pad printing

Magnets, Ferrite Cores and Bobbins

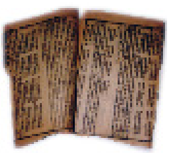


Thin and strong dielectric strength makes parylene useful for coating small ferrite cores used in modems, LAN and other telecommunication devices.

Ferrites are often tumble coated, thus parylene coating is often more economical.

Parylene provides a low friction interface, which speeds stringing and winding operations, while the smoothed rough edges prevent chipping and dusting.

Corrosion Resistant Coatings



Used to protect important papers and photographs

Parylene adds mechanical strength and prevent further degradation of documents

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Basic Specifications of Parylene Coating Machine

Vaporiser

Pyrolyser

Deposition chamber - connected by heated quartz tube

Heating Element (for vaporiser, pyrolyser and last post) 240Vac

Operating temperatures:

Vaporiser	**150°C**
Furnace	**700°C**
Post	**120°C**

Vacuum Chamber/ Deposition Chamber:
- **Stainless Steel 316L**
- **Buna O-ring seal**
- **Chamber mechanically polished**
- **Leak tested to 1×10^{-9} Torr**

Mechanical vacuum pump, two stage pump @ $46 m^3 \times h^{-1}$

Ultimate base pressure 5×10^{-2} Torr with oil mist filter

Shut off valve at every point of deposition chamber

Cold trap (easy clean design), cryogenic immersion chiller to a minimum temperature of –70°C

View ports on deposition chamber

Venting / purging line for nitrogen gas

Electrically controlled shut-off valve

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Specialist Application: Conservation

Important documents can be strengthened and prevented against further deterioration by Parylene coating