ADVANCED COATING

PARYLENE CONFORMAL COATING SPECIALIST

WHAT IS PARYLENE?

The Ultimate Conformal Coating Material

If your application requires electrical, biological or environmental protection, surface encapsulation or enhancement, Parylene can provide the critical properties and meet tight parameters that other coating options cannot.

Thin Parylene polymer film delivers a unique combination of electric-mechanical properties, is truly pinhole-free and conforms evenly to all surfaces due to the deposition method. The three-stage, stress-free vapor deposition process takes place under vacuum with substrates being coated at room temperature.

Parylene is certified to industry standards from military applications though medical implantable. Predetermined production steps provide high level of coating accuracy, consistency, and quality control, and Advanced Coating has decades of technical experience providing the highest level of Parylene conformal coatings, customer support and quality standards.

Types of Parylene

| **PARYLENE C** | This most common Parylene type is highly resistant to corrosive gasses, moisture, vapor and various chemicals and can protect products for upwards of 10 years in extreme environments. Useful properties make Type C suitable for most applications with its extremely low permeability and average crevice penetration activity. Type C deposits onto substrates faster than Parylene N.

| **PARYLENE D** | Parylene D provides reliable assembly protection at 100°C in oxygen-dominated areas. This type displays the greatest thermal stability compared to C and N, and it maintains physical strength and electrical properties at higher temperatures. Parylene D has the lowest crevice penetration activity.

| **PARYLENE N** | Parylene N has a melting point of 420°C (788°F), a unique vacuum stability, and has proven very usefulness in applications of high frequency. It is highly suitable for crevices and tricky topography. Type N has the highest dielectric strength, and the dielectric constant does not vary with changes in frequency. It is commonly used in high frequency applications as well as on elastomers/rubbers for added lubricity as it removes tackiness.

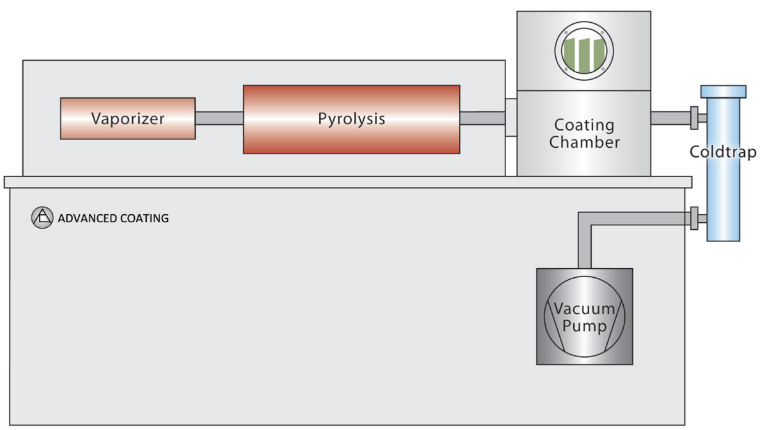
| **PARYLENE F** | Less common is Parylene F which has a fluoride atom added to benzene ring generating a polymer a low dielectric constant and great thermal stability. It also allows for a higher coating density when used in various applications. Parylene F exhibits resistance to high temperatures and ultraviolet (UV) radiation.

How is Parylene Applied?

Parylene is formed by the pyrolysis of a di-para-xylylene (dimer) in a controlled vacuum environment which is then deposited on a substrate at ambient temperature while under continuous vacuum. The vapor phase deposition of the Parylene polymer allows for a completely homogeneous coating formed as a structurally continuous film which is truly conformal to the design and structure of the substrate upon which it is being deposited.

The Parylene thickness is a function of the amount of vaporized dimer and chamber dwell time and can be controlled accurately to within +/- 5% of targeted thickness for most typical applications. It can be effectively and evenly deposited with excellent accuracy in thickness ranging from 0.2 µm (microns) to 0.25 mm (0.010").

Parylene can be used on a wide range of materials and is highly effective without adding weight or mass.



Vacuum Deposition Process

STAGE 1 | Vaporization

Solid state dimer (di-para-xylylene) raw material sublimates at 75-200°C variable into a gaseous state under constant vacuum.

STAGE 2 | Pyrolysis

Dimer is cleaved into a monomer (para-xylylene) in a furnace at 600-700°C constant temperature and becomes a vapor. The monomer gas is drawn through the system towards the cold trap (at -60°C or colder).

STAGE 3 | Substrate Coating

The monomer gas is introduced to an ambient temperature vacuum chamber, where cleaned and masked substrates are fixtured, and becomes a Polymer (poly-para-xylylene). Products being coated are protected from thermal stress and there are no mechanical or temperature stresses on fragile components.

PARYLENE PROPERTIES

Barrier Properties

Due to the physical properties of Parylene and the method of deposition, Parylene forms a pinhole free film on the subject substrate and provides an excellent barrier to both liquids and gasses. The table below lists barrier properties and typical values of Parylene C and Parylene N.

Moisture vapor permeability values have been measured at thicknesses below 0.1 micron. Normalized to equivalent thickness, the values are the same for all thicknesses.

POLYMER	GAS PERMEABILITY cm^3 - mil/100 in^2 - 24 hr - atm (23°C)				MOISTURE VAPOR TRANSMISSION g - mil/100 in^2 - 24 hr - 37°C - 90% RH
	N_2	O_2	CO_2	H_2S	
Parylene C	0.95	7.1	7.7	13	0.50
Parylene N	7.7	30	214	795	1.50

Optical Clarity

The transparency and clarity of Parylene film leaves surface features and printing clearly visible for easy quality assurance examination. This non-absorption of visible light also makes Parylene suitable for optical uses.

Parylene has a high degree of resistance to degradation by gamma rays in a vacuum. During testing, tensile and electrical properties were unchanged after 100 megarad dosage at a rate of 1.6 megarads per hour.

Thermal Properties

The unique structure of Parylene coatings grant them many useful properties, but the thermal properties are among the most efficient, simply because the ability to withstand temperature extremes is crucial in countless applications.

The coefficients of thermal expansion of Parylene are similar to epoxies, and Parylene is capable of withstanding exposure to cryogenic temperatures.

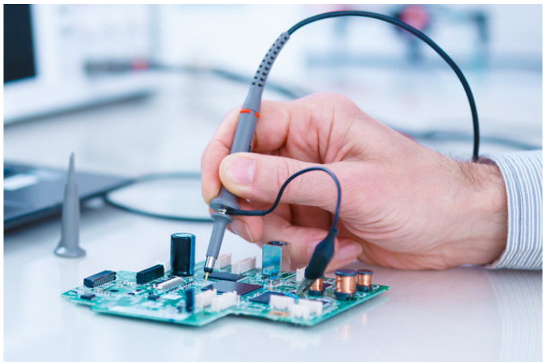
THERMAL PROPERTIES	PARYLENE C	PARYLENE N
Melting Point, °C	290	410
Linear Coefficient of Expansion, 10^{-5}/°C	3.5	6.9
Thermal Conductivity, 10^{-4} (cal/sec) / (cm^2 °C/cm)	2	3

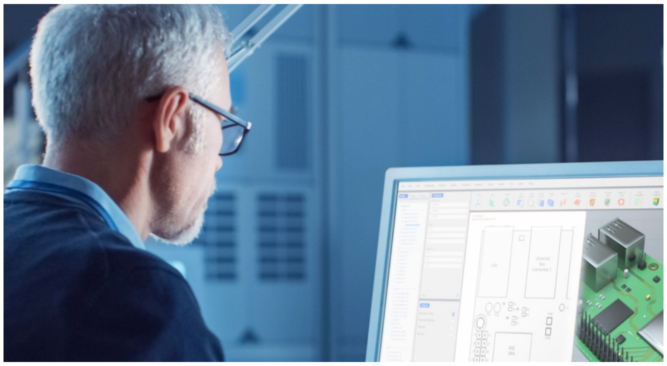
Electrical Properties

Parylene's superior electrical dielectric properties make it ideal for insulating electronic components with minimal dimensional change.

Dielectric strength of the polymer film is greater than 5,000 volts per mil of coating thickness.

ELECTRICAL PROPERTIES	PARYLENE C	PARYLENE N
Dielectric Strength, short time (Volts/mil at 1 mil)	5,600	7,000
Volume Resistivity, 23°C, 50% RH (Ohm-cm)	6 x 10^{16}	1 x 10^{17}
Surface Resistivity, 23°C, 50% RH (Ohms)	1 x 10^{15}	1 x 10^{15}
Dielectric Constant:		
60 Hz	3.15	2.65
1,000 Hz	3.10	2.65
1,000,000 Hz	2.95	2.65
Dissipation Factor:		
60 Hz	0.020	0.0002
1,000 Hz	0.019	0.0002
1,000,000 Hz	0.013	0.0006





Designing for Parylene

Protecting, encapsulating or enhancing substrate surfaces with Parylene is an integral part of the manufacturing process. It is important to take coating requirements into consideration in early stages of product development and to design for Parylene up front.

Advanced Coating offers Engineering Runs at a nominal fee to test the suitability of your unique product for vacuum deposition coating. Our experienced technicians can assist at the early stage of engineering design to ensure coating success at the production phase.

QPL Raw Materials

Parylene dimer, the raw form of the coating, varies in purity and performance from one manufacturer to another. The Qualified Product List ("QPL") certification program, monitored by the Defense Logistics Agency (DLA), assists engineers and manufacturers to analyze and qualify products and materials such as Parylene dimer to ensure that they conform to strict standards and meet the performance level of the most critical coating applications.

Advanced Coating offers QPL listed dimer raw materials along with optimal substrate cleaning, surface preparation and coating deposition procedures that meet the approval of required regulations.

In addition to premium QPL Parylene dimers, we offer low cost, commercial grade dimers as well as coatings for medical devices that are FDA listed in Drug Master File.

Physical & Mechanical Properties

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PROPERTIES		PARYLENE C	PARYLENE N
Tensile Strength, psi		10,000	6,500
Tensile Strength, MPa		69	45
Yield Strength, psi		8,000	6,300
Yield Strength, MPa		55	43
Tensile Modulus, MPa		3,200	2,400
Elongation to Break, %		200	40
Yield Elongation, %		2.9	2.5
Density, g/cm^3		1.289	1.100
Index of Refraction, n_D^{23}		1.639	1.661
Water Absorption (24 hr), %		0.06	0.01
Coefficient of Friction:	Static	0.29	0.25
	Dynamic	0.29	0.25

Parylene is unmatched when it comes to tensile strength, yield strength and elongation, coefficient of friction and hardness.

Questions about Parylene D or Parylene F Properties?

Call our team for more information and to discuss your specific coating application.

Elastomeric Applications

Advanced Coating Parylene coatings are micro-thin, transparent, and flexible with characteristics that enhance the performance of rubber and elastomer components by protecting surfaces and modifying surface properties. These improvements are made without degrading the functional performance of the part.

The thin film's elasticity and surface adhesion integrity enable elongation of the underlying elastomer without fracture or loss of the bond between the film and the substrate. Parylene film has low static and dynamic coefficients of friction which can be valuable for some applications where stickiness is an issue.

Industry & Quality Standards

Advanced Coating materials, workmanship, and processes comply with the most stringent industry and quality requirements. You can find a detailed and updated list on our website.

- ISO 9001/AS9100 Certified
- FAR/DFAR
- ITAR Registered
- QPL Materials
- IPC Standards for Electronic Materials
- REACH and RoHS Compliant
- NASA Standards
- MIL Spec Legacy Work
- FDA Drug Master Files & USP Class VI

Partner with Advanced Coating

Our team is ready to assist with all aspects of the Parylene coating process including material selection, design recommendations and high-tech coating solutions. We lead you every step of the way as an integral part of your supply chain. Contact our specialists to discuss your next coating project.

GREEN TECHNOLOGY

Parylene is safer for the environment than liquid coatings that often contain high VOCs.

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