VSi PARYLENE

UNDERSTANDING PARYLENE

HOW PARYLENE FITS INTO YOUR PRODUCTION

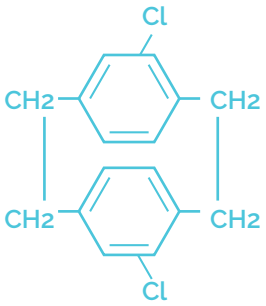
- The Parylene Deposition Process
- Balancing The Benefits
- The Three Parylene Types
- Understanding Cost Drivers
- The Parylene Development Path

THE PARYLENE DEPOSITION PROCESS

I. SUBLIMATION

DIMER | 150°C

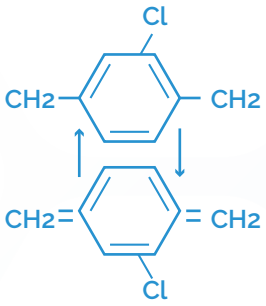
Dimer, parylene's powdery raw material, is added to the machine and heated to 150 C, changing its state into dimer gas.



II. PYROLYSIS

MONOMER | 690°C

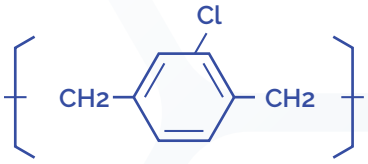
Next, the dimer gas is heated to 690 C. This changes the molecular structure of dimer to a monomer.

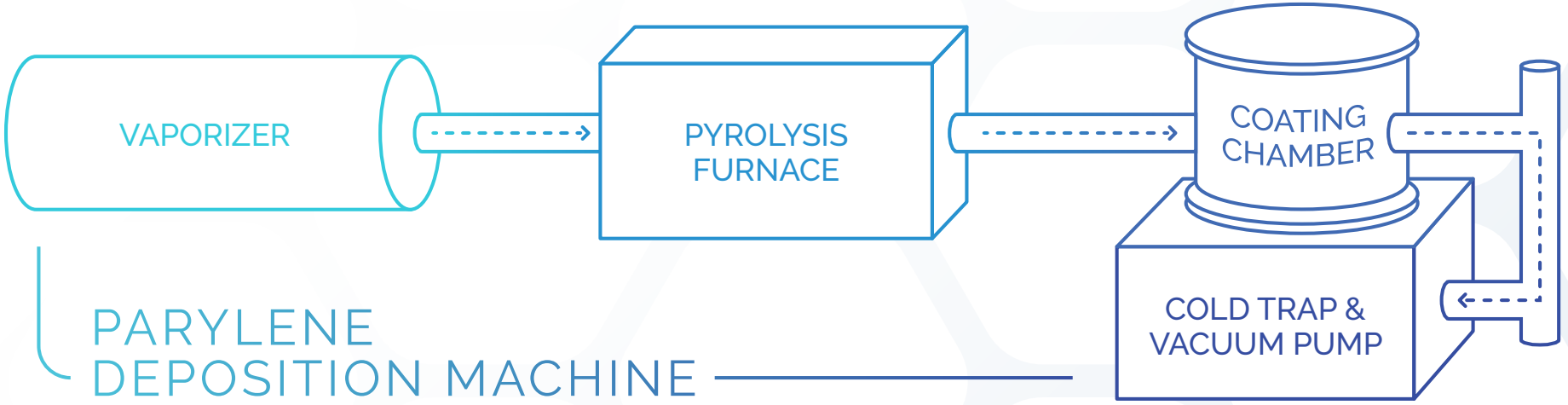


III. DEPOSITION

POLYMER | ~23°C | ~ 50 mTorr

At room temperature, the monomer gas becomes a polymer coating, as it bonds to objects placed in the deposition chamber.





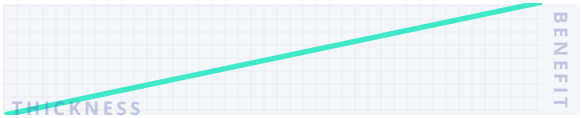
BALANCING THE BENEFITS

Learn the trade-offs between parylene's attributes.

BIOCOMPATIBILITY

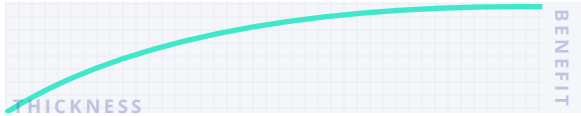
Often a first consideration in selecting high value coatings for medical industries, parylene is an FDA approved material that meets USP Class VI and ISO 10993 biocompatibility requirements for use on human implantable devices. Standing the test of time, the use of parylene is well-documented in an increasingly wide range of medical coating applications over the past 40 years.

BARRIER PROTECTION



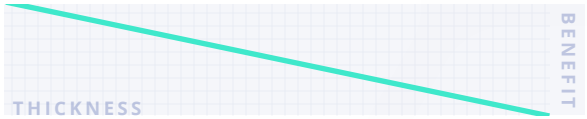
Parylene provides superior protection from moisture, corrosion, salt spray, solvents, airborne contaminants and many hostile environments. It is chemically inert, ultra-thin, pinhole-free and conforms to components evenly and consistently. Due to parylene's unique molecular-level deposition, this high level of protection is achieved with 10% of the mass than spray or dip coatings.

DIELECTRIC STRENGTH



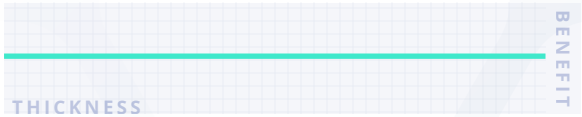
Parylene enables the design of smaller, more compact electronics by providing protection from internal and external electrical interference due to its combination of high dielectric strength, low dielectric constant and very low dissipation factor properties. It is often used in implantable medical devices as parylene forms an electrical barrier between the device's electronics and electrical signals produced in the body.

DRY LUBRICITY



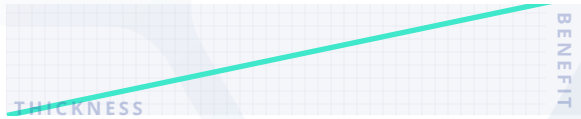
When applied as a sub-micron layer, parylene provides a lubricious surface that bonds completely to a variety of device substrates. Improving lubricity, without the risk of shedding particles, reduces the resistance force of of pushing catheters, guidewires or stents through restricted anatomy. The molecular deposition process produces a smooth, homogenous coating topography that remains flexible.

DRUG ADHESION



Parylene's inert and biocompatible properties enable it to be an important bonding layer for drug-eluting medical technologies. Parylene acts as a release control agent when it applied between the metal or polymer substrate and pharmaceuticals. Additionally, the vapor deposition process allows complex shapes to be consistently coated with a high level of control.

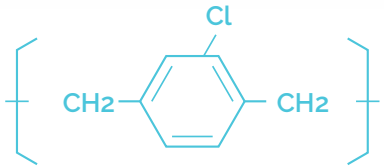
RUGGEDIZATION



Parylene's completely-conformal properties are used to physically reinforce and add strength and rigidity to delicate connections on printed circuit boards (PCBs). Think of this as parylene welding. The combination of parylene's crevice-penetrating ability along with its consistent coating thickness provide a protective "jacket" that greatly reduces failures caused by solder fatigue from thermal cycling and vibration, without board redesign.

THE DIFFERENT PARYLENE TYPES

TYPE C



Parylene C is the most popular parylene type because it provides a combination of barrier and dielectric properties while also having cost and processing advantages.

Parylene C is produced from the same raw material as parylene N but substitutes a chlorine atom for one of the aromatic hydrogens. This gives parylene C very low permeability for better protection from moisture, chemicals and corrosive gases.

Parylene C deposits much faster than other parylene types which allow a thicker layer to be applied with less machine time.

Parylene C is the best choice for:

- Implantable medical devices.
- Pinhole-free barrier layers to electronics or materials from harsh environments.
- Encapsulating electronics to provide dielectric protection.
- Meeting IPC-CC-830 or MIL-I-46058C standards.

TYPE N

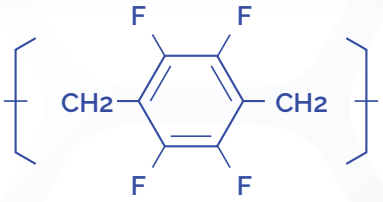
Parylene N is the base structure of the parylene group. Parylene N has excellent dielectric properties. It has a very low dissipation factor, high dielectric strength, and a low dielectric constant that does not change with frequency.

Parylene N is more molecularly active than parylene C during the deposition process. An advantage of the higher activity is increased crevice penetration, which allows parylene N to get farther into tubes and small openings. A disadvantage of the higher activity is slower deposition rates which increase the machine time and cost for thicker layers.

Parylene N is the best choice for:

- Dry lubricity.
- High frequency/RF applications because of its low dissipation factor at high frequencies.
- Applications that require high penetration.

TYPE F (VT-4)



Parylene F fills a niche because it is capable of higher operating temperatures and is more resistant to UV than parylene C or parylene N. Parylene F also has very good dielectric properties and good crevice penetration.

The chemical structure of Parylene F has four fluorine atoms on the aromatic carbons. Parylene F has a slower deposition time and the raw material is more expensive.

VSI Parylene offers parylene F for applications that require the increased temperature and UV resistance parylene F offers.

Parylene F is the best choice for:

- Applications with higher temperature requirements.
- For medical devices and R&D use only. Contact us for details.

COST DRIVERS

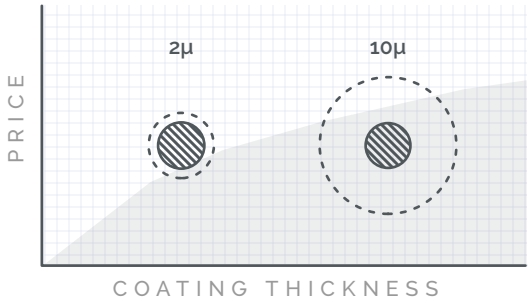
What to expect when adding parylene coating to your product's manufacturing process.

COATING THICKNESS

↳ MACHINE HOURS

Optimal coating thickness is determined by your specific application and benefits desired.

Thicker coats require additional time inside the deposition chamber, increasing total machine hours.

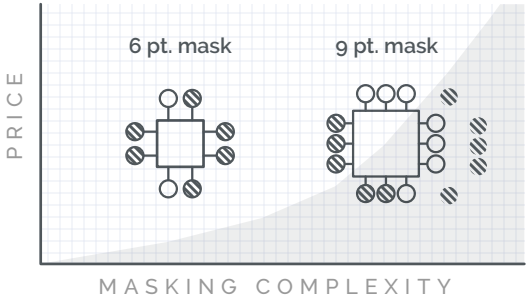


MASKING COMPLEXITY

↳ LABOR HOURS

Masking complexity is determined by your product's design and operating requirements.

As complexity increases, operators must take more time to process each individual part, increasing total operator hours.

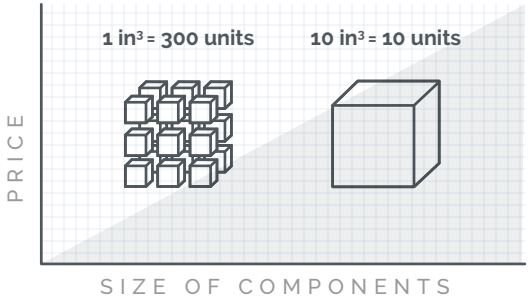


SIZE OF COMPONENT

↳ BATCH SIZE

Parylene coating is applied inside a vacuum deposition chamber of fixed, physical size.

An increase in the individual unit size reduces the number of products that can be coated at one time.



PARYLENE DEVELOPMENT PATH

PROTOTYPE

Testing the coating feasibility of your product or part is the first step in the parylene process. This initial step provides clear feedback on whether parylene is right for your product's specific end-use.

BENEFITS INCLUDE:

Identify areas of potential improvement, with concrete improvement suggestions

Improved budgetary decision making based on quantified improvement potential.

DEVELOP

After a successful application is established, the second step is to design a reliable coating process that is cost effective and able to deliver coated parts of high quality consistently. A critical stage for regulated industries.

BENEFITS INCLUDE:

Establish work processes, quality assurance steps, process controls and documentation.

Reduce customer risk through increased visibility and control over development process.

SCALE

After product and process requirements are defined, you are ready to move into the production phase. Of the two options for production, Scale provides the fastest track to get started quickly.

BENEFITS INCLUDE:

Technical expertise, flexible production capacity, and production efficiencies minimize per-part coating cost.

Facilities, processes, and trained staff to meet broad industry requirements, including ISO, FDA, and ITAR.

TRANSFER

Whether you've completed the Develop stage or are currently in production at Scale, Transfer is the best choice for customers who want maximum control over quality, production and cost.

BENEFITS INCLUDE:

In-house Parylene coating capabilities have the advantage of lowest volume cost, faster response time, dedicated resources, and local control of production.

Complete service includes setup, equipment, know-how transfer and ongoing support.

THE PRODUCT LIFECYCLE