

How to Minimize the Cost of Parylene



www.paryleneconformalcoating.com

Introduction

Parylene is often considered the ultimate conformal coating for the protection of devices, components, and surfaces in the electronics, instrumentation, aerospace, medical, and engineering industries.

Parylene is chemically stable, which makes it an excellent barrier material. It's resistant to solvents and moisture, has incredible dielectric strength, and provides completely uniform coverage.

The perceived cost of Parylene, however, sometimes prevents designers from considering Parylene for their project.

So, how much *does* Parylene cost? The answer is: it depends.

In this white paper, we'll look at the different factors that go into the cost of a Parylene project. And we'll look at ways you can make Parylene more affordable.

The Problem

Product designers need quality conformal coating protection for their devices. But they must also work within a budget.

Background: What Is Parylene

Conformal Coating?

Parylene is the trade name for a family of polymers used to coat and protect objects from moisture, dielectric effects, and other environmental damage.

Raw Parylene “dimer” comes in a powder form.

A typical Parylene coating run uses about a pound of raw Parylene, which costs anywhere from \$200 to \$5,000 per pound.

The powder is then vaporized and pulled into special vacuum coating chambers—which contain the objects to be coated.

Parylene vapor deposits on all exposed surfaces in the vacuum chamber. This process leaves behind a thin, protective coating on the objects in the container. The coating “conforms” perfectly to the object. This is why Parylene is called a “conformal coating.”

The Parylene layer protects the object from moisture, extreme heat and cold, dielectric interference, mold, and many other problems that might cause the underlying device to fail or malfunction.

In this way, engineers use Parylene to protect circuit boards and other objects from environmental damage. This allows circuit boards and electronic devices to function in places they never could without the

protective coating. This includes use on NASA vehicles and even on medical implants for use inside the human body.

How Parylene Is Different than Other Coatings

Parylene is not the only choice engineers have for conformal coating.

There are four other major “wet” conformal coatings: polyurethane, silicone, acrylic, and epoxy. The four wet coatings are applied as a liquid, either by brushing, dipping, or spraying the object with the coating material. A drying process allows the wet coatings to cure, resulting in a protective coating layer on the device.

Each coating has advantages and disadvantages.

When compared to the wet coatings, Parylene often provides the very best performance, especially in situations that require a completely pinhole-free coating, or when you have small tolerances.

Parylene is not the best in all situations, however. You’ll need to work with an experienced conformal coating provider to evaluate your specific needs.

When looking for a coating partner, always choose one that has expertise and experience applying all five of the major coating types. That way you don’t get forced into a coating choice that might not be optimal for your project or your budget.

Parylene Labor Costs

Like all coating processes, masking is usually the most labor-intensive step. Parylene, however, requires especially careful masking.

Parylene molecules will penetrate anywhere that air can. As a result, great care needs to be taken during the masking process to ensure every connector is adequately sealed and all tape is firmly pressed against the coating keep-out areas.

Another factor that will result in increased labor costs is the increased time spent per part to increase Parylene adhesion. Spending extra time cleaning products and applying different adhesion-promotion mediums will result in increased labor times—and increased costs.

The Price of Parylene vs. Other Other Coatings

It's important to understand the cost of Parylene when compared to the four other "wet" coatings.

1. The Cost of Acrylic Resin (Type AR)

Acrylics are usually the least expensive form of conformal coating. The coating itself is relatively inexpensive. It is also easy to apply and remove—keeping costs low even when rework is required.

Acrylics dry rapidly, reaching optimum physical properties in minutes, are fungus resistant, and provide long pot life.

Additionally, acrylics give off little or no heat during the curing process, eliminating potential damage to heat-sensitive components. They also do not shrink during the curing process and have good humidity resistance and exhibit low glass transition temperatures.

Acrylic coatings typically consist of a solution of a thermoplastic acrylic polymer dissolved in a blend of organic solvents which dries by simple solvent evaporation. This means that acrylic coatings will soften at high temperatures and also that they are easily removed to effect board repair.

2. The Costs of Polyurethane Resin (Type UR)

Polyurethane is the second least costly of the coatings due to its low material costs and the many ways it can be applied to components.

Polyurethane coatings are available as single-component, two-component, UV-curable, and water-borne systems.

As a group, polyurethane coatings provide excellent humidity and chemical resistance, plus outstanding dielectric properties for extended periods. This makes them one of the most popular coatings when it comes to protection of the critical operation of your printed circuit boards.

That said, polyurethane coatings can require very lengthy cure cycles to achieve full or optimum cure. What's more, removal of polyurethane coatings can be difficult due to their very high resistance to solvents.

3. The Costs Silicone Resin (Type SR)

Silicone coatings are the third most costly of the coatings.

Silicone is most widely used in high-temperature environments due to its ability to withstand prolonged exposure to high temperatures.

This attribute has made silicone the primary choice for under-the-hood automotive applications. Silicone is also capable of being applied in thicker films, making it useful as a vibration dampening and isolation tool, if the coated assembly is to be placed in a high-vibration environment.

Rework of silicone coated assemblies can sometimes be difficult due to their chemical resistance. Reworking silicone is also difficult because—unlike acrylic and polyurethane coatings—it does not vaporize with the application of heat.

4. The Cost of Epoxy Resin (Type ER)

Epoxy is the second most costly coating—behind only Parylene.

Epoxy coatings are very hard, usually opaque, and good at resisting the effects of moisture and solvents. Usually available as “two-component” compounds, these rugged coatings provide good humidity resistance and high abrasion and chemical resistance.

Epoxy coatings are, however, virtually impossible to remove chemically for rework. Any stripper that attacks the coating will almost certainly dissolve the components underneath the coatings as well, including printed circuit board themselves.

5. The Costs of Parylene Resin (Type XY)

Parylene is generally the most costly coating option available.

When you need ultimate, reliable protection, however, nothing beats Parylene’s performance.

As mentioned earlier, Parylene is considered by many to be the ultimate coating for protection of devices, components and surfaces in the

electronics, instrumentation, aerospace, medical, and engineering industries.

Parylene is unique in that it is applied in a gas form, directly on the surface at room temperature. Parylene is chemically inert, making it an excellent barrier material in a wide variety of harsh environments—including inside the human body.

A unique difference with the Parylene process is that it is perfect for coating the underside of low-profile devices. The coating can be applied much thinner than other coatings, and because the coating goes anywhere air can go, it will apply uniformly even in tight spaces.

The Price of Parylene

Parylene Coatings

When you've decided Parylene is the right coating for your project, there are three questions you should ask your conformal coating provider:

1. "What Variety of Parylene Do I Need?"

Raw Parylene dimer comes in a variety of qualities and types. They range in price from \$200 to \$5,000 per pound.

The C and N varieties of Parylene are the most common types. They have costs much closer to the \$200 per pound.

Specialty Parylene varieties such as D or AF4 have higher costs, but also provide higher performance (better heat resistance, better UV protection, etc.)

It's essential that you work with a company that has deep experience with Parylene. They'll be able to help you choose the right variety of Parylene for your needs.

2. "What Is the Size and Quantity of the Objects I Need to Have Coated?"

This is important because the objects you're having coated will be placed into a vacuum chamber during the process.

The coating chamber has a fixed cost to do one coating run. Maximizing the number of objects we place in the coating chamber on each run will

lower your cost. In some cases, simply optimizing the number of items you have in each run can dramatically lower the total cost per item.

3. “How Much Masking Am I Going to Use?”

If there is a lot of labor involved in the masking, it goes without saying that costs will be higher. If possible, speak with an expert prior to designing your device. Sometimes design changes can be made that will result in a device that’s significantly easier to mask and coat—resulting in cost savings for you.

Parylene Labor Costs

The stringent masking requirements mean the labor costs for Parylene’s tends to be higher than for other types of conformal coatings

Another factor that will result in increased labor costs is the time spent per item to increase Parylene adhesion.

The Cost of Parylene Defects and Rework

Once Parylene has been applied to an object, it is extremely difficult to remove. Because of this, costs can quickly escalate if any defects happen during the coating process.

Engineers usually turn to one of three methods when trying to remove Parylene coating: thermal, mechanical, and microabrasion. Each method is labor intensive and relatively expensive compared to a Parylene run with minimal defects.

How to Make Parylene More Affordable

As you approach your Parylene coating project, here are five ways to make your Parylene project as affordable as possible:

1. Labor Costs for Parylene

There are two ways to minimize your labor costs.

First, the old saying, "measure twice, cut once" applies with a Parylene coating project. Mistakes in the planning stage can often lead to costly, time-consuming repairs. It's important that you clearly document exactly what you want to happen. The last thing you want is a communication error that leads to a problem during the application process.

Second, ensure you have competent, well-trained technicians working on the project. Mistakes with Parylene lead to time-consuming, expensive repair work. This repair work can often be the single biggest unexpected cost for a Parylene coating project.

2. Raw Material Costs for Parylene

Some Parylene dimer types cost as low as \$200 per pound. There are also specialized forms of Parylene that can be as expensive as \$5,000 a pound.

To minimize material costs, consult with a Parylene expert as early as you can in your design process. By working with an expert, you can be sure you're not paying for specialized materials unless you actually need them.

3. Adhesion for Parylene

Parylene can coat almost anything.

Its unique features allow it to be used effectively on a diverse range of materials, including metal, ceramic, paper, plastic, ferrite, resin and silicon.

Despite this, some materials will still need a bit of [preparation](#) to ensure the Parylene properly adheres to the device being coated. The most common surface modification method to improve Parylene adhesion is the use of A-174 silane.

A-174 silane is usually applied after the masking operation. Technicians will apply the material either by a manual spray, soaking, or a vapor phase silane process. The silane molecules form a chemical bond with the surface of the device. This, in turn, provides a surface Parylene can easily adhere to.

The way to minimize adhesion costs is to prepare the device correctly the first time. Poor adhesion due to poor device preparation can be another cause for expensive rework and repair.

4. Parylene Lot Sizes

The vacuum chambers used for Parylene coating have a fixed size. This means one batch of Parylene can only coat as many items as can fit in a single chamber. The chambers we use at [Diamond-MT](#) range from 11" by 11" up to 16" by 31", although larger chambers do exist.

To optimize costs, work with your coating provider to get as many items inside the deposition chamber as possible at a given time.

Optimizing the number of objects you coat per run can lead to major cost improvements for many Parylene projects.

5. Time to Complete a Parylene Batch Run

One run of Parylene takes anywhere from a few hours to over a day. However, the preparation for a Parylene coating project begins weeks or months before the application.

Most coating providers will have a standard, explicit set of processes they use for customer orders. For the best results and lowest costs, let the providers use their standard process with your devices.

If you ask for a rush on a project, you risk introducing errors. Your coating provider might also charge a rush fee for orders on a tight timeline.

The No. 1 Thing You Can Do to Prevent Prevent Runaway Costs

The No. 1 way to keep your costs in line when carrying out a Parylene coating project is to avoid mistakes in the first place. The importance of properly preparing your device for Parylene coating success cannot be stressed enough.

As always, the most effective way to prevent coating failures is to ensure you're working with an experienced coating provider.

They'll know how to apply a wide variety of coatings, without causing any of the problems we've discussed in this article. They'll know which coating is right for you and your budget. And they'll know how to complete your project at the best possible cost for you and for your company.

3 Questions to Ask Your Parylene Coating Provider

Here are three questions you should ask your conformal coating provider before beginning a Parylene coating project:

1. Is Parylene Really the Best Choice for My Project?

Every project is unique. Parylene is often the best choice for conformal coating protection. But sometimes your performance requirements mean a different coating is better suited to your project.

Before you go any further, make sure you're working with a conformal coating provider with experience in all five major coating types. They will be in the best position to help you make the right conformal coating choice.

2. Have I Provided All Necessary Information?

Your coating provider needs to know all your requirements. Document what you expect and what your expectations are for the coating and the coating process.

Explain your situation, your expectations, any issues you've had in the past, and if this is a one-time issue or will be an ongoing project.

Whether you're working with an in-house team or an outsourced provider, have the conversations about expectations and performance before the coating process begins.

It will be costly to fix issues after the coating process has started.

3. How Will the Device Be Cleaned Prior to Parylene Coating?

Water will remove most ionic contaminants, but the water must be pure. Otherwise, it can leave behind salt and other compounds when it evaporates.

Your coating provider should also thoroughly clean your device using a solvent or a surfactant in order to remove nonionic contaminants.

7 Key Points to Remember About

Parylene Pricing

1. Parylene is considered “the gold standard” of conformal coating.
2. Labor—not raw materials—is usually the largest cost of a Parylene project.
3. Mistakes are the No. 1 cause of additional costs for Parylene projects.
4. Putting more items into the coating chambers per run can lead to significant cost savings.
5. There are many different types of Parylene. Some cost \$200 per pound. Others cost \$5,000 per pound.
6. Look for conformal coating providers that have expertise in all five of the major coating types: acrylic, polyurethane, silicone, epoxy, and Parylene.
7. A good conformal coating provider will find the right coating solution for your needs and your budget, not just the coating solution they happen to prefer.

About Diamond MT



Diamond MT was founded in 2001 as a firm specializing in contract applications of conformal coatings for Department of Defense and Commercial Electronic Systems. Since our beginning, Diamond MT has established a reputation for providing the highest quality services in the industry. Our commitment to quality, integrity, and customer satisfaction combined with an unmatched expertise in applications and processes has provided every one of our customers with superior results.

Diamond MT operates out of a freestanding 12,000 square foot building in Johnstown, Pennsylvania, which is located 60 miles southeast of Pittsburgh. Diamond MT is located near three major interstates and is supported by the Cambria County Airport, which serves as a primary freight terminal for south central Pennsylvania. Diamond MT maintains a strict program per NSI ANSI Standard 20.20 for ESD protection. All work areas are safeguarded with the latest in protection devices including wrist straps, garments, and workstations.

Quality Assurance: Diamond MT's quality manual ensures every employee is focused on continuous improvement and service excellence. Our ESD safe facilities stretch over 12,000 square feet dedicated to your conformal coating requirements. We are continually researching and updating our equipment to make sure we are providing the best ESD protection available.

All employees have been trained in proper ESD procedures. We operate at a class 3 level to ensure the job is done right the first time and to the highest quality standards set forth in accordance with the MIL-STDs, IPC, J-STDs as well as having our biomedical and ITAR certification. Furthermore, all assemblies are tracked through every step of the process with documentation/serialization spreadsheets as well as each assembly going through a 100% visual inspection.

Diamond MT has a strong organization consisting of highly motivated personnel, modern facilities, and diverse capabilities. Diamond MT represents one of the most modern, well-equipped facilities in the region. Diamond MT offers a highly skilled workforce, rapid turnaround manufacturing and high reliability through an established quality program, along with experience in commercial manufacturing requirements, competitive pricing and on-time delivery.

Rapid Turnaround: Diamond MT understands that oftentimes conformal coating is overlooked because it's the last step in the process. We are committed to serving the industry with rapid turn times for parylene, (normally 10 business days) with expedited service in as little as 2-5 business days depending upon the complexity and quantity.

For liquid coatings, our normal turnaround time is five business days; again with expedited service in as little as 2-3 business day turns. We understand that there are times you'll need a project completed FASTER. We will accommodate your needs in a budget friendly manner. This service is offered on a FIFO basis.

To learn more about Diamond MT, please contact us today!

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