

# The 'Ins' and 'Outs' of Parylene Coating

**This article reviews the two process alternatives available to users of protective Parylene conformal coating: relying on an external custom coating provider, or establishing in-house coating capabilities. The cost components, benefits, and limitations of these two options can be reviewed to determine the most efficient method for a given application.**

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Managers responsible for manufacturing circuit assemblies, electronic products, or medical devices need to identify the lowest cost coating that will achieve the necessary environmental protection. In some cases, Parylene coating offers the lowest applied cost of any coating option, particularly where environmental performance requirements are demanding.

Once Parylene has been identified as the surface treatment of choice, the challenge is to determine the best method for meeting production requirements. The general options are outsourcing to a qualified supplier, or developing the necessary in-house Parylene capabilities.

### **Parylene Technology**

Parylene coating technology has been around for more than 40 years and is now commonly used in medical device, electronic, aerospace, automotive, and industrial manufacturing. This very thin film has advantageous dielectric properties as well as resistance to moisture, chemicals, organic solvents, acids, and reagents. Substrates are coated in a vacuum chamber, with the film applied by gas phase polymerization with no liquid phase and no solvents or catalysts. This deposition is accomplished under closely controlled conditions of time, temperature, and pressure.

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Published on Medical Design Technology (<http://www.mdtmag.com>)

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Parylene coating serves multiple purposes including electrical insulation, sterilizability, biocompatibility, moisture and chemical isolation, protection from harsh environments, enhanced lubricity, and surface encapsulation to avert flaking or dusting. It is free of pin-holes, meniscus properties, pooling, and other deficiencies commonly associated with liquid coatings.

Parylene coating was initially commercialized by Union Carbide Corp. in the late 50s and early 60s. Widespread access to the process came as smaller coating service companies became licensees and brought the vacuum deposition technology to market. These firms introduced standardized Parylene deposition systems, giving manufacturers the option of bringing the Parylene process in-house. Nevertheless, most Parylene users purchase coating services through suppliers having the requisite technical expertise, application knowledge, and production resources to deliver cost-effective coating services.

### The 'Outs'

Parylene outsource providers generally offer a broad base of coating knowledge, and have established precise, clear work processes, along with quality assurance steps, process controls, and complete documentation to ensure successful coating runs. A Parylene coating service generally encompasses the entire coating process from application engineering, cleaning, masking, production, and inspection to the return of coated parts or assemblies to the customer.

Established Parylene outsource service providers have sophisticated production resources and support operations, along with stable, full-time, trained, and dedicated staffing that is experienced and equipped to deliver very high quality work from day-to-day. They should also have documented capacity to meet military, electronic, and other pertinent specifications for conformal coating. These standards cover all aspects of PCB production from design through production and inspection. While not every manufacturer is required to meet Department of Defense standards, many companies call for Mil-Spec compliance to ensure optimum quality.

Relying on a qualified outsource coating provider allows a manufacturer to take advantage of the benefits of high Parylene performance coating without investing in equipment, raw material inventory, production space, personnel, training, or the

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complexities of satisfying Mil/IPC and RoHS requirements.

As an outside service partner, a Parylene coating provider strives to be an extension of the customer's manufacturing team and process by delivering coated and inspected parts to meet a defined schedule. Effective custom coating service operations have the advantage of strong technical expertise, broad coating experience, substantial production capacity, and production efficiencies that can minimize per-part coating cost. They have invested in facilities, processes, and staffing to meet industry requirements, including ISO, IPC Standards, and Mil-Spec.

Since qualified staff, technical expertise, and coating services can be purchased as needed from a coating service provider, the Parylene user is not required to make an investment apart from per-piece coating costs. However, the details of production timing must be negotiated with the supplier, with costs based on part complexity, quoted specifications, and delivery requirements.

Custom Parylene coating generally begins with process development and a sample run to confirm the viability of Parylene coating for the application. The production process involves cleaning to remove surface contaminants, masking to isolate areas to remain uncoated, vacuum coating, de-masking, inspection, and delivery of coated parts to the customer.



Given the diversity and volume of work presented to a service provider, fixture loads can be optimized to achieve efficient vapor transmission and Parylene coating consistency. The coating supplier is generally responsible for the cost of rework that may arise from supplier error. This provides an added incentive for the outsource provider to deliver timely and error-free coating services.

### The 'Ins'

Firms that establish in-house Parylene coating capabilities have the advantage of faster response time, dedicated resources, and local control of production. These

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benefits entail substantial facility and staffing expense. Challenges include responding to unexpected problems, maintaining quality control, and dealing with staff turnover and retraining. The essential in-house coating question is whether the nature and volume of parts to be coated justifies the cost of investment for equipment, qualified staff, floor space, raw material inventory, training, and system maintenance.

With in-house coating facilities, turnaround times can be fast, and companies can do build-to-order work without waiting for an outside supplier. This ability is particularly important for manufacturers who need to ship new parts quickly. However, these benefits cannot be enjoyed without investing in engineering, quality control, and the technical resources required to identify and resolve unanticipated challenges.

Another setting where in-house coating may be desirable is where production is predictable, high in volume, long term, and consistent in part type and coating parameters.

Several questions must be considered in choosing the best production option. For example, is there an over-riding reason to keep parts in-house? Issues might include the difficulty of transporting extremely delicate parts off-site for coating, a need for tight security beyond conventional carrier services, requirement to protect critical medical or aerospace components from contamination, or extremely tight production timing needs.

In-house coating is most practical where there is sufficient coating volume that will not fluctuate in part type or coating parameters. The complexity of parts to be coated will be important to the in-house coating decision because it affects the level of process engineering as well as production requirements. The more challenging the coating application, the higher the level of skill and production sophistication will be required to achieve satisfactory results.

With in-house coating, the manufacturer must develop and administer steps required to meet pertinent industrial and environmental protection standards, and absorb the cost of process errors, including coating rework. Manufacturers with substantial coating volumes are best able to absorb these costs and develop a dedicated and experienced workforce.

Companies contemplating in-house capabilities need to identify the investments required to meet current and anticipated future coating needs. These include:

Once the full complement of coating costs have been determined, it should be possible to calculate the per-part coating expense as well as the anticipated payback period required to fund in-house coating capabilities.

When assembling resources for an in-house Parylene operation, the manufacturer should review vendor options to be confident that coating equipment and production support will be available for the long term. The chosen supplier should demonstrate ongoing technology development, process improvements, and a clear

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record of effective customer service. Look for equipment that offers advanced processes, and coating practices that ensure consistent performance and production economies.

Every company seeks to develop core competencies that give it marketplace advantages and the ability to provide a clear value proposition for its customers. As with any production decision, managers should consider the impact of bringing Parylene coating in-house on the broader ability of the company to pursue its core competencies and serve the market effectively.

Some Parylene coating specialists can assist interested customers with the complex production analysis that is required to reach a reasoned decision. Should an in-house Parylene coating capability be warranted, it will be important to deal with a supplier that can provide effective, proven coating equipment, manufacturing engineering services, staff training, process implementation, and on-going technical support.

### Conclusion

Whether a company decides on in-house Parylene coating or outsourcing to a coating service, it is important to find a Parylene supplier that works as an extension of the customer's manufacturing process and strives for ongoing technology development and continually improved processes and service. Such a relationship will result in consistent performance, production economies, and lowest total production cost.

### Online

For additional information on the technologies and products discussed in this article, see *MDT* online at [www.mdtmag.com](http://www.mdtmag.com) or Para Tech Coating Inc. at [www.parylene.com](http://www.parylene.com) [2].

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### Links:

[1] <mailto:info@parylene.com>

[2] <http://www.parylene.com>