



# Just the FAQ's



## An Important List of Phygen Coating Frequently Asked Questions.

### Why do some coatings fail?

Coating failure usually can be traced to two major problems areas: poor substrate and deficiencies in the coating process itself.

Substrate problems include improper preparation (poor surface finish, incomplete cleaning), weak or soft substrate (wrong material selection or insufficient heat treatment).

Coating process problems include uniformity problems (inconsistent or inadequate thickness; porosity; macro particles, impurities, or columnar structures within the coating), and adhesion problems (peeling or wearing off due to substandard or extremely hot application processes).

### What makes FortiPhy<sup>SM</sup> coatings different?

As an engineer from a Detroit automaker told us, "There are A LOT of good coatings, but none of them stick."

Hot coating processes exist to try to solve this problem. Unfortunately, using a hot process may require making several extra tools to get one that meets tolerance requirements after coating. That adds cost and uncertainty to the development process. In the Phygen process, we have extremely good process control and management of coating thickness, while applying at a lower temperature. Phygen's patented process delivers a more energetic plasma, capable of creating nano-sized particles. The resulting coatings have vastly superior adhesion, structure, uniformity, density, and coating thickness control.

### What makes Phygen different?

The Phygen team is made up of physicists, engineers, and machinists dedicated to the custom application of ultra-performance coatings. The patented FortiPhy<sup>SM</sup> process goes well beyond the technical capabilities of other coating shops. But, technology is only part of the Phygen difference. Our commitment to customer service makes Phygen stand alone in providing personalized service. Unlike other shops, we provide a truly customized product, fine-tuned to specific applications and customer needs. One of our customers commented that his satisfaction and high confidence level were due in part to his daily communication with Phygen. He stated that, in addition to feeling that he had a personal Phygen coatings expert dedicated to his project, "The founders are on the floor," ensuring that each part gets custom treatment.

### What applications are the best fit for coatings?

Phygen coatings can help wherever engineered components need better wear, stress, corrosion, or friction characteristics. Look at the current lifespan of individual components and at your production numbers. You might be surprised to find that simple items such as pierce punches are causing most of your downtime. Coating those items could improve productivity, eliminate unnecessary setup costs, and lead to a dramatic reduction in your need to manufacture and stock redundant tools. In other cases, you might be spending too much on specialized material for one high-stress component, where a FortiPhy coating on a more conventional material would actually perform better.

### What is the best substrate for coating?

While FortiPhy coatings can improve the toughness of nearly any metal, critical applications call for better materials. High-performance tool steels or carbides, with a fine surface finish, are the best choice for extreme applications. In addition, the ideal material would have a final tempering temperature higher than 975°F to prevent annealing during the coating process. The ultimate hardness and toughness of FortiPhy coatings are related to the hardness of the substrate.

### How does surface finish affect coatings?

Surface finish also will affect coating performance. A finer surface finish will allow a more uniform layer of coating to be applied. In general, you should specify a slightly better surface finish than usual. This will ensure maximal coating adhesion, toughness, and lubricity. An exception to this would be applications that require friction, such as thread rolling dies. In these cases, talk to a Phygen coating expert about strategies for increasing friction while improving toughness.

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### Are there substrate materials to avoid with the Phygen process?

For extreme stress applications such as metalforming or stamping, tool steels with an annealing temperature lower than 975°F should be avoided to ensure that hardness and grain structure are not compromised during the coating process. In other applications, such as components subjected only to abrasive wear, substrate hardness is less critical.

### What is the coating thickness?

For standard applications, Phygen coating will add between 1 and 1.5 ten thousandths (0.0001"—0.00015") to the most critical surfaces to be coated. We also can adjust the thickness to suit your particular needs. In the patented Phygen process, we have extremely good process control and management of coating thickness. Customers who send us very expensive plastic injection molds tell us that we are the only coating-service company that can deliver the precise and uniform coating thickness they require. Overall, coatings you get from Phygen will be uniform, and have the specified thickness.

### How are ultra-endurance coatings applied?

Phygen's patented, proprietary process uses very energetic plasma to deposit extremely uniform, nanocrystalline coatings. After a multiple stage cleaning process, your parts are attached to appropriate, electrically insulated fixtures. When necessary, special masks are fabricated to prevent the coating of selected areas. Parts are placed in a vacuum chamber along with a small quantity of inert or reactive gas. The parts inside the chamber are slowly heated to a precise temperature. Next, an electrical charge is supplied to the coating material, and a highly charged stream of ions begins to flow to the negatively charged component. In this way, the coating is "grown" on the surface of the part, one ion at a time. Phygen's skilled technicians and meticulous process controls ensure that coatings are applied to the precise thickness and locations specified.

### What is the coating application temperature?

Phygen coatings are applied at 950°F, helping to ensure that your heat treatment, dimensions, and other physical characteristics remain "as designed." Some commercial coating processes can subject your engineered components to temperatures of 1,800°F and beyond.

### How will the coating process affect part tolerances?

Many coatings require temperatures in excess of 1,800°F for extended periods. This can anneal tool steel, compromise physical properties, and cause components to warp. Some customers have told us they previously had to make several parts in order to ensure that they would have one usable item after coating. The patented FortiPhy<sup>SM</sup> coating process goes on at 950°F, very low compared to most high-performance coating processes. This typically eliminates the need for rework after coating.

### Is there a minimum or maximum surface area for coating?

Any surface that must remain uncoated will be masked off. Therefore, the minimum surface that can receive coating is extremely small. Phygen's in-house machining capabilities allow us to quickly produce any necessary masking or fixtures. The maximum coated area is limited by the fixturing requirements for a particular component, and the maximum size of the coating chamber. Phygen has applied FortiPhy coatings to a variety of parts and profiles, with great success. Contact your Phygen representative for details.

### What type of contours are right for coating?

FortiPhy coatings are applied using a modified line-of-sight operation. Generally, this means that all working surfaces can be coated, including holes to a depth up to two times the diameter. For more radical profiles and complex features, contact a Phygen coating expert.

### How should component details be prepared for coating?

The three main elements of success for details that will receive coating are substrate, surface finish, and heat treatment. Talk to your Phygen representative about our sharpening, polishing (both pre- and post-coating), and tool restoration services.

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### What is the maximum part size that can be coated?

Phygen has successfully coated very large parts, including a 325-pound ring used to form automotive transmission torque converters for a Detroit automaker. The ring had a 26" diameter (21" diameter is the standard maximum) and a 12" depth. If in doubt, call a Phygen coatings expert for advice on your larger components.

### What about rework? Can the coatings be removed?

Phygen can safely and completely remove FortiPhy<sup>SM</sup> coatings and various other commercial coatings through a proprietary process whenever rework needs to be done. We can polish and recoat immediately, or we can send your components back to you for more extensive rework. Talk to your Phygen representative about our coating removal and tool restoration services.

### In aluminum die casting applications, how should coated pins be cleaned?

Do not use abrasive stones. A 4-micrometer thick coating is easily removed on polishing with abrasive stones. There is a need to use a new die cleaning practice that involves cleaning the surface of the die (coating) with a dilute sodium hydroxide solution applied with a paintbrush.

### How does FortiPhy<sup>SM</sup> coating affect hardness?

FortiPhy has both extreme hardness and good toughness. Also, it is less brittle than other similar coatings, due in part to its uniform, nano-crystalline structure. Other coating processes often produce very large macro particles, pores, or columnar structures within the coating. These act as stress concentrators, weakening the coating and decreasing its useful life. Phygen's patented application process produces a more uniform coating structure with virtually no defects.

### What about overall strength and toughness?

Critical load is a measure of toughness. In extreme-stress machine tools, such as roll forming, forging, and heading dies, FortiPhy extends tool life significantly by increasing the allowable critical load. Surface hardness is increased without brittleness, allowing components to withstand higher mechanical loads and longer load cycles. Because of its highly uniform structure, FortiPhy is actually more flexible (less brittle) than other coatings—more able to "roll with the punches" without losing adhesion. Because it has more "stretch" than other coatings, it has better ability to withstand repeated impact.

### What are the physical properties after recoating?

Unlike hot-processed CVD coatings, which combine with carbon molecules from the substrate to form a hard layer, FortiPhy CrN is a chemically complete coating, applied to a surface using a special high-adhesion process.

Typical CVD coatings are applied above 1800°F in order to increase diffusional activity within the substrate. During the CVD coating process, carbon atoms move to the surface and combine with the coating material to form a third compound. This can produce a hard coating, but there are drawbacks: only some of the substrate's carbon is available to migrate to the surface, and it can only travel a short distance. This means that as tools and coatings wear, the second application of a CVD coating usually lasts about 70 percent as long as the first application. A third application generally has a life of only 30 percent of the original tool. The free carbon molecules are all "used up" after that. When no more carbon can be leached to the surface, the process ceases to provide any benefits.

FortiPhy coating does not require diffusional action within the substrate to build a hard coating. Instead, the patented Phygen process, with its unprecedented level of process control, applies a chemically complete layer of nano-sized particles onto the surface. The FortiPhy coating does not require any carbon or other molecules from the substrate. This means that every re-coat of FortiPhy has the same toughness, and lasts as long, as the first. Tool life is extended, and the chemical composition of the substrate remains the same, regardless of rework.

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**How will coatings affect friction and lubricity?**

A key benefit of FortiPhy<sup>SM</sup>'s nano-crystalline microstructure is its low coefficient of friction. FortiPhy CrN has a COF of less than 0.1 under properly lubricated conditions in an oxidizing environment. FortiPhy coating users report better release properties and fewer cosmetic rejects after coating molds used for silicone rubber, aluminum casting dies, and precision stamping dies. We also can help you with applications in which you must increase toughness while maintaining higher friction characteristics.

**How can FortiPhy<sup>SM</sup> improve abrasive wear resistance?**

FortiPhy coatings increase surface hardness and toughness, and reduce friction. This combination, plus high hardness, makes treated surfaces extremely resistant to abrasion. FortiPhy coating reduces abrasive wear in machine tools and engineered components used

**Will coatings improve corrosion resistance?**

Because of its dense, non-columnar structure, FortiPhy is chemically inert and provides excellent corrosion resistance. In one extreme example, acid burn was destroying the vents in a thermoplastic injection mold after only 8 hours. After treatment with FortiPhy coating, the mold was still in "like new" condition after more than 50,000 shots.

**What is the operational temperature range?**

FortiPhy CrN is chemically and thermally stable in air up to at least 1550°F (850°C). This high resistance against oxidation gives FortiPhy-coated components higher temperature resistance than uncoated or conventionally coated parts.

**Is the Phygen process environmentally safe?**

Phygen's patented process begins with a substrate cleaning using an EPA- and OSHA-approved aqueous solvent bath. Parts are cleaned in an efficient closed-loop cleaning line that includes a hard-piped vapor recovery system to capture and return vapor emissions. To reduce chemical use to an absolute minimum, final substrate cleaning is performed electronically, with no emissions. Finally, the FortiPhy coating is applied electronically within a vacuum chamber, producing no toxic byproducts and releasing nothing into the atmosphere. The final product, a FortiPhy ultra-endurance coating, is inert, safe, and approved for food contact.

**Is the Phygen process for one or two parts at a time?**

Or can high volume production parts be batched and processed? Large parts will usually be treated individually, but smaller, similar parts can be batch processed.

**What is the turn-around time?**

Most parts are coated and returned to you within 4-6 business days of receipt. In special cases we can provide faster turnaround. Let us know your scheduling needs.

**What is the cost of FortiPhy coating?**

Coating cost is a combination of many factors, including component dimensions, surface finish, material, critical surfaces to be coated, weight, heat treatment, and number of parts. Contact Phygen with your specific requirements for a timely quote. National testing labs and our many successful customers have proven that FortiPhy coatings are tougher and longer-lasting than traditional coatings. That makes FortiPhy coating an investment that can pay for itself quickly.

**What is the chemical composition of FortiPhy coatings?**

Phygen's patented process applies chromium-nitride-based coatings in a more uniform and dense layer than was previously possible, without brittleness. This gives the FortiPhy coating much better adhesion and toughness than ordinary chromium nitride applied by "mass-production" coating shops. In addition, FortiPhy CrN gives better performance than other coating formulations such as titanium nitride. Chemically speaking, FortiPhy coatings are a stoichiometric, non-columnar, equiaxially grained, face-centered cubic chromium nitride crystalline structure with virtually no macro droplets. Typical particle size is 15-40 nanometers.