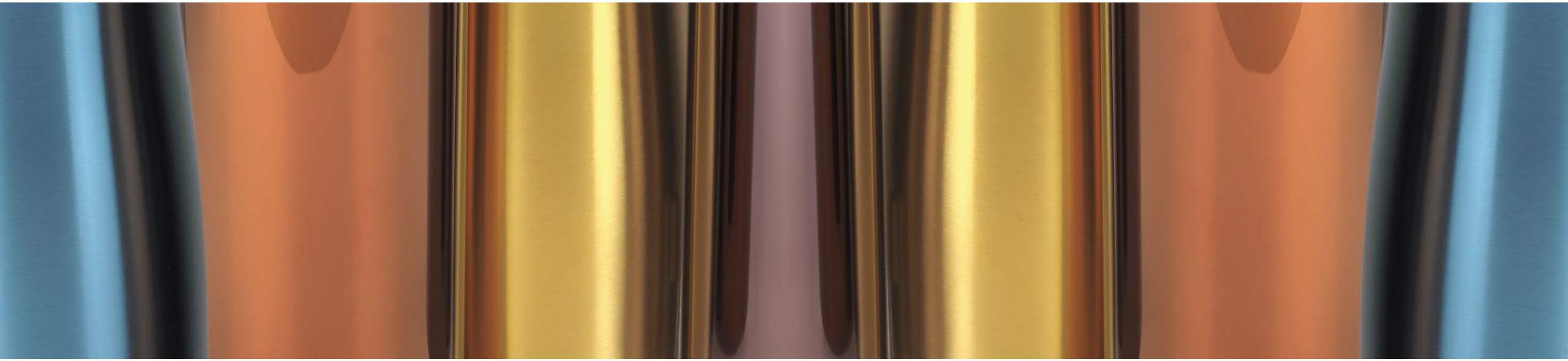
THIN-FILM DEPOSITION

AN INTRODUCTORY GUIDE to PVD, CVD & DLC coatings



VaporTech®

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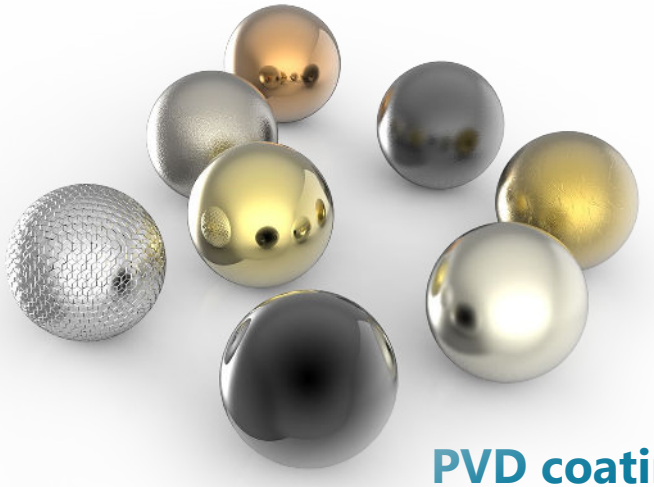


PVD coating

Have you ever wondered what “PVD coating” is and where and why it’s used? We hope you’ll find this introductory guide answers your questions. For more information, please contact us at vtsales@vaportech.com

Contents

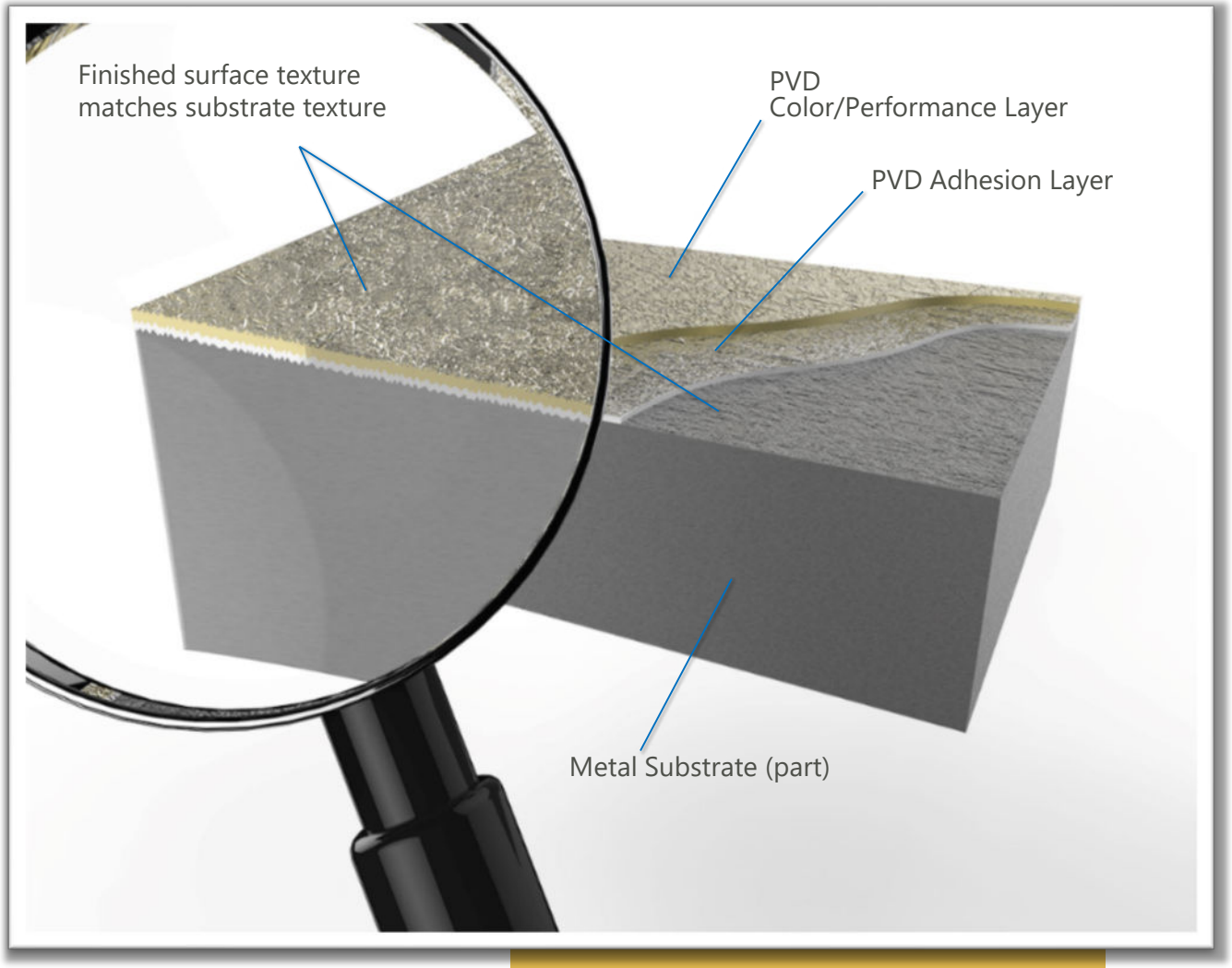
INCLUDED IN THIS GUIDE

Introduction

TO THIN-FILM COATINGS

Thin-film coatings (often called ‘PVD,” “DLC,” chrome replacement, or vacuum deposition) present an alternative way to improve product characteristics or even appearance at a fraction of the per-part coating cost of other coating methods, and without the environmental impact. These include durable color and performance coatings, which are applied to reduce friction and wear-resistance.

Take a material...



...vaporize it in a vacuum, and deposit it, atom-by-atom, onto a surface.

Advantages

OF PVD COATINGS

Extremely thin

Typically, 0.25 to 10 microns, perfect for high-tolerance components where dimensions or mass are critical to function.

Durable

Multiple times the hardness of hardened steel and extremely wear resistant.

Improved appearance

Improve both durability and appearance with a broad range of colors from stainless steel to rose gold, blue, and black.

Flexible

Coat hardened metal or even plastic parts without softening using the unique, low-temperature VaporTech® thin-film process.

Reduces waste

Minimize your environmental impact with a thin-film coating process that generates no hazardous waste.

Low per-part coating cost

Coat for $20 a batch, not $20 a part!

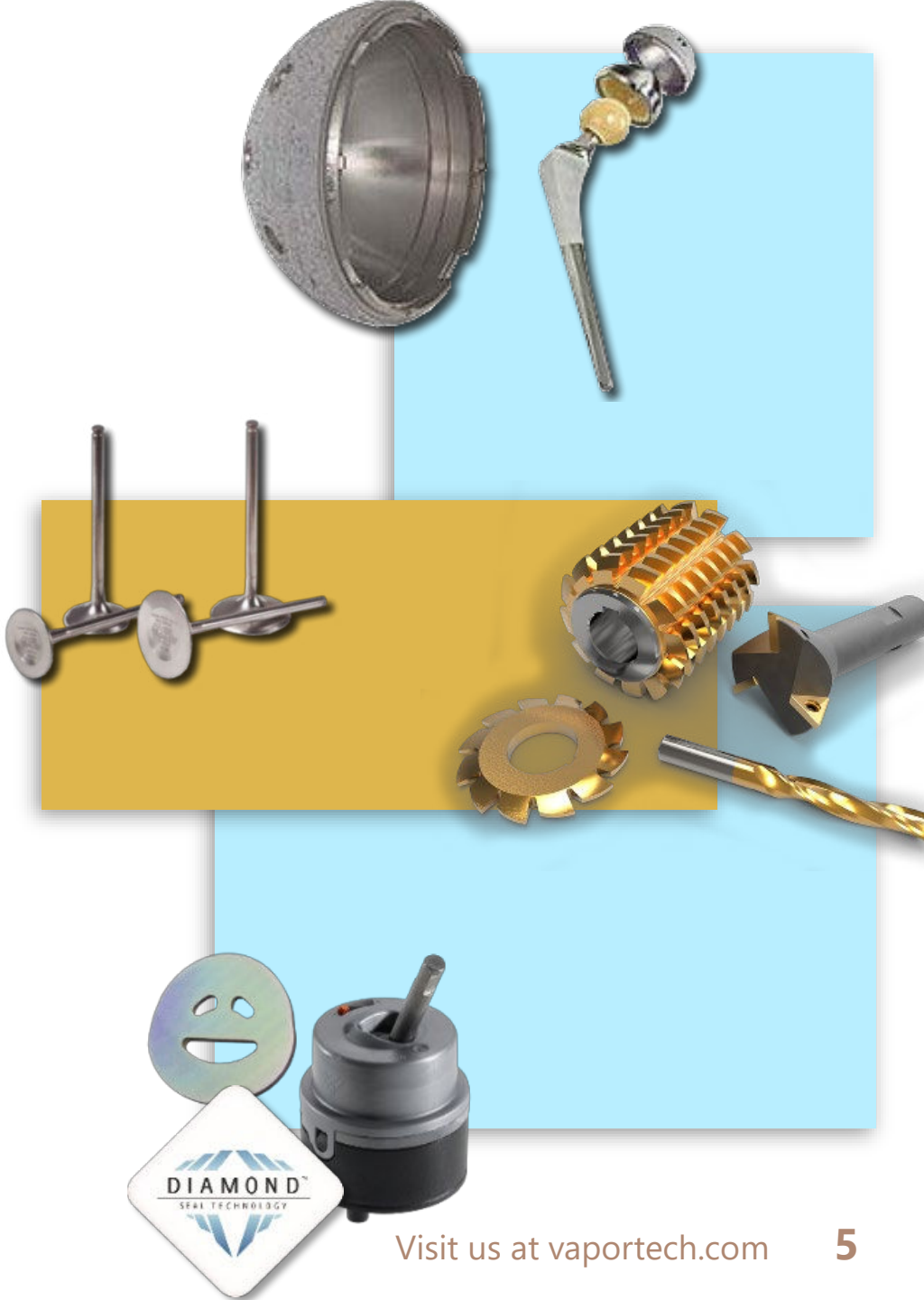
Applications

DEFINED

What is PVD coating used for?

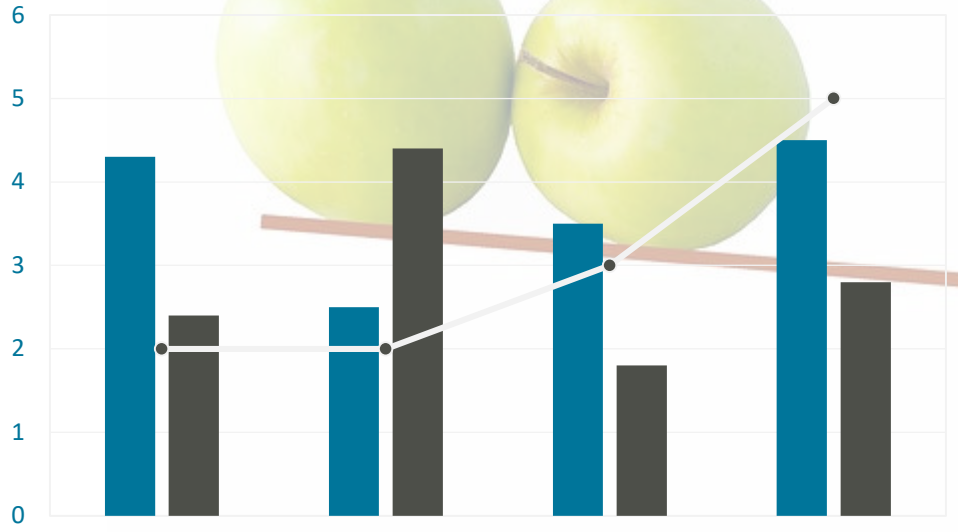
Wondering which industries routinely used PVD coating and for what applications?

- Automotive: Improve the function and durability of engine components and create a high-end look for auto and motorcycle interiors and trim.
  - Chassis
  - Engine components
  - Interior trim
- Home products – Create decorative finishes in many colors and add scratch/wear resistance to kitchen & bath fixtures.
  - Door hardware
  - Faucets (kitchen and bath)
  - Other plumbing products
- Consumer goods – Add quality, durability, great colors, and added value to products.
  - Jewelry
  - Promotional items
  - Watches
- Medical devices – Add chemical/wear resistance, hardness, and durable color without affecting product performance.
  - Dentistry
  - Orthopedics
  - Surgical instruments
- Sporting goods – Quality sporting goods must look great, perform well, and be extremely durable.
  - Firearms
  - Golf clubs



Compare

TO OTHER COATINGS



Thin film compared to powder coating

- Minimize part tolerance issues with a finish that is more than 50 times thinner
- Products last longer due to significantly increased hardness and resistance to wear.
- Improve UV resistance with a metal-based finish vs an organic polymer.

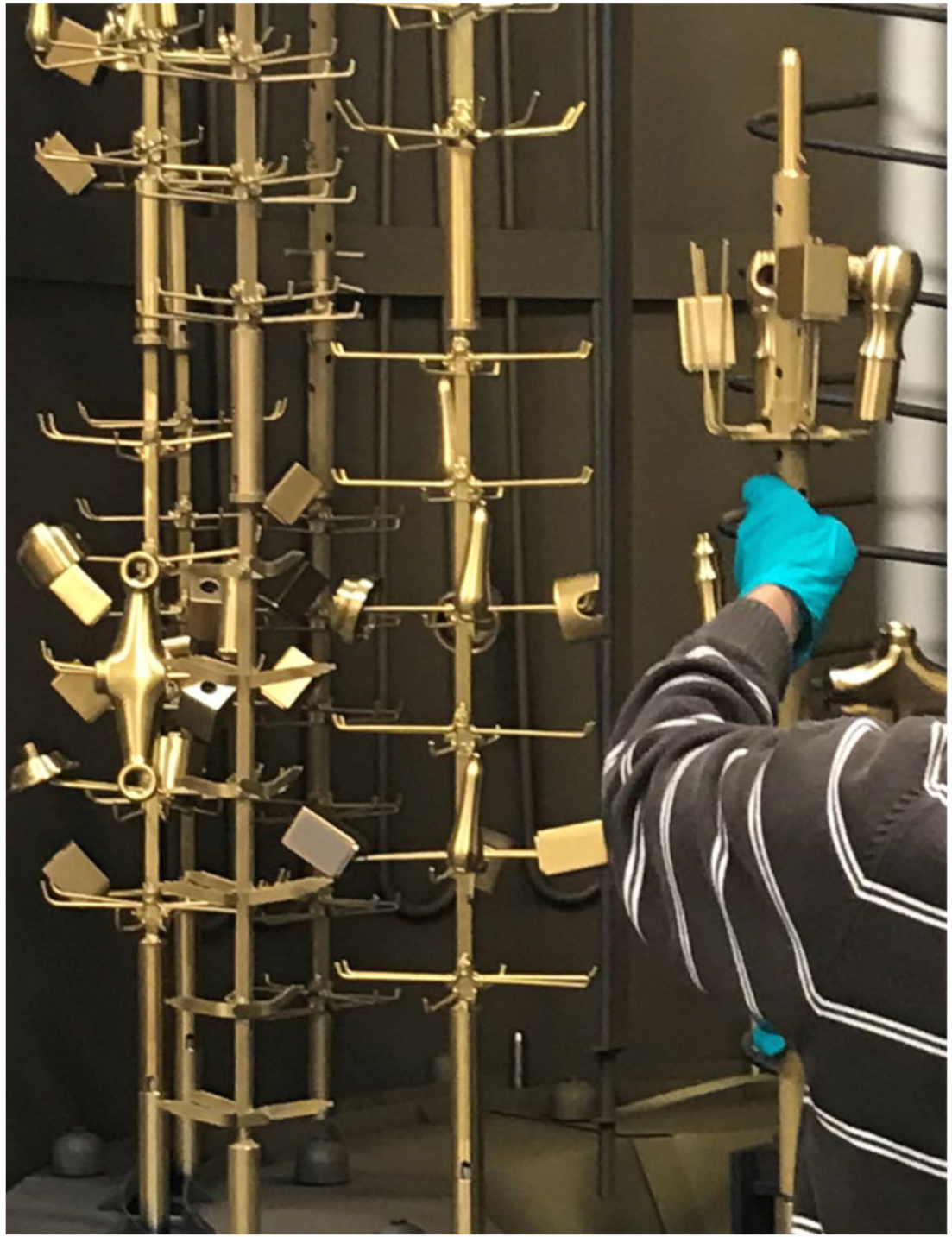
Thin film compared to electroplating

- Improved scratch and wear resistance due to increased hardness
- Differentiate a product with a broad range of metallic colors.
- An environmentally friendly process that does not require the use of acids, cyanides, or hexavalent chrome.
- Thin films can also be deposited over an electroplated base-layer to improve wear resistance and offer a broad range of colors.

Color

POSSIBILITIES

Thin-film deposition systems can apply durable coatings many part sizes and geometries in a wide range of colors.

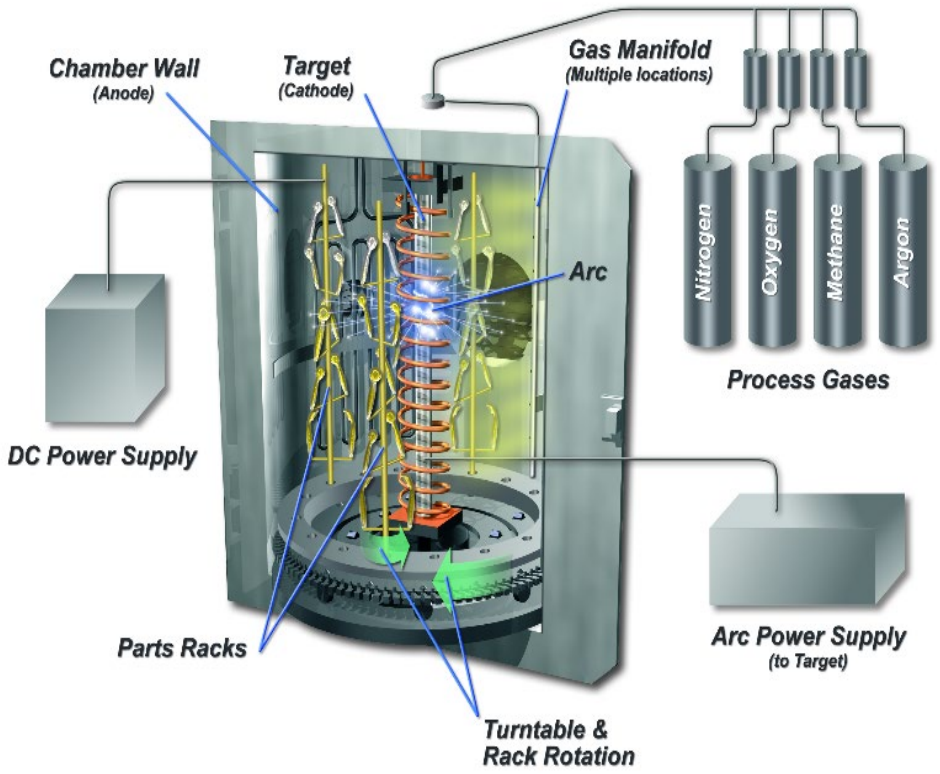


Parts

PROCESSING

1. Machined parts are cleaned to remove oils and particulates.
2. Parts are loaded onto carriers or “racks.”
3. Racks with parts are loaded into the vacuum chamber of a coating system.
4. The operator initiates an automated coating process.
5. Parts are unloaded and transferred to assembly or packaging.

The PVD process forms a thin, bonded, metal, or metal-ceramic layer on the surface that greatly improves a part or product's appearance, durability, and performance. The deposition process can be easily customized to change the color, wear-resistance, or other coating characteristics.



The Process

PHYSICAL VAPOR DEPOSITION

1. The coating system chamber is pumped down to a high vacuum.
2. Parts are etched/cleaned by creating a high-energy argon plasma in the chamber.
3. Energy is added to a metal target causing it to vaporize through a "cathodic arc" or "sputtering" process.
4. A high-voltage is applied to the parts to help draw vaporized metal to the surface.
5. A thin layer is deposited to improve coating adhesion, followed by one or more primary coating layers.
6. Small amounts of nitrogen, oxygen, or carbon-containing gases are added, which combine with the vaporized metal to form new compound materials with unique colors or functional characteristics.
7. The coating system chamber is cooled and brought back to atmospheric pressure.

PE-CVD (plasma-enhanced chemical vapor deposition) thin-film coating is a process in which the atoms in a gas are energized and deposited on a surface. DLC (diamond-like carbon) coatings are an example of a thin-film coating deposited using a PE-CVD process.

DLC is a carbon-based thin film that can provide extreme hardness, reduced friction, and a unique appearance. Typical DLC applications include tooling components, engine parts, razors, watches, firearms, and medical devices.

The Process

DIAMOND-LIKE CARBON

1. The coating system chamber is pumped down to a high vacuum.
2. Parts are etched/cleaned by creating a high-energy argon plasma in the chamber.
3. A thin adhesion layer is deposited on the part surface to enhance the DLC coating's adhesion.
4. A carbon-containing gas is added to the chamber as a carbon source.
5. A high voltage is applied to the parts to create an argon plasma that will break the gas's carbon bonds and deposit a diamond-like carbon finish on the part surfaces.
6. The coating system chamber is cooled and returned to atmospheric pressure.

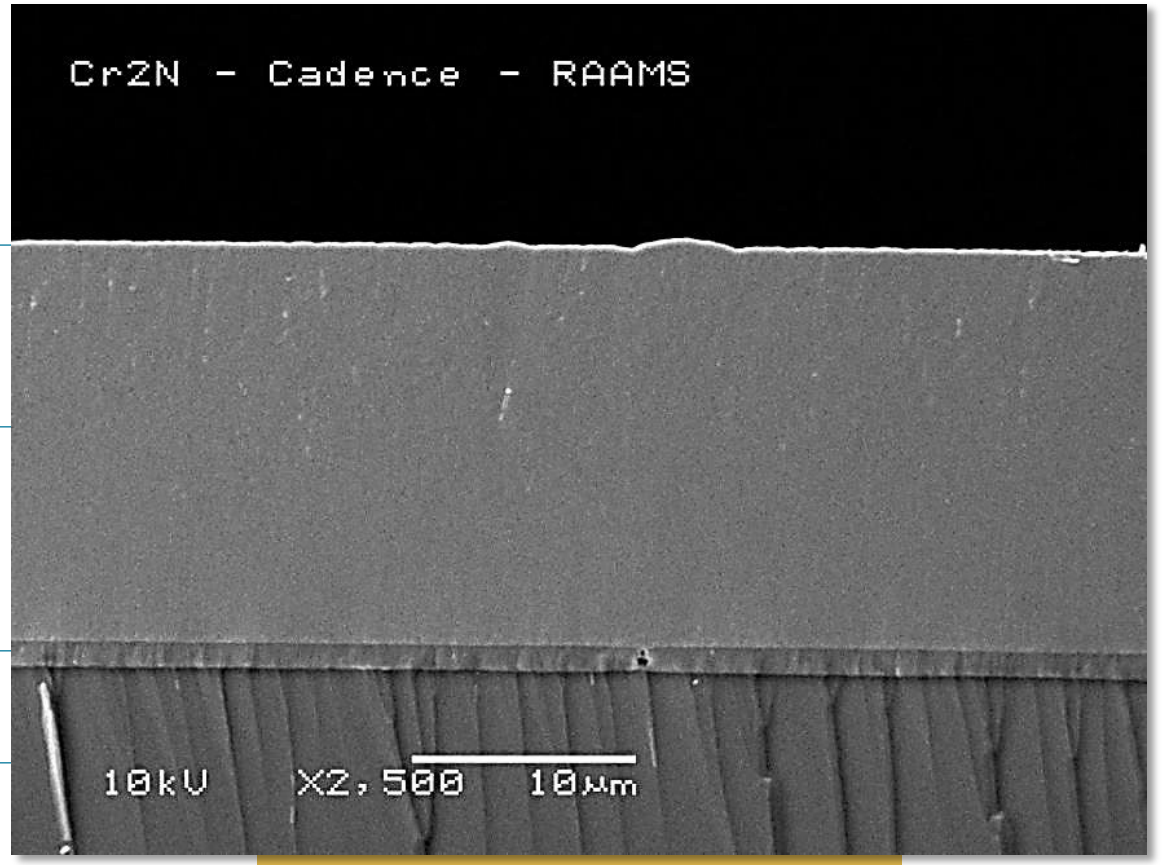
Magnified

WHAT COATINGS LOOK LIKE

The picture to the right is a cross-section of a functional chromium nitride coating, deposited by combining chromium metal with nitrogen gas, magnified 2,500 times under an electron microscope.

The bottom layer is the part's surface, followed by a thin layer used to improve coating adhesion, and finally the coating itself (the new durable surface of the part). This example coating is suitable for high-wear metal surfaces.

Extremely durable coating...



...suitable for high-wear metal surfaces.

Options

IN-HOUSE OR OUTSOURCE

- ✓ **Third-party coating** service providers coat your parts and products along with those of their other customers. You must package, send, wait for, and receive products before repackaging for sale.

- ✓ **In-house coating** equipment is integrated into your manufacturing and QC process and requires purchasing a piece of capital equipment. This investment can significantly lower your per-part coating costs, depending on your needs.

Service Providers

THE OUTSOURCING OPTION

01 Companies manufacture parts up to the coating stage, package their items, and send them to a provider.

02 The provider coats the items, repackages them, and returns them to the manufacturer.

03 Parts are received and returned to manufacturing for quality assurance.

04 Manufacturer repackages items for sale.

Outsourcing is a good solution for companies that:

- ✓ Don’t coat regularly.
- ✓ Coat low volumes of parts, thus minimizing equipment ROI and cost savings.
- ✓ Can manage supply chain delays.
- ✓ Can rework parts and manage lower yields.

In-house coating

MAKING THE CASE

Cost efficiency

Surprisingly low per-part coating costs—$20 a batch instead of $20 a part.

Time savings

Eliminate lead time delays and shipping expenses.

Quality control

Improve coating consistency and quality with control over the entire process.

Small footprint

New systems no longer require significant changes to the manufacturing floor.

Optimized coatings

Get the specific hardness, lubricity, durability & color you need.

Choose the right system

QUESTIONS TO ASK BEFORE BUYING

Which types of coatings can the system produce: If you introduce a new product or color, will it be challenging to use the same machine? Can you use the same chamber for PVD as well as DLC coatings?

Does the system come with your choice of standard coatings or with the R&D expertise to create optimized coatings?

Is the system right-sized to meet your needs? Don't invest in more (or less!) than you need.

Is the system footprint small enough to easily integrate into your facility?

How easy is the system to purchase, install, operate, and maintain?

Does the equipment manufacturer have the resources to support you from coating development to service throughout the life of your system?

VaporTech® Systems

RIGHT SIZE, RIGHT COATINGS

VT-1500*i*™

Compact, Price-Competitive, High-Capacity Hybrid Machine with Cathodic Arc and Sputtering Capabilities

Cadence™ systems

Compact, Fast, & Easy to Use Enhanced Magnetron Sputtering Machine for Performance Coatings

VT-1000*i*™

Compact, Higher-Capacity PVD Coating Machine for Medium-Size Operations.

VT-3000*i*™

High-Capacity Coating Machine for Large-Scale Operations

Glossary

OF INDUSTRY TERMS

Adhesion Layer: As part of the thin-film deposition process, a thin layer of metal is often deposited on the part to make the coating adhere more effectively to the surface. The coating equipment will automatically deposit the adhesion layer as part of the coating process.

Cathodic Arc: A PVD deposition method where a high-current electrical arc is applied to the surface of a target, causing the material to vaporize, ionize, and condense on a part.

Coating System: The equipment required to deposit PVD coatings consists of a vacuum chamber, pumping system, racking system to hold parts, power supplies used for deposition, and a control system/user interface.

Diamond-Like Carbon (DLC): A thin-film coating made primarily of carbon with a diamond-like structure, extremely hard surface, low coefficient of friction, and gray to black color. DLC is often deposited using the PE-CVD process.

Magnetron Sputtering: A PVD deposition method where plasma is created at the surface of a target material, causing ions to bombard the target surface and eject coating material towards the surface of a part.

PE-CVD (plasma-enhanced chemical vapor deposition): A thin-film process where elements in a gas (carbon, for example) are deposited on the surface of a part in a vacuum.

PVD (physical vapor deposition): A thin -film process where a solid metal or other material is evaporated in a vacuum and deposited on the surface of a part.

Reactive Deposition: A process where a small amount of gas is added to a vacuum deposition process. The gas combines with the vaporized target material to form a new compound coating. This process can change the coating's hardness, color, or other physical characteristics. An example would be adding nitrogen gas to chromium deposition, creating a more wear-resistant chromium nitride coating.

Target or Source: A term used to describe the solid coating material before deposition. Different coating systems use different shape targets. Some common target materials include zirconium, chromium, or titanium.

Thin-Film Coating: A general term for any functional or decorative finish applied with a vacuum deposition process.

Contact Us

TO LEARN MORE TODAY

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