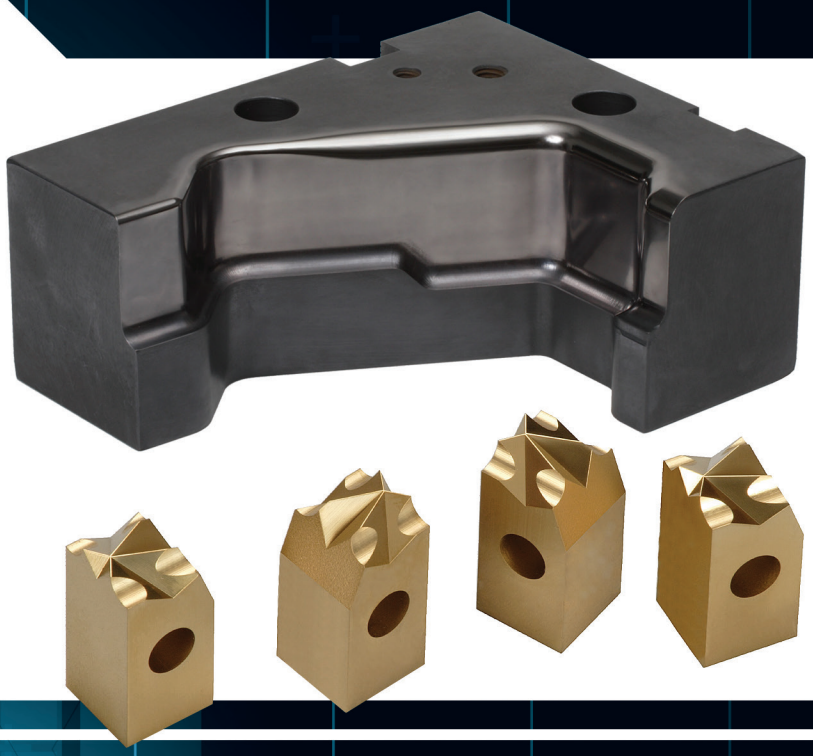
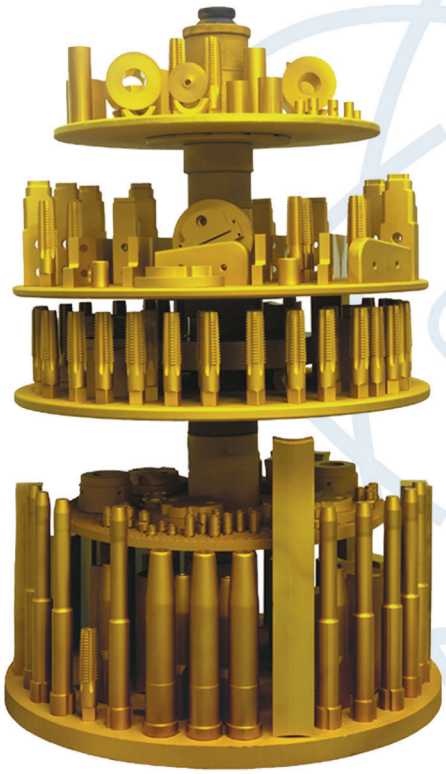


CVD

CHEMICAL VAPOR DEPOSITION

Progressive Coating Technology
For Metal Forming Applications

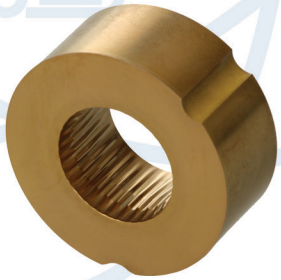
RICHTER PRECISION INC.

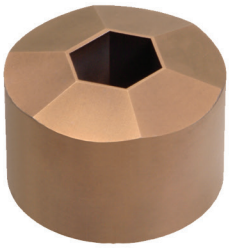


RICHTER PRECISION INC.

Richter Precision Inc. is North America's preeminent PVD, CVD, and DCD coating company. For more than 35 years, our coatings have been helping customers realize the full potential of their tools, thereby improving the efficiency and profitability of their manufacturing operations. Our one goal is to provide our customers with the best possible coating process and composition for their particular application.

We are pleased to provide Chemical Vapor Deposition (CVD) coating processes as part of our line of wear-resistant coatings. As one of the first companies in North America to provide CVD coating services, we are confident in our ability to provide superior CVD films. Our CVD coatings will unlock the full potential of your tools.





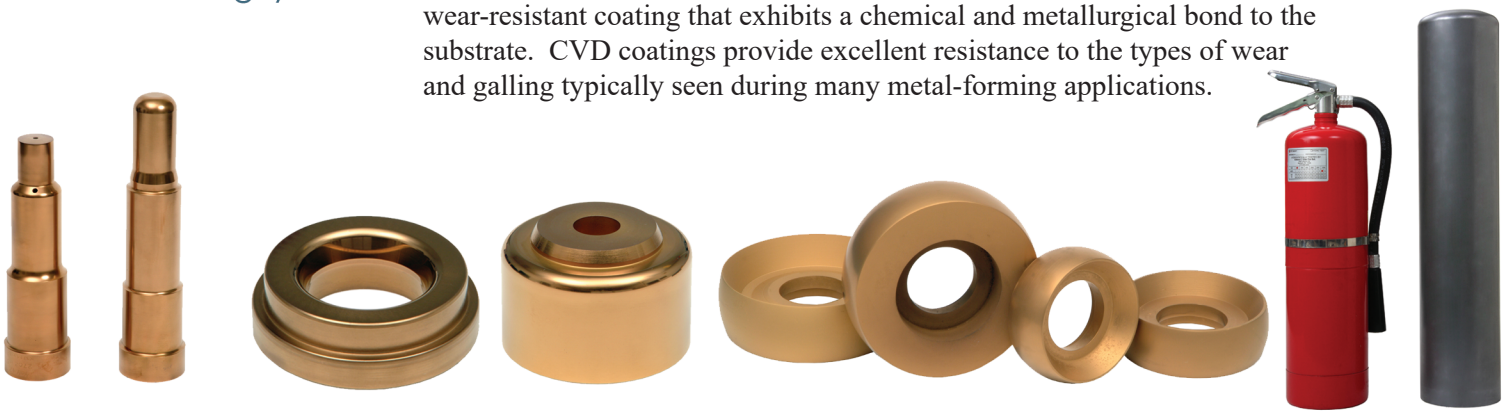
General Comparison of Process Characteristics

Process Characteristics	PVD Physical Vapor Deposition	CVD Chemical Vapor Deposition	DCD Dynamic Compound Deposition
Method	Processed in a vacuum chamber (10^{-2} to 10^{-4} mbar)	Processed in atmospheric or vacuum reactor	Processed in a proprietary vessel
Temperature	Low process temperature (320° to 800° F)	High standard process temperature (1925°F)	Low temperature process (100° F)
Deposition Limitations	Line of sight process	Coats wherever gases contact the tool surface	Coats wherever coating media contacts the surface
Bond Type	Physical	Chemical & metallurgical	Mechano-chemical
Average Thickness	1-5 μm, or .00004-.0002"	4-12 μm, or .00016-.00047"	0.5-2 μm, or .00002"-.00008"
Material Limitations	Suitable for a wide range of substrates	More limited range of substrates than for PVD	Suitable for a wide range of substrates
Tolerances	Ideal for closely toleranced components (+/-.0001)	Requires loose tolerances (ex.: +/-.0005 per 1.0" dia.)	Ideal for closely toleranced components (+/-.0001)
Post-Processing	No heat-treating required after coating	Heat-treating required on steel parts	No heat-treating required after coating
Edge Build-Up	No excessive coating build-up	Requires hone on edges due to thicker coating	No excessive coating build-up
Surface Finish	Coating generally replicates existing surface finish	Post-coating polish can achieve good finishes	Coating may have slight matte effect

RPI CVD Coating System

WHAT IS CVD COATING?

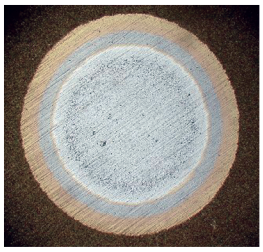
Chemical Vapor Deposition (CVD) is an atmosphere controlled process conducted at elevated temperatures (~1925° F) in a CVD reactor. During this process, thin-film coatings are formed as the result of reactions between various gaseous phases and the heated surface of substrates within the CVD reactor. As different gases are transported through the reactor, distinct coating layers are formed on the tooling substrate. For example, TiN is formed as a result of the following chemical reaction: $TiCl_4 + N_2 + H_2$ 1000° C → $TiN + 4\ HCl + H_2$. Titanium carbide (TiC) is formed as the result of the following chemical reaction: $TiCl_4 + CH_4 + H_2$ 1030° C → $TiC + 4\ HCl + H_2$. The final product of these reactions is a hard, wear-resistant coating that exhibits a chemical and metallurgical bond to the substrate. CVD coatings provide excellent resistance to the types of wear and galling typically seen during many metal-forming applications.



CVD IN METAL FORMING APPLICATIONS

CVD coatings are used in many manufacturing applications as a wear-resistant coating: carbide milling and turning inserts, wear components, some plastic processing tools, etc. However, the most common application for CVD coating is for metal-forming tools.

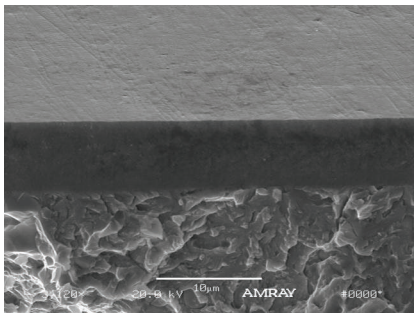
In high stress metal-forming applications, where the tool's tolerances and substrate permit, high temperature CVD coating processes will perform better than "cold" processes like PVD, thin-dense chrome (TDC), nitriding, etc. The chemical/metallurgical bonding that results from the CVD coating process creates adhesion characteristics that simply can not be duplicated by a "cold" process. This enhanced adhesion protects forming tools from the sliding friction wear-out caused by the severe shearing stresses generated in heavy metal-forming applications.



Ball Crater Test
100x magnification

Typical Metal-Forming Applications for CVD Coating

- Punches
- Draw Dies
- Forging Tools
- Trim Dies
- Stamping Tools
- Wire Draw Dies
- Extrusion Dies
- Coining Dies
- Trim Dies
- Swaging Dies
- Sizing Dies
- Form Rolls
- Seaming Rolls
- Cold Heading Tools
- Crimping Tools
- Tube Bending Dies



SEM Image of Titankote H
CVD Film

Titankote™ H+ [TiC]

This mono-layer CVD coating has excellent bonding properties that make it a great choice for heavy load applications like metal-forming, stamping, extrusion, and cold-heading. The high hardness of the TiC layer provides excellent abrasion resistance.

Titankote™ H+S [TiC/(Mo, W)S_2]

This coating has excellent bonding properties that make it a great choice for heavy load applications like metal-forming, stamping, extrusion, and cold-heading. The TiC CVD layer has extremely strong bond strength and provides excellent abrasion resistance. The (Mo, W)S_2 dry-film lubricant layer of this coating greatly reduces the friction between tooling and work piece, reduces pick-up of material, and improves the release properties. When the tooling substrate and the tolerances allow, this coating works well in forming most materials.

Titankote™ H [Multi-layer TiN/TiCN/TiC/TiN]

This multi-layer CVD coating has excellent bonding properties that make it a great choice for heavy load applications like metal-forming, stamping, extrusion, and cold-heading. The cumulative effect of the four layers in this multi-layer coating makes it our first choice for most heavy-forming applications. This coating also works well as a general coating for carbide milling and turning inserts.

Michigan

RICHTER PRECISION INC.
21427 Carlo Drive
Clinton Township, MI 48038
Phone: (586) 465-0500
E-Mail: info@richterprecision.com

Michigan

RICHTER PRECISION INC.
34270 Riviera Drive
Fraser, MI 48026
Phone: (586)-465-0500
E-Mail: info@richterprecision.com

Pennsylvania

RICHTER PRECISION INC.
1021 Commercial Ave., Box 159
East Petersburg, PA 17520
Phone: (717) 560-9990
Fax: (717) 560-8741
E-Mail: info@richterprecision.com

WWW.RICHTERPRECISION.COM
Call 1-800-RICHTER
with any coating questions