



TiFusion™
DUPLEX PVD COATING TECHNOLOGY

Taking PVD Coating
To The Next Level

RICHTER PRECISION INC.

RICHTER PRECISION INC. ● ● ●

Richter Precision Inc. is North America's preeminent PVD, CVD, TD and DCD coating company. Since 1978, our focus has been on helping customers improve the efficiency and profitability of their tools and products through the deposition of advanced thin-film coatings. We have developed numerous technologies to meet a wide range of challenges. Our TiFusion™ PVD coating technology, developed primarily for metal-forming and other high load applications, represents our company's latest efforts to provide high performance solutions to customer's manufacturing challenges.

What Is TiFusion™ PVD Coating ● ● ●

TiFusion™ is Richter Precision Inc.'s proprietary "duplex" coating process. A duplex coating simply refers to the combination of two different surface treatments. In the case of our TiFusion™ process, a combination of plasma nitriding and PVD (Physical Vapor Deposition) coating is used to improve both the wear resistance and fatigue properties of coated substrates. The TiFusion™ process provides exceptional tool performance, close to CVD and TD processes, but without the dimensional instability of those higher temperature coating technologies.



Nitriding ● ● ●

Nitriding is a ferritic thermochemical process that diffuses nitrogen into the surface of metals to form a case-hardened layer. Nitride-forming elements such as aluminum, chromium molybdenum and titanium are needed to form the nitride case layer. This layer is produced without quenching and the resulting distortion problems. Both the surface hardness and fatigue life on the nitrided tool are greatly improved.

PVD Coating ● ● ●

Physical Vapor Deposition (PVD) is a vacuum coating process that involves the bombardment of the substrate with energetic positively charged ions to promote high film density. Reactive gases such as nitrogen, acetylene or oxygen are introduced into the chamber during metal deposition to create various coating compositions. These films have a strong bond and tailored physical, structural and tribological properties.

TiFusion™ combines the advantages of nitriding and PVD...

Nitriding Advantages:

- Improved surface hardness
- Enhanced fatigue resistance
- Anti-galling properties
- Improves corrosion resistance

PVD Coating Advantages:

- High micro-hardness improves wear resistance
- Very high temperature resistance
- Reduced coefficient of friction
- Replicates existing surface finish

Additional Advantages gained through the TiFusion™ Process:

- Relatively low processing temperatures ($\leq 500^{\circ}\text{C}/932^{\circ}\text{F}$) allows us to maintain tight tolerances
- The reduction in the hardness gradient between the coated surface and the substrate results in improved coating adhesion and overall tool durability
- Provides better distribution of contact stresses
- Improves impact resistance and restricts plastic deformation of the base material

Characteristics of the TiFusion™ Coating Process ● ● ●

- Performed in a vacuum (10^{-2} – 10^{-4} mbar)
- Relatively low process temperature ($\leq 500^{\circ}$ C/ 932° F)
- Line of sight PVD coating deposition
- PVD coating exhibits a physical bond to the substrate
- Average PVD coating thickness: 2-6 μ m, or .00008-.00024"
- Nitrided case layer depth will vary depending on base material
- Suitable substrates may be more limited than standard PVD coating
- Ideal for components with close tolerances ($\pm .00005$ " is appropriate)
- No post-coating heat-treating is required
- Parts can be pre-/post-polished to improve the surface finish and tool performance



Materials suitable for the TiFusion™ process: ● ● ●

4140	CPM 10V®	H13	P20
A2	Cru-Wear®	M2	S7
A6	D2	M4	Vanadis 4®
Caldie®	DC53	NAK55®	...and many more!

Most air-hardenable tool steels and high speed steels are compatible with the TiFusion™ coating process. The suitability of materials should be discussed with your technical sales representative before sending them to us for processing.

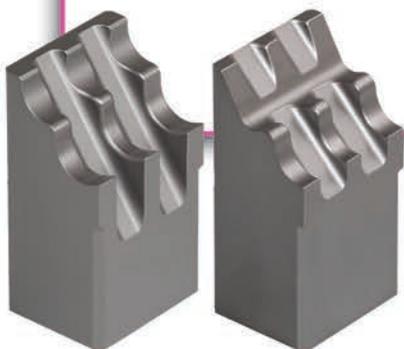
Additionally, tools should be hardened and tempered prior to sending them to us for processing. You will also want to confirm that the final tempering temperature is high enough to ensure that no distortion and/or softening of the parts occurs during the TiFusion™ coating process.

Typical applications for the TiFusion™ process:

Extrusion Punches & Dies
Embossing Rolls

Draw Punches & Dies
Bending Dies
Forging Dies
Coining Punches & Dies

Plastic Injection Molds
Rubber Molds
Die-Casting Molds & Cores



Standard TiFusion™ PVD Coating Processes

Proprietary Name	Composition	Color	Thickness (microns)	Mi-cro-Hardness (HV)	Coefficient of Friction	Max. Working Temp.	Process Temp.*
TiFusion™ C	TiN	Gold	1-5	2300-2500	0.35	600°C/1112°F	≤ 500°C/932°F
TiFusion™ C2-SL	AlTiN-CrN	Gray	4-6	3200-3500	0.35	1000°C/1832°F	≤ 500°C/932°F
TiFusion™ C2-SL+S	AlTiN-CrN/(Mo, W)S ₂	Gray	4-6	3200-3500	0.15	1000°C/1832°F	≤ 500°C/932°F
TiFusion™ C3	CrN/CrC	Silver/Gray	3-5	2000-2200	0.35	700°C/1292°F	≤ 500°C/932°F
TiFusion™ C3+S	CrN/CrC/(Mo, W)S ₂	Gray	3-5	2000-2200	0.15	700°C/1292°F	≤ 500°C/932°F
TiFusion™ C6	AlTiN	Violet/Black	2-4	3000-3400	0.35	900°C/1652°F	≤ 500°C/932°F
TiFusion™ C6+S	AlTiN/(Mo, W)S ₂	Violet/Black	2-4	3000-3400	0.15	900°C/1652°F	≤ 500°C/932°F
TiFusion™ C14	C-DLC	Black	1-2	2200-4000	0.06-0.15	350°C/662°F	≤ 500°C/932°F

Data has been generated from lab samples. Characteristics may vary depending on customer's material, surface condition and part geometry.

*- the processing temperature may vary depending on the material being processed.

TiFusion™ C [duplex TiN]- typical applications for this coating include improving erosion resistance in the gating areas of plastic injection molds, while also improving flow and release characteristics.

TiFusion™ C2-SL [duplex AlTiN-CrN super lattice]- this coating is used for heavy metal-forming applications, especially when forming HSLA, Dual Phase and stainless steel materials. The high temperature resistance of this coating also makes it ideal for higher temperature applications, including forging and die-casting.

TiFusion™ C2-SL+S [duplex AlTiN-CrN/(Mo, W)S₂ super lattice]- also used for heavy metal-forming applications, this coating has an added dry-film lubricant layer to reduce galling.

TiFusion™ C3 [duplex CrN/CrC]- this chrome-based coating worked very well in both aluminum die-casting and rubber molding applications.

TiFusion™ C3+S [duplex CrN/CrC/(Mo, W)S₂]- the addition of a dry-film lubricant combined with the better ductility of this film can make this a good choice for higher impact applications.

TiFusion™ C6 [duplex AlTiN]- this is a good general purpose coating process for both metal-forming and die-casting applications.

TiFusion™ C6+S [duplex AlTiN/(Mo, W)S₂]- a good general purpose coating for metal-forming applications, with an added dry-film lubricant layer to reduce galling.

TiFusion™ C14 [duplex C-DLC]- typical applications for this coating include improving performance of plastic injection molds, powder compaction tooling & some metal-forming applications.

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