Phygen℠

FortiPhy℠

Chromium Nitride Coating

Phygen's patented[1] Physical Vapor Deposition (PVD) coating technology allows the deposition of extremely tough and hard coatings with much higher abrasive wear resistance than is provided by conventional PVD processes. The technology is based on principles of Plasma Acceleration and results in a higher plasma density and an intense low energy ion bombardment during the coating deposition. With Phygen's environmentally-friendly PVD process, a wide variety of coatings (metals, alloys and compounds) can be adhered to virtually any substrate.

FortiPhy℠ Chromium Nitride coatings, deposited by Phygen's PVD process, exhibit extreme hardness and toughness superior to the best conventional PVD-based coatings. Phygen's technology provides a unique combination of coating properties by creating a thin and dense, non-columnar coating structure having the highest possible adhesion level to virtually any substrate material. The microstructure of the coating is controlled by precise process parameters and, as a result, the FortiPhy Chromium Nitride coating constitutes an exceptionally thin, single-phase, stoichiometric, nanocrystalline chromium nitride with a highly textured dense structure that maintains the critical dimensions of the coated tool or component.

[1] U.S. Patent 6,103,074

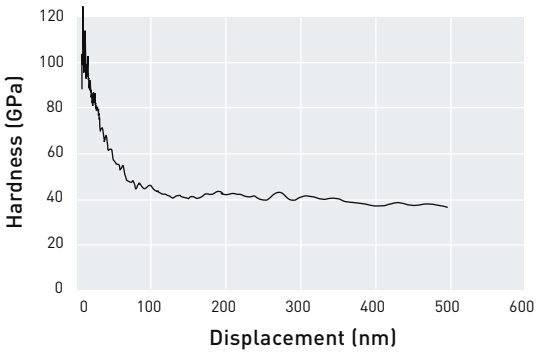
BENEFITS

- FortiPhy coatings are less brittle and tougher than conventional hard PVD coatings and may withstand much higher mechanical loads.
- The microhardness of the FortiPhy Chromium Nitride coating exceeds that of conventional PVD chromium nitride coatings.
- The combination of high hardness and toughness results in exceptional abrasive wear resistance.
- The coating possesses low friction properties (C.O.F. less than 0.1) under properly lubricated conditions in an oxidizing environment.
- The coatings are chemically and thermally stable in air up to 850° C (1550° F).
- The coatings are chemically inert and provide excellent corrosion resistance because of their dense, non-columnar microstructure.
- The thin but extremely wear resistant FortiPhy Chromium Nitride coating, deposited by using Phygen's patented PVD process, results in virtually no change to critical dimensions of the coated tools or precise components.

Physical and Mechanical Properties of FortiPhy℠ Chromium Nitride Coating

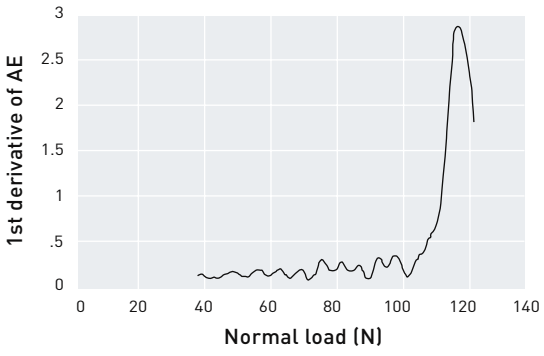
Crystal structure	fcc
Microstructure	non-columnar equiaxially grained structure
Modulus of elasticity (GPa)	400
Knoop microhardness @ 200g load, (HK)	3000 – 3500
Nanoindentation hardness (GPa)	30 – 50 (SEE FIG.1)
Coefficient of friction:	
– Diesel fuel lubricated	0.09 – 0.12
– Dry nitrogen	0.18 – 0.22
Surface roughness, Ra (nm)	40 – 70
Coating wear rate: Ball-on-disk test, 100g, 440C steel ball, (mm3/N·m)	$2x10^{-6}$ – $6.7x10^{-8}$
Coefficient of thermal expansion (x10-6/K)	2.3 (20 – 800°C) 7.5 (850 – 1040°C)
Scratch Test Critical Load (N)	115 – 120 (SEE FIG.2)

FIGURE 1



Nanoindentation hardness versus displacement (i.e., diamond indenter penetration depth) plot. The horizontal portion of the graph represents the nano-hardness value.

FIGURE 2



First derivative of acoustic emission signal (AE) produced during Scratch Adhesion Test. The peak position on the graph indicates Critical Load value when the coating starts to fracture.

Phygen

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