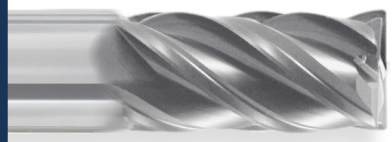
SURFACE TREATMENTS & COATINGS

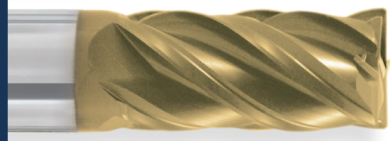
SELECT ADVANCED SPECIALTY COATING

Certain applications, materials or performances simply require the enhancement of a specialty coating and knowledge of the properties of the coatings available. Temperature, friction resistance, hardness, lubricity, toughness and cohesion of the resulting process must be examined prior to the selection.



UNCOATED

- For general purpose machining on low power machines
- Not recommended for most cutting applications

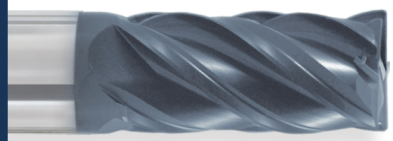


TIN (TITANIUM NITRIDE)

- Suitable for use as a general purpose coating in a wide range of materials
- Intended for moderate improvements in tool life and machining
- Increased machining speeds of 20 – 30%

TICN (TITANIUM CARBON NITRIDE)

- For aggressive machining of tool steels, high carbon steels and high silicon aluminums
- Improved wear resistance, 30% higher hardness than TiN
- Increased machining speeds of 25 – 35%

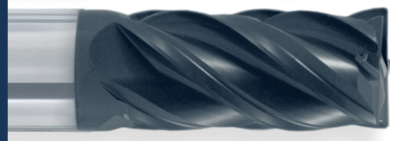


TIALN-X (TITANIUM ALUMINUM NITRIDE NANO)

- Aggressive machining of stainless & high carbon steels; nickel-based hi-temp & ti-alloys
- Ideal for roughing and interrupted cuts
- Increased machining speeds 30 – 45% and tolerates thermal stresses

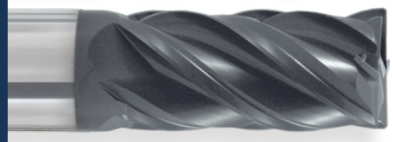
ALTIN-X (ALUMINUM TITANIUM NITRIDE NANO)

- Has the highest temperature resistance of any of the standard available coatings
- Similar to TiAlN-X; Best for dry machining cast iron, titanium, Inconel, and stainless alloys where machine power is available to generate adequate heat; Increased machining speeds 35 – 45%



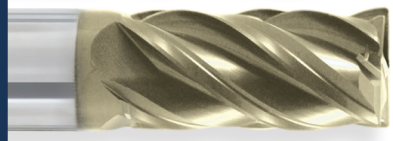
ALTIN/SI3N4 (ALUMINUM TITANIUM NITRIDE/ SILICON NITRIDE)

- Unique nanocrystalline AlTiN and amorphous Si3N4 deposits create a honeycomb-like structure
- Extremely hard and tough with excellent wear and abrasion resistance. Up to 35% greater tool life.
- Provides a near diamond-like coating (DLC) for high temp alloys and hardened materials



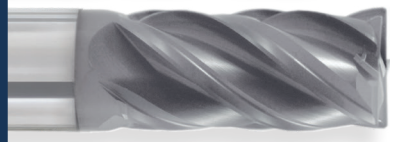
ALCRN/SI3N4 (ALUMINUM CHROMIUM NITRIDE NANO)

- Unique nanocrystalline AlCrN and amorphous Si3N4 deposits create a honeycomb-like structure
- Run dry or wet in extreme cutting conditions. Increased machining speeds of 40 -50%
- Improved wear performance at the cutting edge by uniform distribution of mechanical force



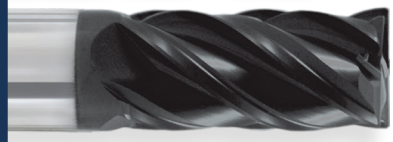
ZRN (ZIRCONIUM NITRIDE)

- Ideal for machining aluminum, plastics and other non-ferrous materials
- High lubricity reduces built up edge and hardness improves tool life
- Excellent surface finishes



TIB2 (TITANIUM DIBORIDE)

- Reduced costs when machining aluminum, titanium, magnesium and copper
- Higher speeds and chip removal rate due to its smooth surface and low coefficient of friction
- Provides increased wear resistance



AMORPHOUS DIAMOND

- For high speed machining of graphite, carbon fiber, composites and abrasive materials
- Extremely high thermal conductivity, hardness and lubricity
- Removes heat from the cutting edge and has best tolerance retention

Additionally, 16 specialty coatings are available for specific applications as may be necessary. Due to the small batch nature of these unlisted coatings, minimum batch orders may apply.

APPLICATION, IDENTIFICATION AND BENEFITS

The correct coating for your tool can produce significant time and money savings. Additionally, coatings will increase tool life and performance. The chart below can help you identify the correct coating for your particular application.

	INADVISABLE	GENERAL PURPOSE		FERROUS	
	UNC	TiN	TiCN	TiAlN-X	AlTiN-X
APPLICATION / BENEFITS		General purpose coating for machin ing ferrous materials. Improves tool life by acting as a thermal and chmical barrier betwee ltool and workpiece. A good low cost alternative to AlTiN in applications with low material removal rates.	Increased tool productivity over TiN with higher feed and speed capabilities. Considered supplimental and offered as an option when AlTiN-X cannot be used, as in applications which do not generate the speeds and feeds required for high cutting temperatures.	High performance coating designed for machining in demanding, dry, hard metal milling applications. Excellent high temperature resistance and hardness. Maintains high surface hardness even at elevated temperatures, improving tool life and allowing faster feed rates.	Premium coating for ferrous materials, the latest generation of AlTiN coating with a unique nanocomposite structure which improves hardness, heat resistance and toughnes over traditional AlTiN cotings. Superior results, extended tool life and reduced cycle tmes over traditional AlTiN coatings in demanding applications.
MATERIALS		Easy to machine ferrous and non ferrous materials.	Moderate machinability ferrous, cast irons, brass, bronze, copper, plastics and high silicon aluminum alloys.	Moderate to difficult to machine alloy steels, stainless steels, tool steels, titanium, inconel, nickel, and other aerospace materials.	Moderate to difficult to machine harneded steels, stainless steels, tool steels, nickel based alloys, titanium alloys, inconel and other aerospace materials.
COLOR		Gold	Silver-Gray	Dark Gray / Black	Violet / Black
STRUCTURE		Monolayer	Gradient	Nano Monolayer	Nano Multilayer
HARDNESS (HV 0.05)		2300 - 2500	3000 - 3200	3200 - 3400	3300 - 3800
COEFFICIENT OF FRICTION		0.40 - 0.65	0.30 - 0.45	0.45 - 0.55	0.45 - 0.55
COATING THICKNESS		1 - 4	1 - 4	1 - 4	1 - 4
MAX WORKING TEMP		1100 F / 600 C	750 F / 400 C	1450 F / 800 C	1650 F / 900 C

	FERROUS		NON-FERROUS / EXOTICS		HI-TEMP & EXOTICS
	AlCrN Si3N4	AlTiN Si3N4	ZrN	TiB2	DIA
APPLICATION / BENEFITS	Features a unique nanocrystalline AlCrN deposit, where the voids are filled with Si3N4, creating a honeycomb effect which greatly increases both hardness and heat resistance. Designed to wear evenly and resist chipping which occurs in other materials, resulting in extremely high temperature resistance and consitent performance in challenging applications. Dry or wet, the AlCrN-X excels in interupted cuts.	Features a unique nanocrystalline AlTiN deposit, where the voids are filled with Si3N4, creating a honeycomb effect which greatly increases both hardness and heat resistance. The hardness and heat resistant properties of this coating are the highest available, outside of DLC. Incredibly extended tool life and reduced cycle times when high speed machining without coolant.	Excellent non-ferrous material solution due to high hardness, lubricity and abrasion resistance. Works well with gummy workpiece materials due to its lubricity and edge retention properties.	Maintains extremely high metal removal rates in aluminum due to its incredibly low affinity to the material. Prevents edge material building up on the edge and chip packing. Has a high hardness, toughness and working temp making it an excellent cross over into hi-temp alloys.	A thick crystaline diamond (CVD) is grown directly on the substrate. Hardness and abrasion resistance are increased for extended tool life in abrasive materials. Amorphous diamond is similar in performance to a CVD diamond, though it is deposited through a PVD process, reducing both price and performance in comparable materials. The thinner PVD coating lends well to machining applications which require a sharper tool edge.
MATERIALS	Moderate to difficult to machine harneded steels, stainless steels, tool steels, nickel based alloys, titanium alloys, inconel and other aerospace materials.	Moderate to difficult to machine harneded steels, stainless steels, tool steels, nickel based alloys, titanium alloys, inconel and other aerospace materials.	Specifically designed for aluminum, works well in abrazive non-ferrous alloys such as brass, copper, bronze, fiberglass and composites.	High silicon aluminium alloys, titanium alloys, magnesium alloys and copper alloys.	Abrasive materials, plastics, graphite, carbon fiber, high silicon alloys, composites, green carbides and green ceramics.
COLOR	Silver-Gray	Blue-Black	Light Gold / Champagne	Light Gray / Silver	Black
STRUCTURE	Nano Composite	Nano Composite	Monolayer	Monolayer	Monolayer
HARDNESS (HV 0.05)	4000 - 4200	4400 -4600	2300 - 2500	3800 - 4200	8500 - 10000
COEFFICIENT OF FRICTION	0.35 - 0.40	0.40 - 0.45	0.50 - 0.60	0.40 - 0.50	0.05 - 0.30
COATING THICKNESS	1 -5	1 - 4	2 - 5	1 - 3	0.5 - 8
MAX WORKING TEMP	2010 F / 1100 C	2190 F / 1200 C	1100 F / 600 C	1550 F / 850 C	1100 F / 600 C

FOR MORE INFORMATION ON OUR SPECIALTY COATING PROGRAM, SEE PAGE 21

COATING SELECTION GUIDE

SELECTING THE OPTIMAL COATING FOR YOUR APPLICATION & MATERIAL

The chart below will guide you to the best choice of coating for you tool, dependent on your application's material. Feeds and speeds can be increased significantly when using the proper coating. All coatings create a benefit, provided the best coating is selected.

ISO GROUP	SYMBOL	HARDNESS	DESCRIPTION	TiN	TiCN	TiAlN-X	AlTiN-X	AlCrN Si3N4	AlTiN Si3N4	ZrN	TiB2	DIA
P 1 - 11	ST CARBON STEEL LOW CARBON	≤ 38 HRC	10xx; 11xx; 12xx; 12Lxx; 15xx; etc	★	★★	★★	★★★					
	ST CARBON STEEL MEDIUM CARBON	≤ 38 HRC	13xx; 41xx; 43xx; 86xx; 92xx; etc		★	★★	★★★					
	TS TOOL STEEL ≤ 38 HRc	≤ 38 HRC	A2; A3; D2; H11; H13; M1; O1; S7; NAK 55; etc		★	★	★★	★★★	★★★			
	TS TOOL STEEL 39-48 HRc	39 - 48 HRC	P20; P21; S-136; PX-5; NAK 80; etc		★	★	★★	★★★	★★★			
H 38 - 41	HS HARDENED STEEL 48-57 HRc	48 - 57 HRC			★	★	★★	★★★	★★★			
	HS HARDENED STEEL 58-65 HRc	58 - 65 HRC			★	★	★★	★★★	★★★			
M 12 - 14	SS STAINLESS STEEL EASY	72 - 85 HRB	410; 416; 420; 430F; 440C; 302; 303; etc		★	★	★★	★★★	★★★			
	SS STAINLESS STEEL MODERATE	25 - 41 HRC	304; 304L; 316; 316L; 320; 321; 347; Invar 36; Kovar		★	★	★★	★★★	★★★			
	SS STAINLESS STEEL DIFFICULT	31 - 50 HRC	13-8 PH; 15-5 PH; 17-4 PH; Carpenter; Invar		★	★★	★★	★★★	★★★			
K 15 - 20	CI CAST IRON GRAY	100 - 200 HRB	Gray		★★	★	★★	★★★	★★★			
	CI CAST IRON DUCTILE	150 - 300 HRB	Ductile		★★	★	★★	★★★	★★★			
	CI CAST IRON MALLEABLE	150 - 310 HRB	Malleable		★★	★	★★	★★★	★★★			
S 31 - 37	TI TITANIUM ALLOYS 25-36 HRc	25 - 36 HRC	6AL4V; Grades 5-38; etc			★	★★	★★★	★★★		★★★	
	HI HI-TEMP ALLOYS 30-52 HRc	30 - 52 HRC	Inconel, Model, Hastalloy, etc			★	★★	★★★	★★★		★★★	
N 21 - 28	AL ALUMINUM ALLOYS Low Si (<10%)	LOW SI (< 10%)	20xx; 50xx; 60xx; 70xx; etc	★	★★					★★★	★★★	
	AL ALUMINUM ALLOYS High Si (>10%	HIGH SI (> 10%)	A-38x; A-39x; B-39x; etc		★					★★	★★★	★★★
	MG MAGNESIUM ALLOYS ≤ 38 HRc	≤ 38 HRC			★					★★	★★★	
	CA COPPER ALLOYS 39 - 48 HRc	39 - 48 HRC	Manganese & Tin Bronze, Beryllium Copper	★	★★					★★	★★★	
	CG CARBON & GRAPHITE 48 - 57 HRc	48 - 57 HRC		★	★★							★★★
	PL PLASTICS & COMPOSITES 28 - 57 HRc	28 - 57 HRC		★	★★					★★		★★★

★ = good ★★ = better ★★★ = best

OUR TOOLS HAVE BEEN USED IN EVERY APPLICATION IMAGINABLE, FROM SCULPTURAL ICE CARVING TO PRECISION MANUFACTURING OF CUSTOM NUCLEAR REACTOR PARTS.