PVD

PVD coating

for molds, cutting tools and machine parts

A full lineup of coatings, change manufacturing technology

株式会社 北熱

HOKU-NETSU
Surface Technology

PVD coating

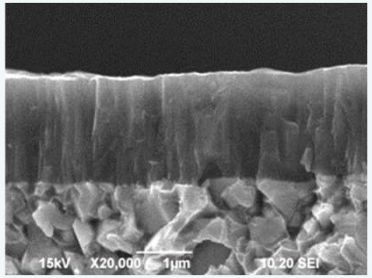
HOKU-NETSU Surface Technology

- High hardness value (2,000 – 3,000HV)
- Low process temperature (under 500 ℃)
- No change in dimensions (coating thickness at 3 μm)

*Based on the characteristic of our standard coating

Thin and hard metal-ceramic film

- Enable to extend product lifetime significantly by forming a thin and hard metal-ceramic film (TiN, CrN etc.) onto the top surface of cutting tools or molds.
- Achieves excellent wear resistance, due to hardness value of metal-ceramic film range from 2,000-3,000HV, it's about 3-7 times harder than general heat treated tool steel.
- Process temperature of PVD coating is under 500 ℃, therefore, no heat treatment is required for dies steel or high-speed steel, it minimizes the change in dimensions.
- Typical thickness of metal-ceramic film is 3 μm, it also can be used for high-performance molds.



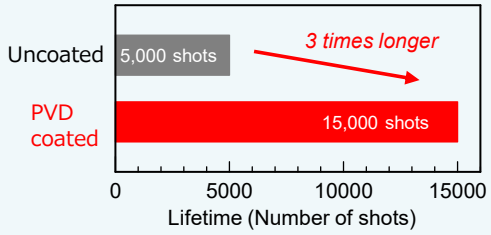
A cross-sectional observation of PVD coated surface layer

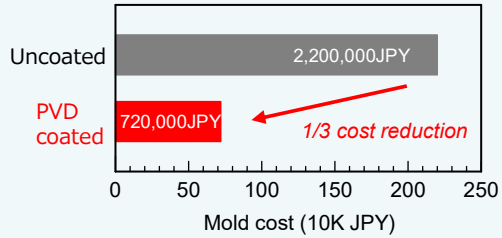
Increasing lifetime of the tools lead to improve productivity

Mold is the most expensive part of the molding project, longer the mold lifetime means lower the cost.

Longer the mold lifetime will reduce the number of the mold replacement, downtime in production and operating cost.

Achieve a significant productivity improvement by selecting an appropriate coating material.





Example of mold cost at the time of 100K shots for forging parts

Gives functional properties to mold surface

HOKU-NETSU Surface Technology

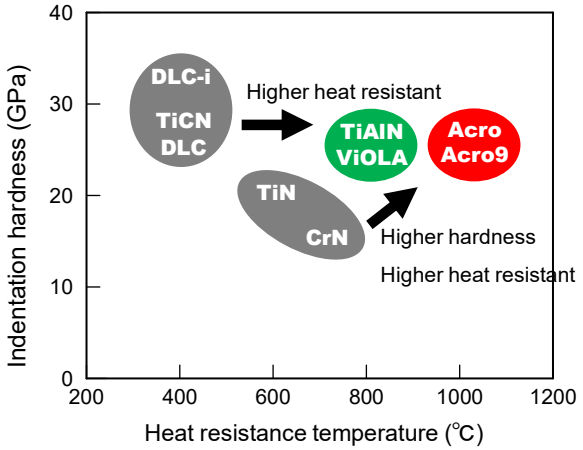
- Friction coefficient is 0.1 (DLC type)
- Heat resistance temperature up to 1000 ℃ (**Acro**)
- Surface roughness Rz <0.2 (Smooth type)

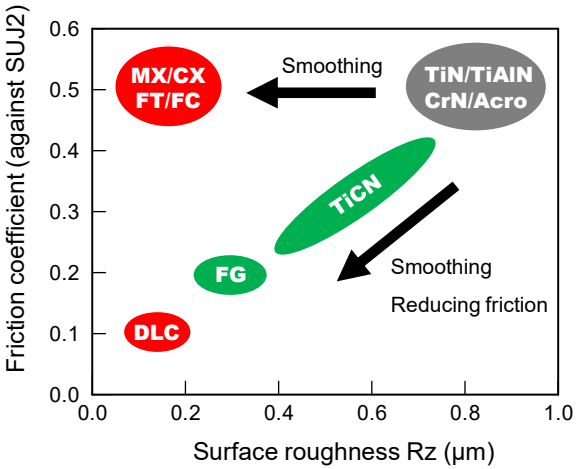
A full lineup of 23 types of coating material

- PVD coating achieve high-efficiency and high-accuracy of manufacturing technology, the conventional "hard coating film" which emphasizes wear resistance is changing to a "functional coating film" that specializes in the required characteristics.

- In addition to “Standard type”, we have developed our own “Smooth type”, “Thick film type”, “Deep hole type" and "DLC type" in-house, appropriate type of coating will be proposed for your application.

  - Standard type …… **TiN / TiCN / TiAlN / CrN / Acro**
  - Smooth type …… **Fine FT / Fine FG / Fine FC / Smooth AX / Smooth MX / Smooth CX**
  - Thick film type …… **ViOLA / ViOLA-R / ViOLA-S / Acro9 / Acro9P**
  - Deep hole type …… **diXis-TiN / diXis-TiCN / diXis-TiAlN / diXis-CrN / diXis-Acro**
  - DLC type …… **DLC／DLC-i**





A full range of optional services

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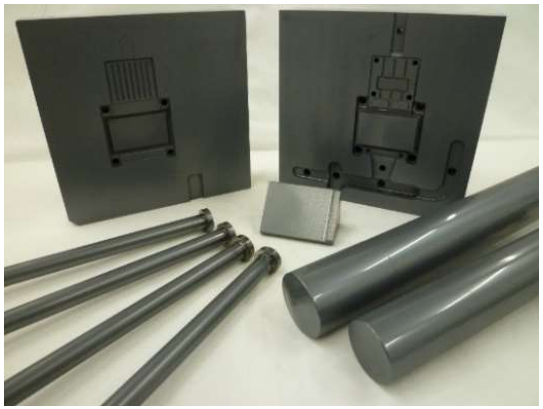
To improve the characteristics of a wide variety of products, a full range of optional services are available.

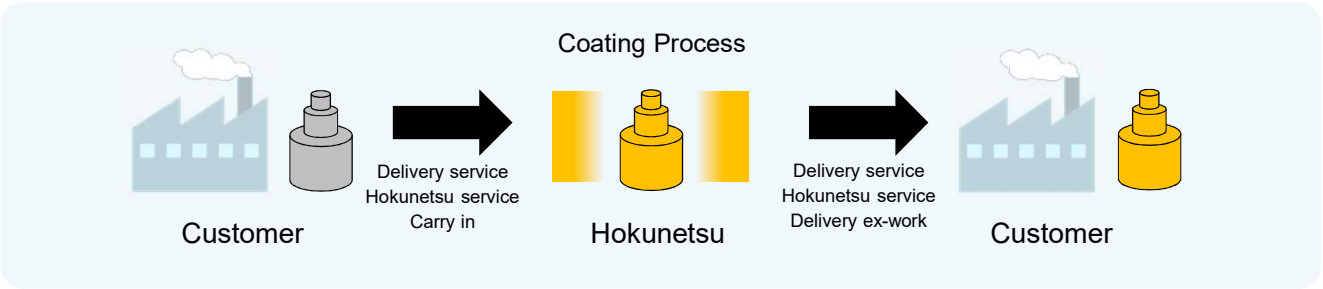
- Need to strengthen the steel substrate ..... Radical nitriding treatment
- Some areas don't want to coat ..... Masking instructions
- Need to remove the coating ..... Coating removal agent
- Want to improve surface roughness
  even if it is not a smooth type ..... Lapping process
- Want to remove foreign matter adhering to the surface ..... Shot blasting
- Want to investigate the cause of mold problems ..... Surface analysis



Quick delivery achievement

- Quick delivery is required during the final process of mold building, for this reason, the coating process cannot be time-consuming.
- With our 8 PVD coating machines, we provide 3-7 days delivery time for PVD coating.

*Delivery time depends on the coating material and production situation, specific delivery time is available on request.



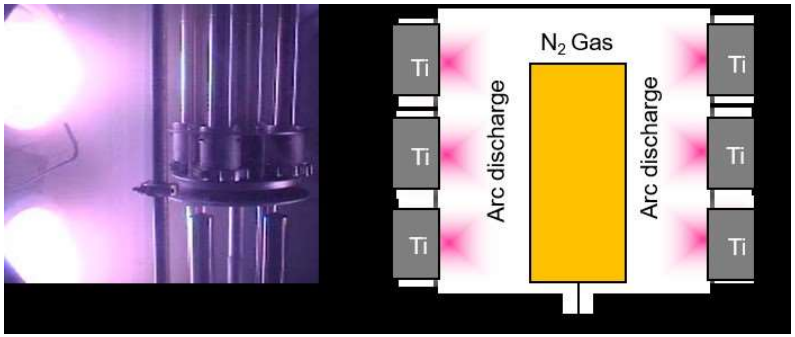
Standard type Basic PVD coating

HOKU-NETSU Surface Technology

- Basic PVD coating suitable for cutting tools, molds and machine parts.
- We support large workpieces with one of the largest AIP equipment in the industry.
- We promise to improve your productivity with high performance, quick delivery and cost performance.

Industry standard arc ion plating

- This is the most popular coating process for cutting tools and molds using the arc ion plating method.
- The target material is evaporated by arc discharge to efficiently coat the surface of the target workpiece.

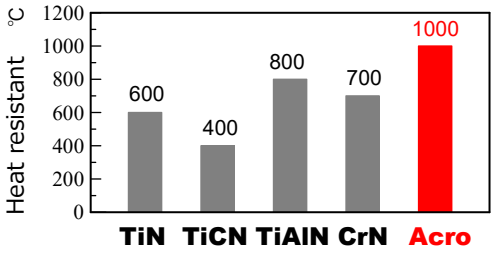


Kobelco AIP-S70
(Largest in Japan)

- With the largest arc ion plating equipment in Japan, coating treatment of large workpieces up to φ750 x 900 mm and 360 kg.
- Four units of arc ion plating equipment manufactured by Kobelco allow us to process in a short delivery time.

Lineup of 5 types of Ti-based and Cr-based films

- Standard **TiN**, low-friction **TiCN**, heat and wear resistant **TiAlN** have a track record in a wide range of applications.
- **CrN** has low affinity with resins and copper, makes it ideal for preventing adhesion.
- **Acro**, which is mainly composed of AlCrN, provides the highest heat resistance temperature of 1000° C in PVD coatings.



Standard type Basic PVD coating

HOKU-NETSU Surface Technology

Lineup

TiN
Titanium Nitride

Balance of hardness, adhesion and heat resistance.
Titanium is a standard for coating

- Hardness: 20GPa
- Thickness: 2～4μm
- Heat resistance temp. : 600℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

TiCN
Titanium Carbon Nitride

Characterized by high hardness and low friction
Coating for cold forming dies

- Hardness: 28GPa
- Thickness: 2～4μm
- Heat resistance temp. : 400℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.2-0.5
- Coating temp.: ＜500℃

TiAlN
Titanium Aluminum Nitride

Characterized by high hardness and heat resistance
Compatible with all cutting tools and dies

- Hardness: 24GPa
- Thickness: 2～4μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

CrN
Chromium Nitride

Strong adhesion to substrate and excellent reliability
Coating for mechanical parts

- Hardness: 16GPa
- Thickness: 2～4μm
- Heat resistance temp. : 700℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Acro
Aluminum Chrome bv Nitride

Wide range of applications from cutting tools to molds.
All-round heat resistant coating

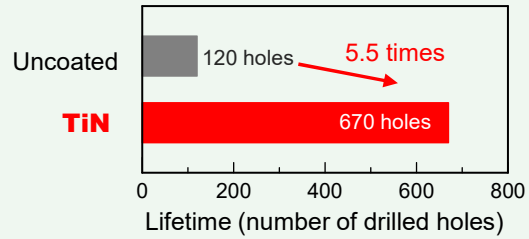
- Hardness: 28GPa
- Thickness: 2～4μm
- Heat resistance temp. : 1000℃
- Surface roughness : Rz＜1.5
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

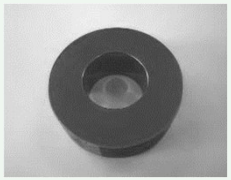
Sample of use

Drilling of steel (SCM440)

The progress of wear on the drill edge is suppressed, greatly improve the drill life.

- Tool: φ6mm SKH51 drill
- Workpiece: SCM440 (thickness: 20mm)
- V=18m/min, f=0.16mm/rev

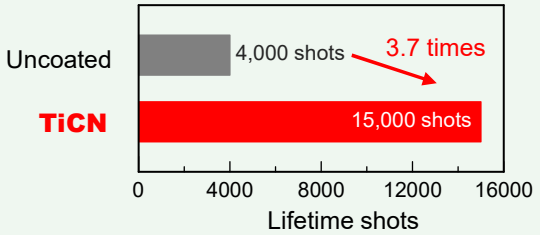




Bending and forming of steel plate (SPCC)

Scratches on mold corners can be suppressed, greatly improve the lifetime of the mold.

- Mold: SKD61 die
- Workpiece: SPCC
- Effectiveness: Suppression of bending scratches



Smooth type Dropletless PVD coating

HOKU-NETSU Surface Technology

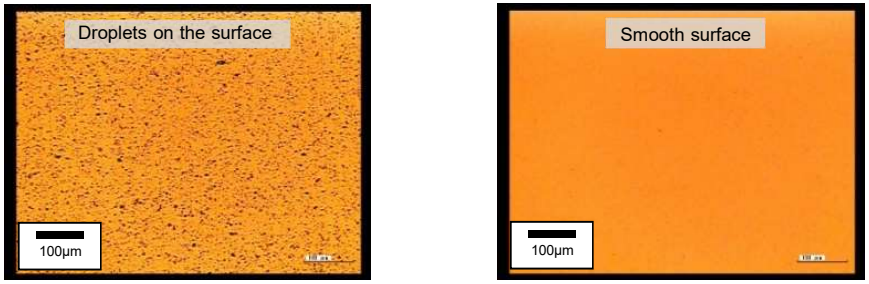
- A high-performance PVD coating that suppresses the formation of surface irregularities.
- Effective against galling, corrosion, and poor mold release in cold forming.
- Compatible with polished finish molds and high-precision molds, as well as realizing improved moldability.

Unique smooth coating technology

- For typical PVD coatings (AIP), microscopic irregularities called droplets are formed on the surface.
- We have developed our own PVD technology (thin film AIP/HCD/UBMS/+polishing) to provide smooth coatings with suppressed formation of droplets.

- Poor galling due to convex shape
- Poor corrosion from concave shape
- Poor mold release due to concavo-convex shape

➡ Solves molding defects with smooth type coating

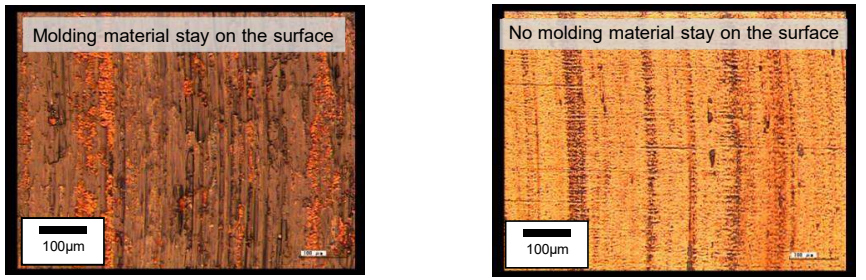


TiN Fine FT

Surface observation image of coating film

No galling, no adhesion

- In cold molding with soft materials may cause "galling" in which the molding material adheres to the mold surface.
- Uneven coating surfaces tend to retain molding material, but smooth coated surfaces prevent molding material from staying on the surface and allow it to slide smoothly.
- The smooth type has a film composition with excellent mold releasability.
  - Iron-based molding material: **Smooth AX/Smooth MX** is recommended
  - Resin molding material : **Smooth CX** is recommended



TiN Smooth MX

Surface observation image of coated film after abrasion test

Smooth type Dropletless PVD coating

HOKU-NETSU Surface Technology

Lineup

Fine FT
Titanium Nitride (HCD)

For anti-galling of various molds
Smooth TiN coating

- Hardness: 24GPa
- Thickness: 2～4μm
- Heat resistance temp. : 600℃
- Surface roughness : Rz＜0.1
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Fine FG
Titanium Carbon Nitride (HCD)

Low friction and further suppresses galling
Smooth TiCN coating

- Hardness: 32GPa
- Thickness: 2～4μm
- Heat resistance temp. : 400℃
- Surface roughness : Rz＜0.3
- Friction coefficient : 0.2
- Coating temp.: ＜500℃

Fine FC
Chromium Nitride (HCD)

Excellent resin releasability
Smooth CrN coating

- Hardness: 20GPa
- Thickness: 2～4μm
- Heat resistance temp. : 700℃
- Surface roughness : Rz＜0.1
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Smooth AX
Titanium Aluminium Nitride (AlP)

Thin film suitable for high precision molds
Smooth TiAlN coating

- Hardness: 28GPa
- Thickness: 1～2μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜0.2
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Smooth MX
Titanium Molybdenum Nitride (UBMS)

High adhesion by molybdenum
Smooth TiMoN coating

- Hardness: 18GPa
- Thickness: 2～4μm
- Heat resistance temp. : 500℃
- Surface roughness : Rz＜0.1
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Smooth CX
Chromium Nitride (UBMS)

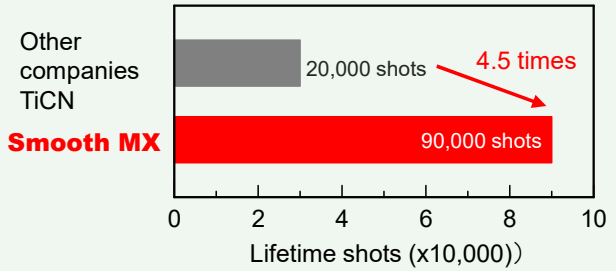
Overwhelming mold releasability and corrosion resistance
Smooth CrN coating

- Hardness: 20GPa
- Thickness: 2～4μm
- Heat resistance temp. : 700℃
- Surface roughness : Rz＜0.1
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

Cold forging of iron-based parts

Smooth and highly adhesive **smooth MX** allows the punch shape to be maintained.

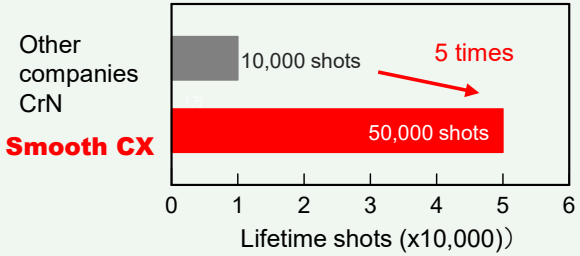
- Tool: Punch of powdered HSS
- Workpiece: SS steel
- Effectiveness: Suppression of bearing wear



Injection molding of plastic parts

The resin can be easily released from the mold, and wear caused by glass fibers can be suppressed.

- Mold: Pre-hardened steel
- Material: PA6-GF
- Effectiveness: Suppression of adhesive wear



Thick film type PVD coating for die casting molds

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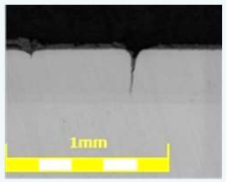
A PVD coating with a thick film structure that corresponds to the damage form of die casting molds. This product suppresses the occurrence of melt loss in die casting molds used in harsh, high-temperature environments and significantly improves the lifetime of die casting molds.

Specializes in die casting molds

- A unique form of damage occurs in die casting molds.



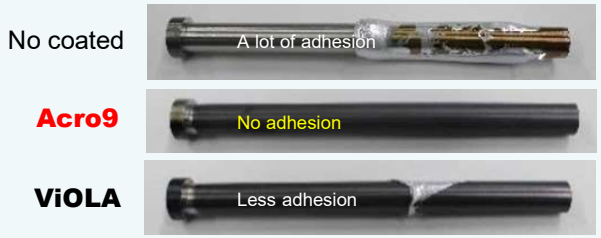
Heat check


Erosion


Adhesion

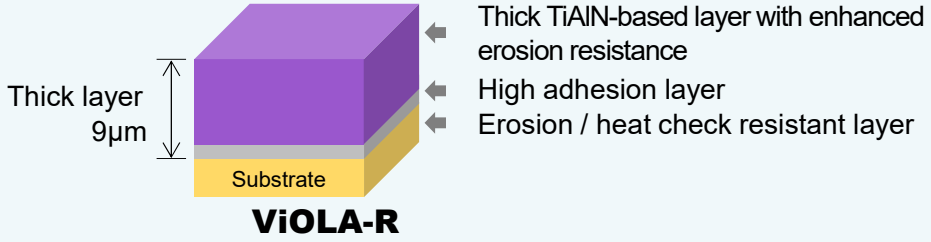
Immersion test for steel alloy (ZDC2)

- **Acro9** coated pin has no adhesion of zinc alloy and exhibits excellent seizure resistance.
  - Pin material：SKD61
  - Molten metal：ZDC2、420℃
  - Immersion holding time ：1s

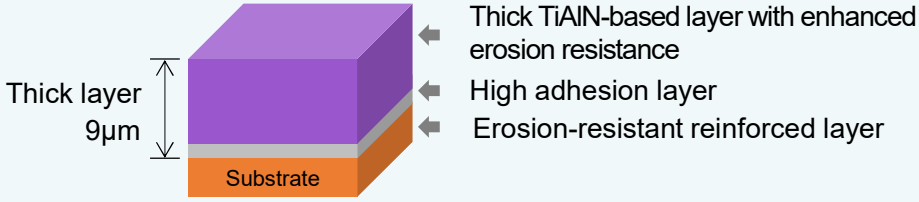


Nitriding + 9μm film thickness

- The film thickness is 9μm, which is 3 times thicker than the conventional film, and has excellent abrasion and erosion resistance, thus protecting molds used in high temperature molten metal environments.
- Composite treatment with nitriding of the base material can further improve erosion resistance and heat check resistance.



ViOLA-R



ViOLA-S

Thick film type PVD coating for die casting molds

HOKU-NETSU Surface Technology

Emphasis on erosion resistance

ViOLA
Titanium Aluminum Nitride

A new standard for die casting molds
Dense thick film coating

- Hardness: 24GPa
- Thickness: 7～11μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜3.0
- Friction coefficient : 0.5
- Coating temp.:＜500℃

ViOLA-R
Nitride+Titanium Aluminum Nitride

New composite treatment that achieves both erosion and heat check resistance

- Hardness: 24GPa
- Thickness: 7～11μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜3.0
- Friction coefficient : 0.5
- Coating temp.:＜500℃

ViOLA-S
Erosion Resistant Nitride + Titanium Aluminum Nitride

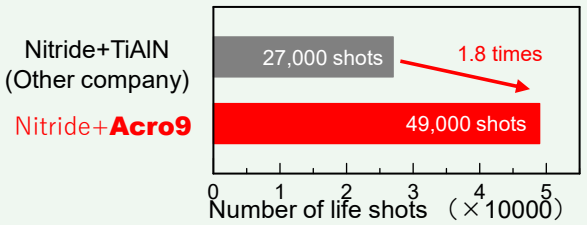
Ultimate erosion resistant coating combined with erosion resistant nitriding

- Hardness: 24GPa
- Thickness: 7～11μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜3.0
- Friction coefficient : 0.5
- Coating temp.:＜500℃

Die cast molding of aluminum parts (ADC12)

Nitriding+**Acro9** suppresses seizure and erosion, thus maintains the shape of the pin.

- Mold：YXR33 core pin
- Material：ADC12
- Effectiveness： Suppression of seizure and erosion



Emphasis on anti-seizure

Acro9
Aluminum Chrome Nitride

Thick AlCrN layer prevents mold erosion
Coatings for die casting molds

- Hardness: 22GPa
- Thickness: 7～9μm
- Heat resistance temp. : 1000℃
- Surface roughness : Rz＜4.0
- Friction coefficient : 0.5
- Coating temp.:＜500℃

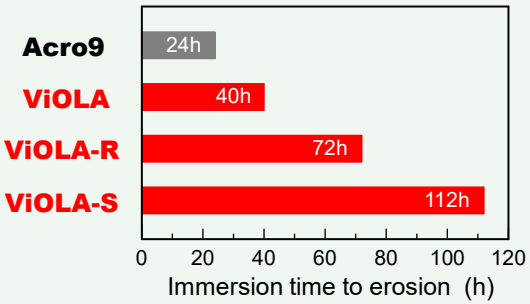
Acro9P
Aluminum Chrome Nitride

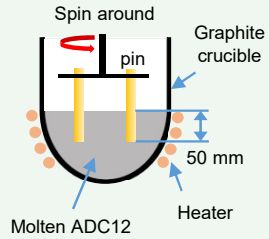
Smooth surface properties prevent seizure
Acro9 for die casting pins

- Hardness: 22GPa
- Thickness: 7～9μm
- Heat resistance temp. : 1000℃
- Surface roughness : Rz＜1.0
- Friction coefficient : 0.5
- Coating temp.:＜500℃

Aluminum alloy (ADC12) long-term immersion test

- Due to its dense and thick film structure, **ViOLA** prevents molten aluminum from penetrating into the base material and suppresses the occurrence of erosion.
- **ViOLA-R** / **ViOLA-S** with combined treatment shows overwhelming resistance to erosion





- Test piece: SKD61 pin
- Molten metal: ADC12
- Judgment: Weight loss 0.1g

Deep hole type

Deep hole inner surface PVD coating

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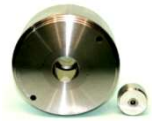
This new coating enables the formation of a protective ceramic film on the inner surface of deep holes while retaining the advantages of PVD coating which can be processed at 500℃ or lower. It improves the life of deep-hole dies and deep-hole parts with progressive wear on the inner surface of the deep hole.

diXis® Facing dual-beam arc ion plating

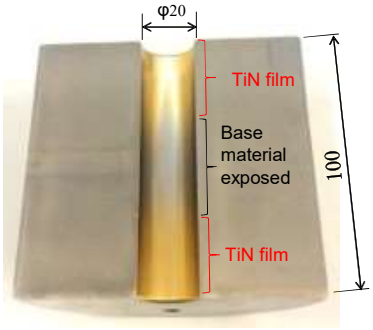
Can the inner surface of the deep hole be PVD coated?

With general PVD coating, it is extremely difficult to form a film on the inner surface of a deep hole that exceeds L (length) / D (inner diameter) ≒ 1.



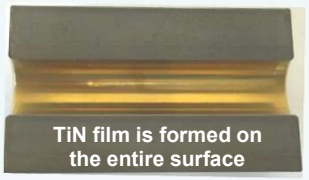
For cold forging

For powder molding



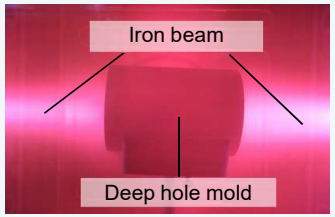
Cut model of deep hole mold
L/D=5 (hole dimension: φ20×100)

- Unique facing dual-beam arc ion plating realizes ceramic film formation on the inner surface of deep holes.
- Hard ceramic protective coatings (TiN, TiAlN etc.) can be formed on the inner surface of deep holes with L (length) / D (inside diameter) = 2-7.
- Even on the inner surface of the deep hole, it exhibits the same high hardness and excellent adhesion as a general ceramic protective film.

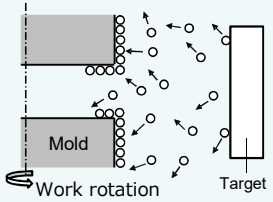


L/D=5 (inner diameter :φ10×50)

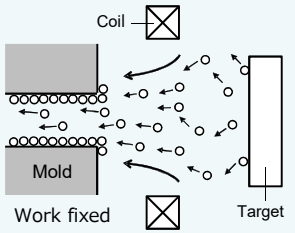
Cut model of deep hole mold with **diXis-TiN** generated



Ion beam irradiation



General PVD coating



Generation image of **diXis**

Deep hole type

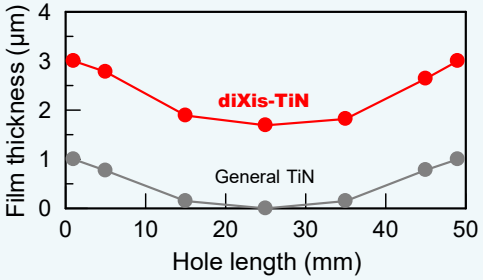
Deep hole inner surface PVD coating

HOKU-NETSU Surface Technology

Application to deep hole molds

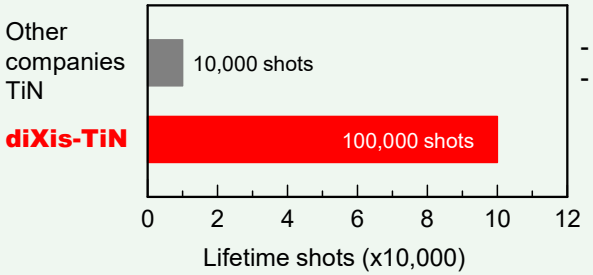
Film thickness distribution

- Inner surface of through-hole that emphasizes wear resistance: L / D ≤ 5 is recommended
- Inner surface of through-hole that emphasizes mold releasability: L / D ≤ 7 is recommended



Powder sintering molding of iron-based automobile parts

In powder sintered molds for automotive parts made of pure iron, the lifetime has been improved more than 10 times compared to conventional molds.



- Carbide shrink-fit die
- Hole dimensions :φ10×100L

Lineup

diXis-TiN
Titanium Nitride
Best-balanced gold for all types of deep hole molds
- Hardness: 10GPa
- Thickness: 2～4μm
- Heat resistance temp. : 600℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

diXis-TiCN
Titanium Carbon Nitride
For galling of deep hole dies
Low friction coating
- Hardness: 32GPa
- Thickness: 2～4μm
- Heat resistance temp. : 400℃
- Surface roughness : Rz＜1.0
- Friction coefficient : 0.2
- Coating temp.: ＜500℃

diXis-TiAlN
Titanium Aluminium Nitride
Excellent wear resistance and heat resistance
Coatings for metal molding
- Hardness: 30GPa
- Thickness: 2～4μm
- Heat resistance temp. : 800℃
- Surface roughness : Rz＜1.0
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

diXis-CrN
Chrome Nitride
Excellent mold releasability and corrosion resistance
Coatings for resin molding
- Hardness: 16GPa
- Thickness: 2～4μm
- Heat resistance temp. : 700℃
- Surface roughness : Rz＜0.8
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

diXis-Acro
Aluminum Chrome Nitride
For harsh wear environments
New generation basic AlCrN
- Hardness: 30GPa
- Thickness: 2～4μm
- Heat resistance temp. : 1000℃
- Surface roughness : Rz＜1.0
- Friction coefficient : 0.5
- Coating temp.: ＜500℃

It can be used not only for round holes but also for various hole shapes.



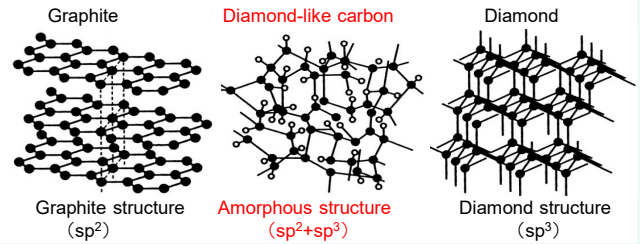
DLC type Diamond-Like Carbon

HOKU-NETSU Surface Technology

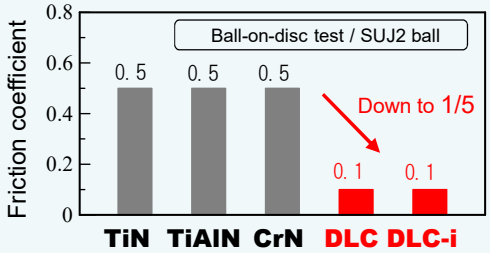
This **DLC** coating achieves overwhelmingly low friction characteristics. Our lineup includes high adhesion **DLC** for molds and machine parts and hydrogen-free thin film **DLC-i** for aluminum alloy cutting tools.

Diamond-Like Carbon

- DLC stands for Diamond-like Carbon, a general term for amorphous carbon structure containing sp2+sp3 hybridized carbon atoms
- Due to the structure is similar to diamond, hardness is its main feature
- Compare to very expensive diamonds, it can be produced on a variety of material surfaces at lower cost.



- It has an overwhelmingly low coefficient of friction compared to metallic materials.
- Even in a dry process, it has the same friction coefficient as oil lubrication.
- Can suppress adhesion of soft metals (aluminum alloys, etc.).



Friction coefficient of each coating film

DLC Classification

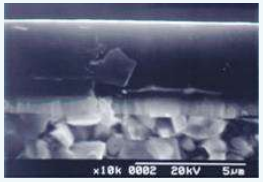
- a-C:H structure which balances hardness and toughness ⇒ **DLC**
- High-density ta-C structure approaching to diamond ⇒ **DLC-i**

DLC type Diamond-Like Carbon

HOKU-NETSU Surface Technology

Strongly adheres to substrate

- By generating an adhesion layer between the DLC layer and the substrate, it exhibits excellent adhesion (DLC-i is DLC layer only).
- Even in a high load atmosphere, which is not good for general DLC, the original low friction characteristics of DLC can be demonstrated.



Lineup

DLC
a-C:H (UBMS)

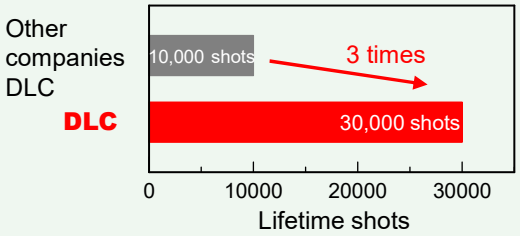
Reduce friction of molds and machine parts
High adhesion DLC coating by UBMS method

- Hardness: 24GPa
- Thickness: 1～2μm
- Heat resistance temp. : 4f00℃
- Surface roughness : Rz＜0.2
- Friction coefficient : 0.1
- Coating temp.:＜220℃

Powder sintered shapes for SUS-based parts

DLC with low friction and peel resistant can suppress galling caused by powder.

- Die: Carbide hardened die
- Material: SUS based powder
- Effectiveness: Suppression of galling

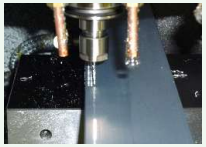


DLC-i
ta-C (AIP)

Prevents adhesion of aluminum alloys and copper alloys
Hydrogen-free thin film DLC coating

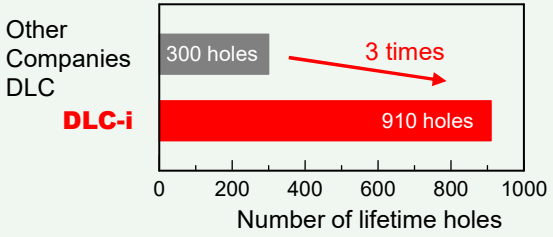
- Hardness: 34GPa
- Thickness: ～ 0.2μm
- Heat resistance temp. : 400℃
- Surface roughness : Rz＜0.1
- Friction coefficient : 0.1
- Coating temp.:＜220℃

Drilling of aluminum alloy (A6063)



DLC-i, which can maintain sharp cutting edges, prevents the formation of built-up cutting edges.

- Tool: φ1mm Carbide drill
- Work material: A6063 (thickness:2mm)
- V=30m/min / f=0.05mm/rev



Radical nitriding

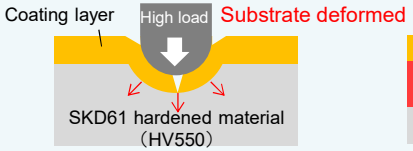
Pre-treatment for coating

HOKU-NETSU Surface Technology

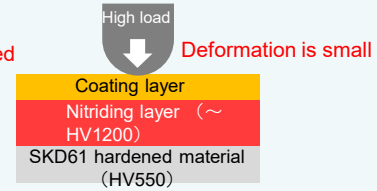
This is a brittle compound layer-free plasma nitriding which is ideal for strengthening the base of PVD coatings. It suppresses plastic deformation of the mold material in a high surface pressure environment and can demonstrate the original wear resistance of the coating.

Strengthening of substrate by radical nitriding

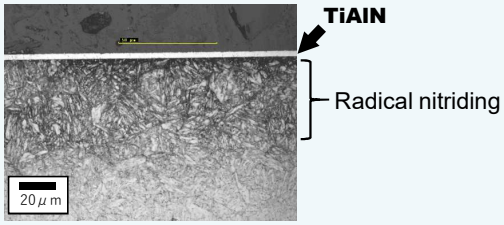
- When a high load is applied to the surface of the coating film, the substrate may be plastically deformed and the original performance may not be demonstrated.
- When the target workpiece is alloy steel (die steel, HSS, pre-hardened steel, etc.), nitriding treatment hardens the surface of the substrate up to 1200HV, thereby suppressing plastic deformation of the substrate that supports the coating.
- Since radical nitriding is performed with a low current density / NH radical (active species), the formation of iron nitride compound (brittle compound layer) can be suppressed and a coating film can be formed with good adhesion.
- Characteristics of radical nitriding (SKD61 substrate) : Surface hardness ≒1200HV, Nitriding Depth ≒50μm



Without radical nitriding



With radical nitriding



Radical nitriding+**TiAlN**

Cross-sectional image of the surface layer

Improved coating adhesion

Adhesion of the coating film is improved by hardening the surface of the substrate through radical nitriding treatment.

Deformation of the substrate is large and the coating peels off

TiN

No peeling of coating

Radical nitriding + **TiN**

Adhesion comparison of TiN coating film by scratch test (substrate: SKH51, indentation at 100N load)

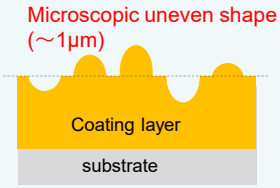
Lapping

Post-coating treatment

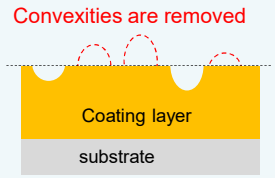
HOKU-NETSU Surface Technology

With our unique lapping technology, finished surface roughness close to that before the coating process, preventing adhesion and burning during molding. It is effective when the work material is soft metal or plastic.

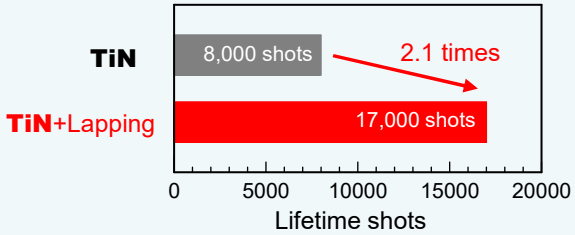
- In the Standard type, Heat resistant type and Deep hole type, droplet particles are generated on the film surface, so the surface becomes rougher than before coating.
- Smooth surfaces are obtained by removing convex-shaped droplet particles through a fine shot blasting process. However, concave-shaped pinholes remain.
- This process is effective in preventing adhesion and improving mold releasability for various types of molds.



Without lapping finish



With lapping finish



Life of cold forging punches

Coating list & characteristic

HOKU-NETSU Surface Technology

Type	Name	Base material	Color	Thick-ness	Hardness※2		Surface roughness※3		Friction Coefficient (Steel)	Heat resistant	Adhesion strength by scratch test		Water contact angle	Process temp.	Maximum processing size		Decoating	
					Indentation H_{IT}	Vickers	Ra (μm)	Rz (μm)			Substrate SKH51	Carbide substrate			Mounting size (coating area)	Weight	Steel	Carbide
Standard	**TiN**	TiN		2～4μm	20GPa	2000HV	＜0.08	＜0.8	0.5	600℃	60N	110N	93°	＜500℃	φ750×900mm（φ730×700mm）	360kg	○	○
	TiCN	TiCN		2～4μm	28GPa	2800HV	＜0.08	＜0.8	0.2～0.5	400℃	50N	90N	93°	＜500℃	φ750×900mm（φ730×700mm）	360kg	○	×
	TiAlN	TiAlN		2～4μm	24GPa	2400HV	＜0.08	＜0.8	0.5	800℃	50N	90N	95°	＜500℃	φ750×900mm（φ730×700mm）	360kg	○	○
	CrN	CrN		2～4μm	16GPa	1600HV	＜0.08	＜0.8	0.5	700℃	70N	120N	98°	＜500℃	φ750×900mm（φ730×700mm）	360kg	○	×
	Acro	AlCrn		2～4μm	28GPa	2800HV	＜0.15	＜1.5	0.5	1000℃	60N	110N	95°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
Smooth	**Fine FT**	TiN		2～4μm	24GPa	2400HV	＜0.01	＜0.1	0.5	600℃	50N	90N	93°	＜500℃	φ180×320mm（φ180×270mm）	25kg	○	○
	Fine FG	TiCN		2～4μm	32GPa	3200HV	＜0.03	＜0.3	0.2	400℃	40N	70N	93°	＜500℃	φ180×320mm（φ180×270mm）	25kg	○	×
	Fine FC	CrN		2～4μm	20GPa	2000HV	＜0.01	＜0.1	0.5	700℃	60N	110N	98°	＜500℃	φ180×320mm（φ180×270mm）	25kg	○	×
	Smooth AX	TiAlN		1～2μm	28GPa	2800HV	＜0.02	＜0.2	0.5	800℃	60N	110N	95°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	○
	Smooth MX	TiMoN		2～4μm	18GPa	1800HV	＜0.01	＜0.1	0.5	500℃	80N	140N	70°	＜500℃	φ500×500mm（φ450×400mm）	180kg	○	-
	Smooth CX	CrN		2～4μm	20GPa	2000HV	＜0.01	＜0.1	0.5	700℃	70N	120N	98°	＜500℃	φ500×500mm（φ450×350mm）	180kg	○	×
Thick film	**ViOLA**	TiAlN		7～11μm	24GPa	2400HV	＜0.30	＜3.0	0.5	800℃	60N	110N	90°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
	ViOLA-R	RN+TiAlN		7～11μm	24GPa	2400HV	＜0.30	＜3.0	0.5	800℃	80N	-	90°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
	ViOLA-S	RN※1+TiAlN		7～11μm	24GPa	2400HV	＜0.30	＜3.0	0.5	800℃	80N	-	90°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
	Acro9	AlCrN		7～11μm	22GPa	2200HV	＜0.40	＜4.0	0.5	1000℃	60N	110N	95°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
	Acro9P	AlCrN		7～11μm	22GPa	2200HV	＜0.10	＜1.0	0.5	1000℃	60N	110N	95°	＜500℃	φ500×600mm（φ450×400mm）	180kg	○	×
Deep hole	**diXis-TiN**	TiN		2～4μm	22GPa	2200HV	＜0.10	＜0.8	0.5	600℃	60N	110N	93°	＜500℃	φ450×340mm（φ80×340mm）	300kg	○	○
	diXis-TiCN	TiCN		2～4μm	32GPa	3200HV	＜0.10	＜1.0	0.2	400℃	50N	90N	93°	＜500℃	φ450×340mm（φ80×340mm）	300kg	○	×
	diXis-TiAlN	TiAlN		2～4μm	30GPa	3000HV	＜0.10	＜1.0	0.5	800℃	50N	90N	95°	＜500℃	φ450×340mm（φ80×340mm）	300kg	○	○
	diXis-CrN	CrN		2～4μm	16GPa	1600HV	＜0.10	＜0.8	0.5	700℃	70N	120N	98°	＜500℃	φ450×340mm（φ80×340mm）	300kg	○	×
	diXis-Acro	AlCrN		2～4μm	30GPa	3000HV	＜0.10	＜1.0	0.5	1000℃	60N	110N	95°	＜500℃	φ450×340mm（φ80×340mm）	300kg	○	×
DLC	**DLC**	DLC		1～2μm	24GPa	2400HV	＜0.02	＜0.2	0.1	400℃	40N	70N	80°	＜220℃	φ750×1200mm（φ700×800mm）	360kg	○	○
	DLC-i	DLC		～0.2μm	34GPa	3400HV	＜0.01	＜0.1	0.1	400℃	20N	40N	80°	＜220℃	φ500×600mm（φ450×400mm）	180kg	○	○

※1 Erosion resistance enhanced type　※2 Nanoindentation hardness measurement　※3 When coated on the polished surface of SKH51

Coating selection guideline

HOKU-NETSU Surface Technology

- The affinity between the processed material and the base coating material and the molding temperature are the criteria for selecting the coating.
- For mirror-finish molds, selecting a coating from Smooth type or DLC is recommended.
- If adhesion between the mold surface (steel material) and the coating is important, radical nitriding + PVD is recommended.

Processed Material	Mold（molding temperature）				Cutting tool
	Injection / Laminate / Powder / Drawing / Forging		Drawing / Forging / Die casting		
	< 400℃	< 500℃	< 600℃	< 800℃	
Steel	TiN / TiCN / DLC	TiN / TiMoN	TiN / TiAlN	TiAlN / AlCrN	TiCN / TiAlN
SUS	TiN / TiCN / DLC	TiN / TiAlN	TiN / TiAlN	TiAlN / AlCrN	TiAlN / AlCrN
Aluminum alloy	Smooth TiN / DLC	Smooth TiN / TiAlN	Smooth TiN / TiAlN	TiAlN / AlCrN	Smooth TiN / DLC
Copper / Brass	Smooth CrN / DLC	Smooth CrN	Smooth CrN	-	Smooth CrN / DLC
Plastic	Smooth CrN / TiN	-	-	-	Smooth CrN / TiN

Point to note

- Coating is available if material properties unchanged (Phase transformation, softening, melting, dimension change) and the material does not generate gas at processing temperature.
  There is a risk of deformation, dimensional change, and hardness reduction for low-temperature tempering material (SKD11, SKS etc.)
- Products with soldering, welding, annealing or surface treatment (plating etc.) may not be able to be coated. Please contact us separately.
- For masking (The areas where you do not want to coat), we will accommodate your requests, but there is a limit if the product is extremely small or requested to mask on narrow areas and complex shapes. Please contact us.
- Except for Deep hole type, it may not be able to form a coating in narrow areas or deep holes.
- In principle, full surface coating is not available because a holding section is needed.
- There is a risk of peeling of the coating if the surface of the product is dirty, burnt, corroded or burred.
- If the surface roughness of the product is rough, the original performance of the coating may not be achieved. It is recommended to finish the surface roughness Rz≦0.8 by grinding or polishing process before coating process.

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