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Hard Part Turning

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Hard Part Turning

- What is hard turning?
- Characteristics of hard turning (VS Grinding)
- Hard Turning and the cutting tools history
- Typical application case of hard turning
- Hann Innvoation of hard turning

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What is hard turning?

The so-called hard turning refers to one process that make hardened steel turning as the final processing or finishing process. Hardened steel usually refers to one type materials that include martensite after quenching, high hardness, high strength, almost no plastic.

When hardened steel hardness> 55HRC, its strength is about 2100 ~ 2600N/mm^2. Normally, the work piece has already been rough machined before heat treatment, and only left finishing process.

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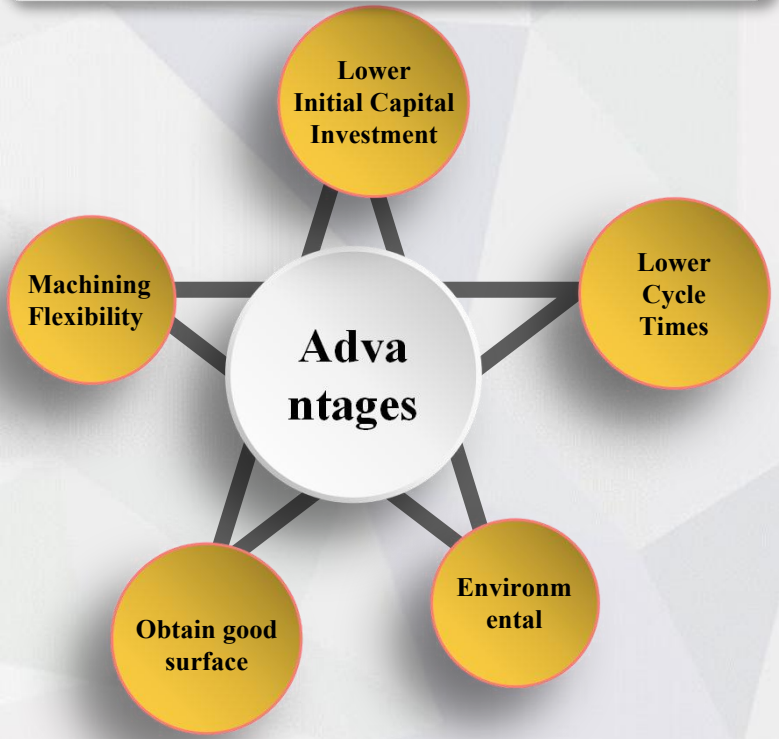
Advantages of hard turning



Hard Turning VS Grinding

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Hard Turning and the cutting tools history

Before the nineteen ninties, turning is still only applied to roughing before quenching, finishing after quenching still used grinding method. The traditional processing technology is rough car - heat treatment (quenching) - grinding.

In the early nineties, hard turning really began to develop. With the continuous development of the machinery manufacturing industry, more and more hard-to-machine materials and complex materials appear, and the traditional tool materials have been difficult to handle or can not realize the processing of high-strength and high-hardness materials at all. Modern tool materials such as ceramic inserts and **PCBN inserts** make it possible for hard turning.

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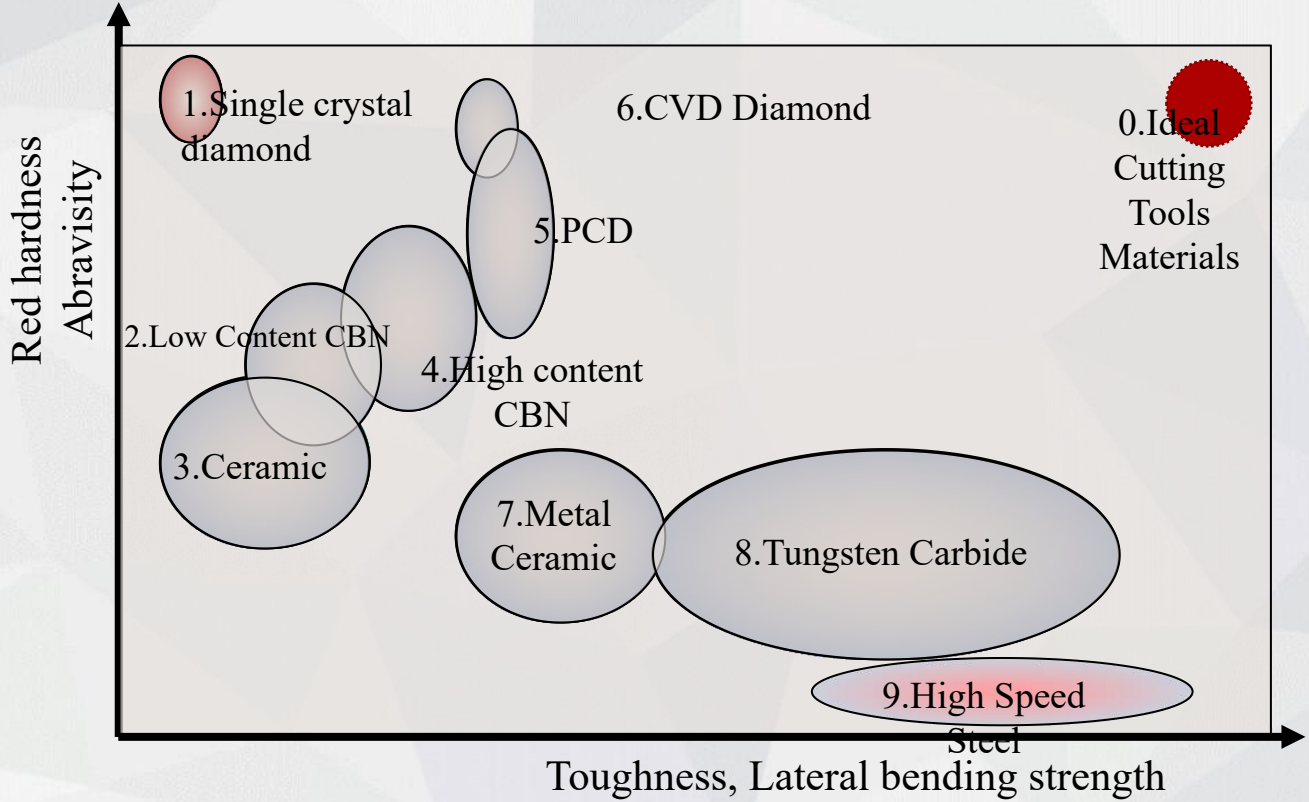
History of cutting tools materials



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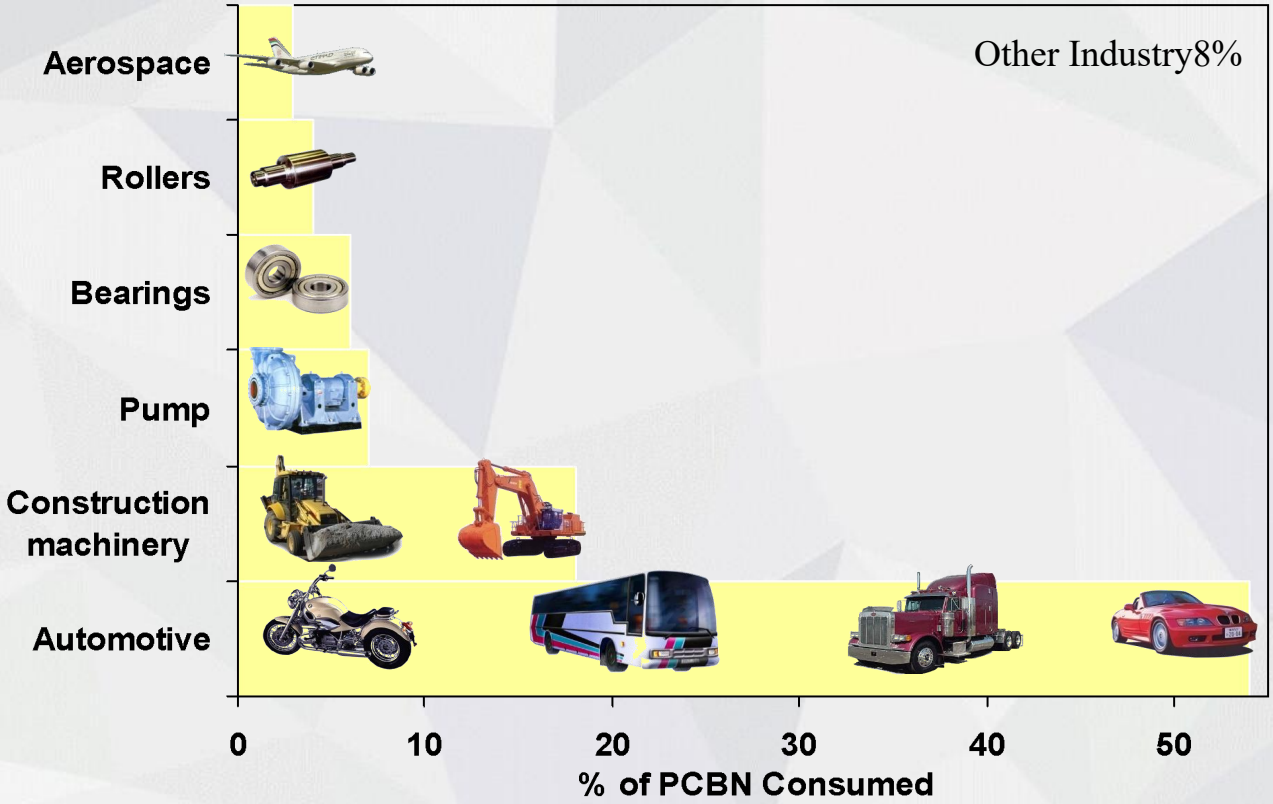
Common Application of CBN Inserts



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Halnn Hard turning CBN Materials

Halnn CBN Grade	Binder	CBN Content (%)	Granularity	Hardness
BN-S20	TIN	76	4~6	2900-3100
BN-S200	TIN	60	2~4	2800-3000
BN-H11	TIN	70	2~4	2800-3000
BN-H20	TIC	80	2~4	3100-3300
BN-H05	TIN	45	≤1	2700-2800
BN-H10	TIN	50	≤1	2700-2800
BN-H21	AL, TINC	60	1~2	2600-2800
BN-H05 C25	TIN	45	≤1	2700-2800
BN-H10 C25	TIN	50	≤1	2700-2800
BN-H21 C25	AL, TINC	60	1~2	2600-2800

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Cutting Condition of Halnn CBN for hard turning

CBN Content	Characteristics	Insert Grade	Depth of Cut (mm)	Recommend Cutting condition	Suited Materials	Typical Application
Low Content CBN	Toughnes（Roughing）	BN-S20	1-10mm	Interrupt-Continuous	Hardened Steel, Heat and abrasive resistant steel, High manganese steel	HSS Rolls, Ball Screw, Wind Power Bearings
		BN-H20	≤1mm	Semi-Interrupt	Hardened steel, other materials of difficult to machine	Hardened Steel Gears, Mold,ect
		BN-S200	≤1mm	Continuous	Hardened Steel, Superalloy	Wind Power Bearings
	Hardness（Finishing）	BN-H11	≤1mm	Continuous	Hardened Steel	Bearings, Gears, Gear Shaft, Hardened Mold
	Hardness	BN-H05	≤0.2mm	Continuous	Hardened Steel	Gears,Gear Shaft, Bearings
		BN-H10	≤0.5mm	Continuous-Semi-interrupt	Hardened Steel, high strength cast iron	Bearings, Gears, Gear Shaft, High hardness component
	Toughness	BN-H21	≤0.5mm	Semi-interrupt—Heavy Interrupt	Hardened Steel	Bearings, Gears, Gear Shaft,Mold,ect.
	Hardness	BN-H05 C25	≤0.2mm	Continuous	Hardened Steel	Gears,Gear Shaft, Bearings
		BN-H10 C25	≤0.5mm	Continuous~Semi-Interrupt	Hardened Steel, high strength cast iron	Bearings, Gears, Gear Shaft, High hardness component
	Toughness	BN-H21 C25	≤0.5mm	Semi-Interrupt~Heavy Interrupt	Hardened Steel	Bearings, Gears, Gear Shaft,Mold,ect.

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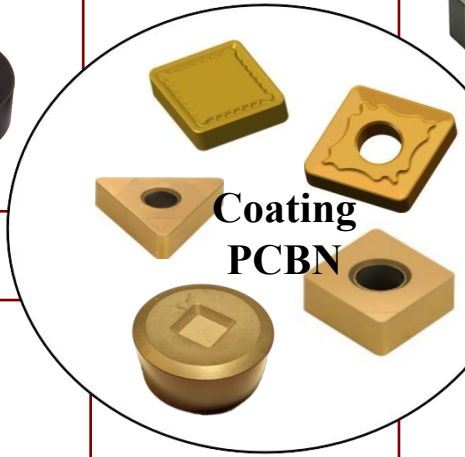
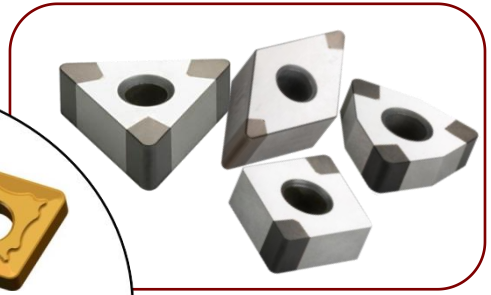
Halnn CBN Insert Type

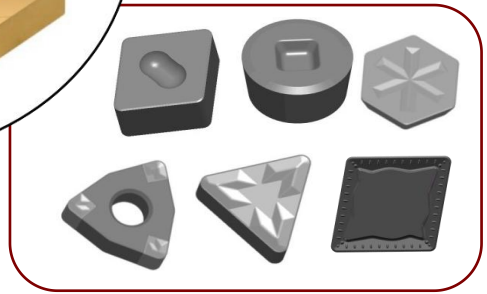
Solid CBN Insert





Brazed PCBN

PCBN Insert



Other Type PCBN

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The key to success of hard turning

（1）**Hard turning stability：** Continuous hard turning gear endsurface or inner bore already not a difficult problem, but when machining deep hole, contouring cutting grooves, it belongs to for interrupt turning condition, because of the complex process, we need to consider more informaiton, such as hard turning lathe, Fixture, tool material, program design,ect.

（2）**Hard turning economy：** Not all the hard turning process will lower the costs and improve the efficiency comparing grinding process. Sometimes, we need to use special grinding machine or grinding wheel. So for hard turning process, we need to value that if it is suitable.

（3）**Hard turning roughness：** Common materials include 20CrMnTi, 16Mn5,42CrMo,ect. The hardness after heat treatment will reach about HRC58~62, the roughness will require within Ra0.8, some will require Ra0.4. Halnn CBN Insert can meet all the requirements, and Halnn wiper insert and coating pcbn insert also improve the efficiency and the surface quality, extand the tools life.

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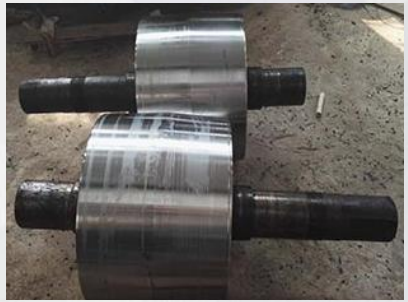
Hard Turning typical application



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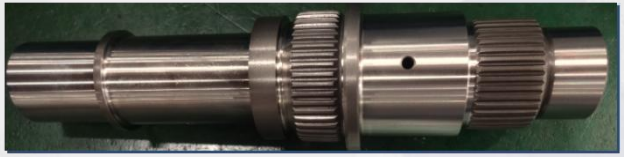
Hard turning automotive Transmission gear shaft

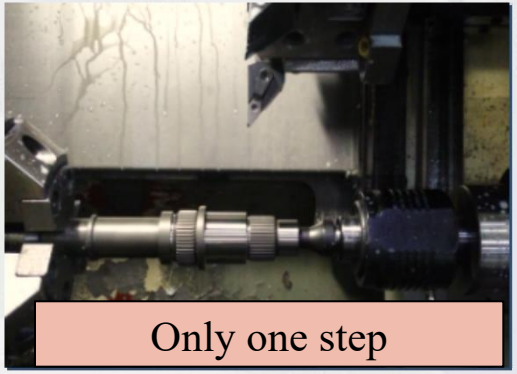
CNC Lathe

Interrupt turning

Before Machining



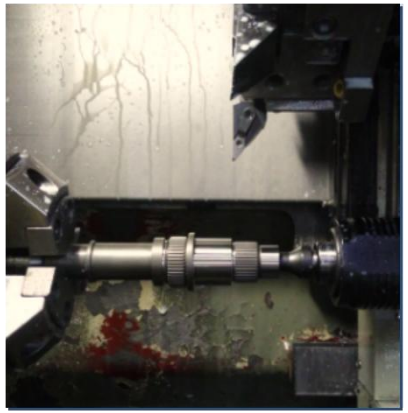
After machining



Only one step

Previous Insert
Kyocera KBN25M

Current PCBN
Halnn BN-H10



Component：Transmission gear shaft

Materials：20CrMo

Hardness：62-65HRC

Selected Insert：BN-H10 VNGA160408

Cutting Parameters：Vc=132m/min,ap=0.1mm,fr=0.15mm/r

Roughness：Ra1.6

Coolant Method：Wet Cutting

With Halnn BN-H10, tool life improved 45%!

CBN Materials	Select Insert	Cutting Speed Vc(m/min)	Average tool life (pieces/tip)
Kyocera PCBN	KBN25M VNGA160408S01225	132	100
Halnn PCBN	BN-H10 VNGA160408T01535	132	145

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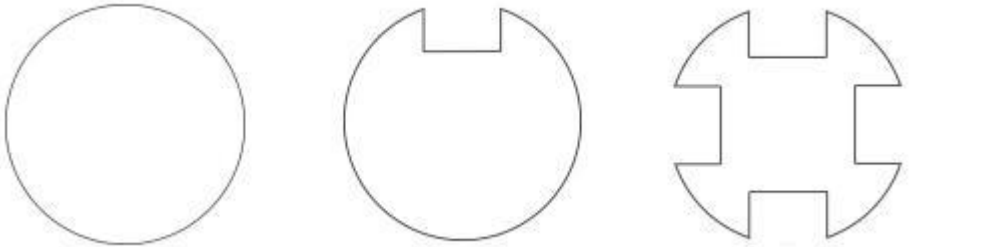
Hard Turning Condition

- **Definition of Interrupt turning:**

➢ Heavy Interrupt: Broken Slot θ<40°, or it exists 5 or more holes on the machining surface,

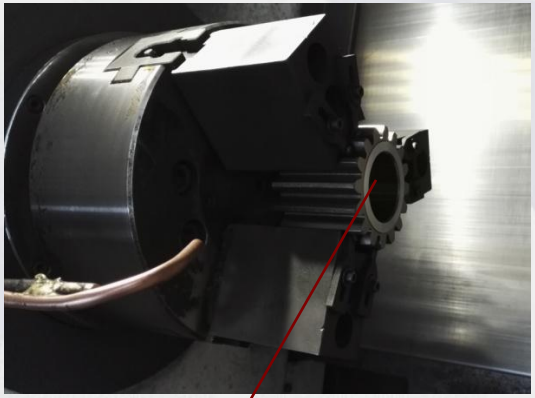
➢ Semi-Interrupt:Broken Slot 90°>θ>40°, or it exists 2~4 holes,

➢ Light Interrupt:Broken Slotθ>90°, or it exists 1 hole, or slot.



Continuous | Semi-Interrupt | Heavy Interrupt

BN-H05 Continuous turning Gear Inner Bore



Gear
Inner Bore

Machining Condition:Continuous Turning
Materials:20CrMnTiGears,
Hardness:HRC58-62
Selected Insert:BN-H05 CNGA120408
Cutting Condition:ap=0.1mm,Fr=0.1mm/r,Vc=180m/min,
Dry Cutting

BN-H05 Tool life will improve 45%!

Insert Materials	Roughness	Tool Life
Halnn BN-H05	≤Ra0.8	800 pieces ↑
Other Brand PCBN	Ra1.0	550 pieces

BN-H10 Light Interrupt turning Gear inner bore

When machining the Gears inner bore with slot, it will produce large impact force for the gear inner bore, which belong to interrupt turning condition. Specific for this interrupt turning condition, Halnn recommend BN-H10 PCBN Insert for light interrupt, application case as follows:

Gear Inner Bore with key Slot

Machining Condition： Semi-Interrupt turning inner bore
Materials： 20CrMnTi Gears, HRC58~62
Selected Insert： BN-H10 CCGW09T304
Cutting Condition： ap=0.25mm,Fr=0.08mm/r,Vc=135m/min,dry cutting

Halnn BN-H10 efficiency improve 22%, tool life improve 66%，

Cutting Tools Materials	Cutting Speed	Tool Life	Efficiency
Halnn BN-H10	135m/min ↑	1000 pieces ↑	Improved 22% ↑
Other PCBN	110m/min	600 pieces	----

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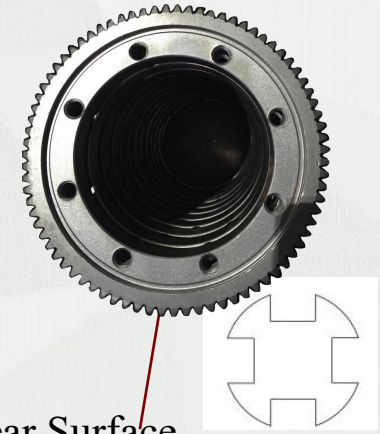
BN-H21 heavy interrupt finishing gear endsurface

When the gear endsurface have many holes, it will have much impact force in the process, which belongs to heavy interrupt turning condition, Halnn BN-H21 is researched specific for heavy interrupt turning condition, the following is one application case:



Gear Surface
with much hole

Machining Condition:Heavy Interrupt turning condition
Materials:20CrMnTi Gear,HRC58-62
Selected Insert:BN-H21 WNGA080404
Cutting Condition:ap=0.15mm,Fr=0.1mm/r,
Vc=117m/min,Dry Cutting

Halnn BN-H21 improve 5 times, and also be normal wear

Selected Insert	Tool Life	Failure Mode
Halnn BN-H21	600 pieces	Normal Wear
Other PCBN	100 pieces	Damage Broken

BN-H20 hard turning synchronizer gear sleeve

With Halnn BN-H20, the lifetime improved 4 times!

Component:synchronizer gear sleeve
Materials:Gear Steel（HRC58~63）
Process:Finish turning gear sleeve(Continuous)
Selected Insert:BN-H20 VNGA160404S01020
Cutting Condition:ap=0.15mm,Fr=0.1mm/r,Vc=170m/min

Insert Materials	Cutting Speed Vc	Tool Life	Failure Mode
Halnn BN-H20	180m/min	350pcs/tip	Normal Wear
Ceramic Insert	120m/min	70pcs/tip	Damage

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BN-H10 Hard Turning wind power bearings raceway

Processing Difficulties：
1.Wind Power Bearings common materials: 50Mn, 42CrMo, hardness: Above HRC50， it exist interrupt turning condition
2.Large working allowance, about 2~6mm

Component: Wind Power Bearings 42CrMo, HRC58~62,
Semi-Interrupt turning
Selected Insert:BN-H10 RNGN090300
Cutting Condition:
ap=1mm(Roughing),ap=0.15mm(Finishing)
Fr=0.45mm/r,Vc=145m/min, dry cutting

Halnn BN-H10
Efficiency improve 20%
Tool life improve 50%

Insert Materials	Cutting Speed	Tool Life	Efficiency
Halnn BN-H10	145m/min ↑	3pcs/blade ↑	Improve 20% ↑
Other Brand	120m/min	2pcs/blade	----

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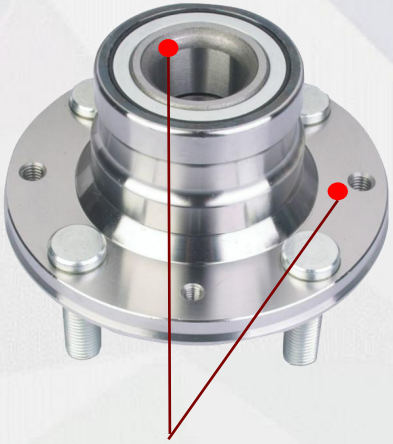
Halnn Coating PCBN application case 1

After coating, the smooth coating will combine with the cbn perfectly, which can obtain excellent cutting performance, improve the precision and the tool life comparing with the cbn insert without coating

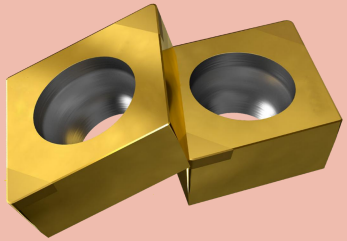


Hub bearing unit bore and raceway

Component:Hub bearing unit,,

Hardness: HRC58~62

Selected Insert：**BN-H10 C25**



Cutting Condition： Vc=180m/min;Fr=0.1mm/r;ap=0.15mm

Roughness：**≤Ra0.6**

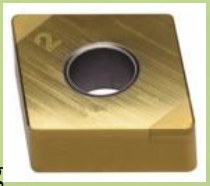
Halnn Coating PCBN application case 1

Materials：20CrMnTi，HRC58~62

Insert Model：BN-H05 CNGA120408

Cutting Condition：ap=0.1mm,

Fr=0.1mm/r, Vc=180m/min,Dry cutting



Insert Materials	Roughness	Tool Life（Pieces/insert）
Other PCBN	Ra1.0	550
Halnn BN-H05	Ra≤0.8	800
Halnn BN-H05 C25 （Coating PCBN）	Ra≤0.8	1200

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Characteristics of BN-S20 hard turning Ball Screw

With the development of the cutting technology, the cutting tools manufacturers researched new tool materials “cubic boron nitride” which can be use for turning instead of grinding, it will have Compressive stress when with traditional cbn inserts roughing the ball screw raceway, it will be easily make the insert chipping. Finally Halnn research non-metal adhesive solid cbn inserts BN-S20, solving the problems of chipping

Advantages of Halnn solid cbn inserts BN-S20 hard turning ball screws;
(1) High hardness, abrasive resistance and heat resistance
(2) Strong impact resistance, avoid the insert chipping, damage problem
(3) High speed cutting, improve the efficiency
(4) Dry cutting method reduce the pollution
(5) Long tool life, will be 1.5~2 times of traditional cbn inserts.

BN-S20 hard turning Rolling screw ends

Materials:Rolling Screw Gcr15
Hardness:HRC60-62
Selected Insert:BN-S20 CNGN120708
Cutting Parameters:ap=4.5mm,Fr=0.10mm/r,Vc=95m/min,
Dry Cutting

Insert Materials	Cutting Speed	Cutting Depth	Failure Mode
Halnn BN-S20	95m/min	4.5mm ↑	Normal Wear ★
Ceramic Insert	65m/min	0.5mm	Broken Damage

Halnn BN-S20 cutting depth will arrive 4.5mm, normal wear

BN-H10 hard turning ball screw raceway

Component:Ball Screw Thread,Gcr15
Hardness:HRC60-62
Selected Insert:BN-H10
Cutting Condition:Fr=0.10mm/r,Vc=150m/min,dry cutting

Insert Materials	Roughness	Failure Mode
Halnn BN-H10	≤Ra0.8 ↑	Normal Wear ★
Other PCBN	Ra1.2-1.6	Damage or Broken

Halnn BN-H10 make roughness achieve Ra0.8, normal wear

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Machining Characteristics of high speed steel

High speed steel，also called HSS，is a type tool steel with high hardness, high abrasive resistance and heat resistance, and is one of the hardest steel through heat treatment in ferrous metal materials, it is used for processing metal cutting tools, mold, rolls and typical parts, the hardness usually is HRC65~HRC68. Halnn has much experience on machining HSS Steel. The following will share you some application case.

High-speed steel as cutting tool material, the hardness will be HRC65 or higher, what cutting tools will you used for machining high hardness HSS?

BN-S20 hard turning high speed steel rolls

Processing Difficulities:

（1）High hardness
（2）Large working allowance
（3）Large cutting force
（4）It exists interrupt turning, the inserts will be easily chipping.

Materials:High speed steel
Hardness:HSD90
Selected Insert:BN-S20 RCMX120700
Cutting Condition:Fr=0.20mm/r,Vc=35m/min,dry cutting

Insert Materials	Tool Life	Failure Mode
Halnn BN-S20	25	Normal wear ★
Other CBN	12	Damage Broken

The tool life of BN-S20 will be about 2 times of other CBN.

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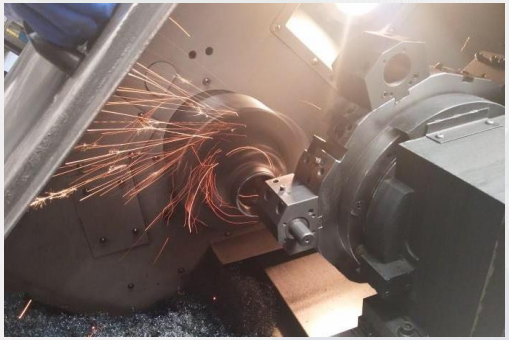
Case 1 Machining high speed steel

Materials： Powder high-speed tool steel （M2、M4、M5、M6）
Hardness： HRC65-HRC68



Process Difficulties：
Previous insert is international pcbn insert, the tool life is short when roughing, the reason is the inner wall of micro-deformation, resulting in the processing of intermittent turning hit theinsert after Vacuum heat treatment, the blade loss is extremely large.

Solutions：
Machining Powder high-speed tool steel with hardness HRC65~67 after heat treatment with BN-H10 PCBN Insert(pcbn insert which can bear interrupt turning), it will have excellent performance.

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Case 2 Machining high speed steel

Materials： High-speed tool steel
Hardness： HRC67-HRC68

Processing sequence：

Process Difficulties

(Next Page)

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Process Difficulties：

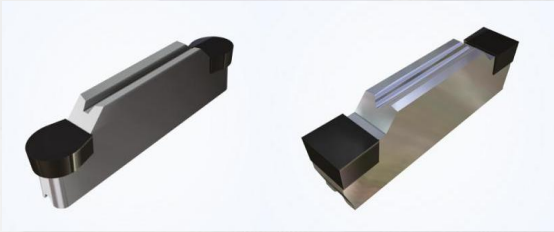
a． Because of high cutting temperature, the current cbn insert will be easily damaged.(as right image)

b． The tool life is short, finishing 0.02mm with speed 600 r/min, the roughness will become not as well as before, and need change the insert frequentlty. If change the speed to 1000r/min, the roughness perform well, the tool life will be lower.

Tool Solutions:

1.**Tool Structure:**Because of HSS high hardness, and customers use customized tools, the insert damage easily, so we advise change to ISO Grooving Insert (as right image);

2.**Insert Materials:** It need to choose the cbn materials with high abrasive resistance, heat resistance and high hardness cbn grade BN-H05, which can meet all the requirements on the size, roughness, durability and the tool costs.



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Case 3 Machining high speed steel

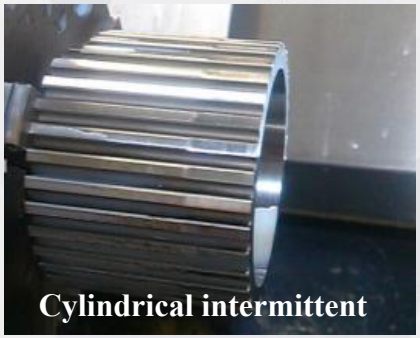
Lathe：OKUMA：

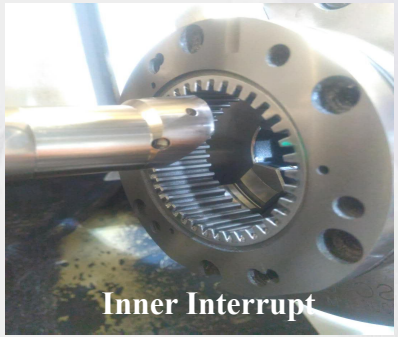
Materials：High Speed Steel (Hardness: HRC65~65)

Process Difficulties： 1.Interrupt turning (as following image)

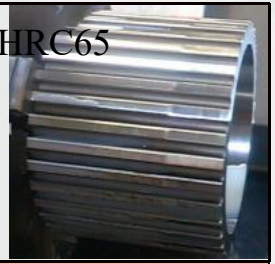
2.Dimension tolerance:0.005mm


Migraine Interrupt


Cylindrical intermittent


Inner Interrupt

Materials:High wear-resistant powder high-speed steel,HRC65
Machining Site:Heavy Interrupt turning Cylindrical
Selected Insert:BN-H21 CNGA120408
Cutting Condition:Fr=0.10mm/r,Vc=35~60m/min,
ap=0.15mm,dry cutting



Insert Materials	Insert Life	Failure Mode
Halnn BN-H21	5	Normal Wear
Other CBN	＜1	Broken Fragmentation

Testing Result:
Other Brand PCBN broken
Halnn CBN normal wear

Further consider produce coating pcbn, and improve the cutting efficiency.

Summary:
1.Machining high hardness component, and have heavy interrupt turning condition, the cutting speed is not large.
2.If the size tolerance is less 0.01mm, normally it need coolant, BN-H10 and BN-H21 can meet the requirements.

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Processing Characteristics of Nickeal alloy spraying welding parts

Difficult factors of processing Nickel-based alloy

（1）Cutting Force will be 50% higher than 45# steel， the surface layer hardened after processing, the hardening up to 200%~500%, tool tip and the boundary wear is extremely seriously, the flank groove wear is also very easy to happen;

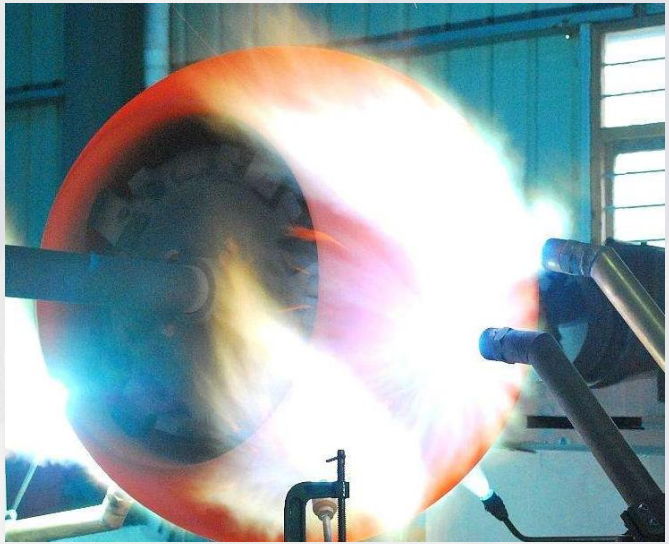
（2）Thermal conductivity is 1/5 ~ 1/2 of 45 steel , cutting temperature is high.

（3）Easily Bonding with the tool and produce BUE, which will affect the surface quality.

（4）The tungsten carbide, intermetallic compunds and other hard points will has stong impact on the insert.

（5）The workpiece will have irregular surface after surfacing or spraying process, and require high on the insert impact resistance.

BN-S20 hard turning Nickel based spraying component



Component: Nickel based alloy spraying,welding layer 2mm, HRC60
Selected Insert: BN-S200
Cutting Condition: Fr=0.25mm/r,ap=1.7mm,Vc=120m/min,dry cutting

Insert Materials	Cutting Speed	Depth of Cut	Failure Mode
Halnn BN-S20	120 m/min	1.7mm	Normal Wear
Carbide Insert	16 m/min	0.6mm	Damaged Broken

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BN-S20 hard turning Hydraulic phop

Laser cladding workpiece processing difficulties:
1.High hardness,about above HRC50
2.Complex component, it doesn't have suitable grinding machine
3.Large allowance, it belongs to interrupt turning condition.

Component: Hydraulic phop,27SiMn, HRC55
Selected Insert：BN-S20 CNMN120712
Cutting Condition：ap=1mm，Fr=0.15mm/r，Vc=145m/min,dry cutting

With BN-S20, efficiency improved 11 times

Insert material	Cutting Speeds	Roughness	Efficiency
Halnn BN-S20	145m/min	Ra0.4	Improved 11times
Carbide Insert	30m/min	Ra3.2	----

BN-S200 milling the mold

Component:Mold
Materials:Cr2MoV,HRC65
Machining Process:Finish turning mold surface
Selected Insert:BN-S200 RNGN090300
Cutting Condition:ap=0.5mm，Fr=0.12mm/r,Vc130=m/min

Insert Materials	Cutting Speed Vc	Tool Life	Tool Cost/piece
Halnn BN-S200	130m/min	120 pcs	USD 0.05
Other PCBN	130m/min	115 pcs	USD 0.08

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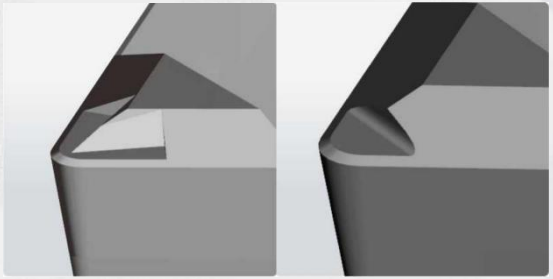
Hann Innvoation of hard turning

1.Chibreaker Insert： Excellent chip breaking performance, to avoid the chip wrapped around the workpiece or tool, to ensure good surface quality and tool life.



Chipbreaker Insert

Chips
（Insert without chipbreaker）

Chips
（Insert with chipbreaker）

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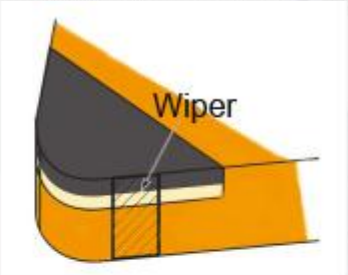
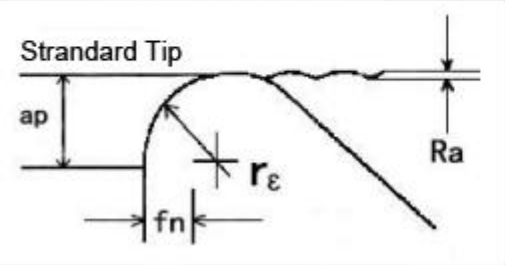
2.Wiper PCBN Insert:

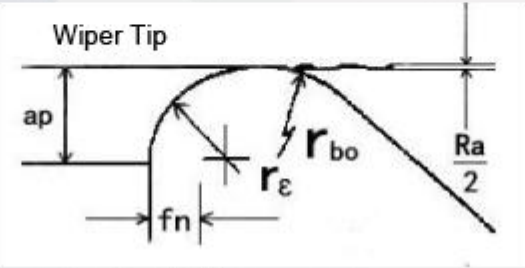
（1）With same feeds, wiper insert can obtain better surface quality

（2）With same roughness requirements, wiper insert can use larger feeds, which can reduce the time on each component, improve the efficiency.

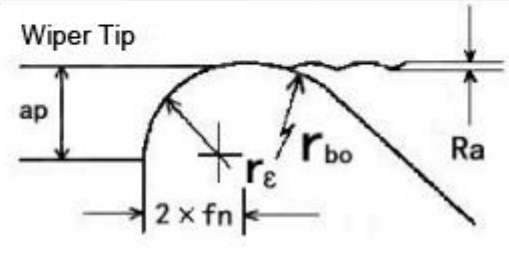




Common Tip



Wiper Tip
(High Surface Quality)



Wiper Tip
(High Feed,High Efficiency)

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单击此处添加标题内容

单击此处编辑标题

3.Coating PCBN Insert: The perfect combination of smooth coating and CBN base can achieve better cutting performance and improve machining accuracy and life.

About Halnn

Halnn Superhard, as the pioneer of superhard cutting tools in China, make national Superhard Materials Key Laboratory and Henan University of Science and technology as technical support, have our own research center, focus on **cbn cutting tools and high grade diamond tools for machining brittle and hard materials**, have obvious advantages on most industries, such as **turning instead of grinding, high hardness materials machining, heavy turning, high speed machining**, ect. At the same time, we have launched a series of new cbn/pcd cutting tools and other material tools in 3C, aerospace and Nuclear energy military field, depending on the research center of Henan Superhard Materials Institute. Our customers have covered many countries and areas, including China Mainland, German, Italy, USA, Korea and other areas.

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