HUASHENG

2026

GFOUR-Coating Equipment

Committed to becoming a world-class supplier of vacuum surface treatment solutions

Striving to reduce industrial energy consumption

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Contents

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01

Introduction

Equipment Introduction-GFOUR

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GFOUR introduces a new four-target solution, featuring high-power, tunable square-wave plasma technology with precise ionization control. This enables both thin and thick coatings, delivering excellent adhesion and consistently smooth, droplet-free surfaces

0.5~30μm

Max.3μm/h

Smooth coating without droplets

High adhesion strength

Tunable coating density

Flexible coating targets

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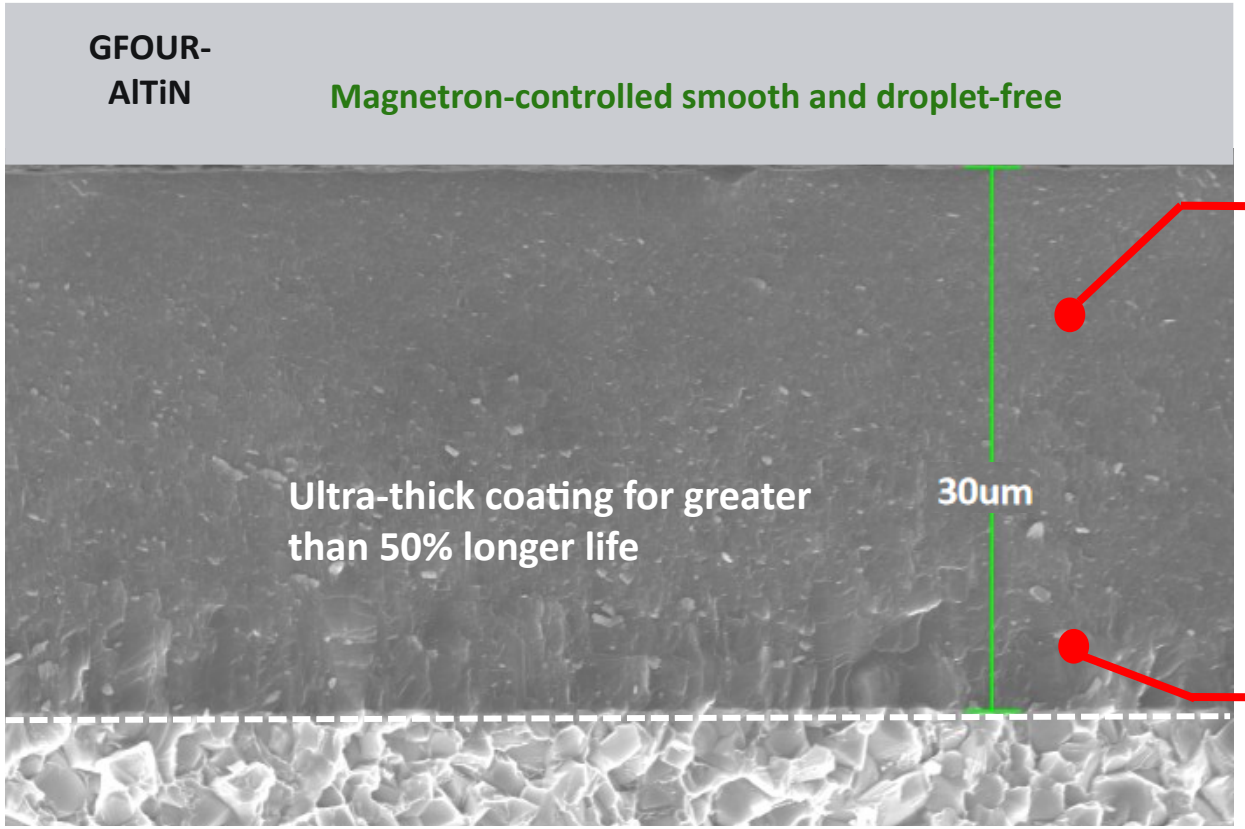
02

Features

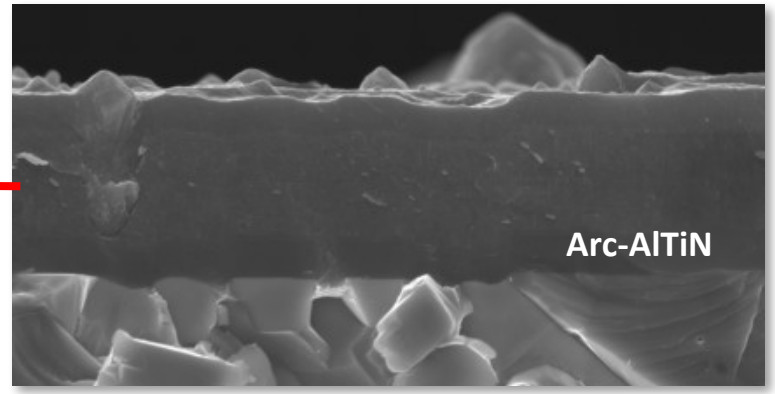
Equipment Features-GFOUR

GFOUR coating integrates the best of both worlds —

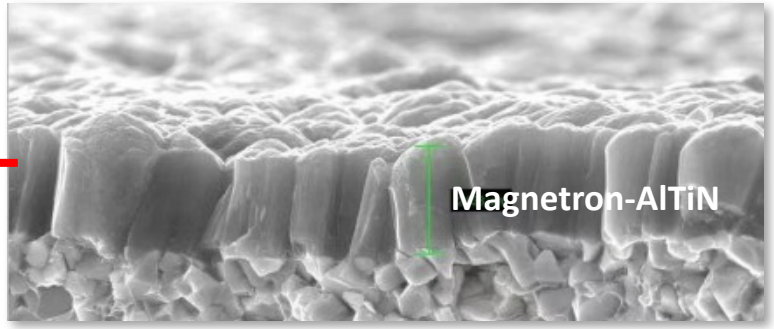
the high density of arc deposition and the low-stress, droplet-free performance of magnetron sputtering



Arc-level density

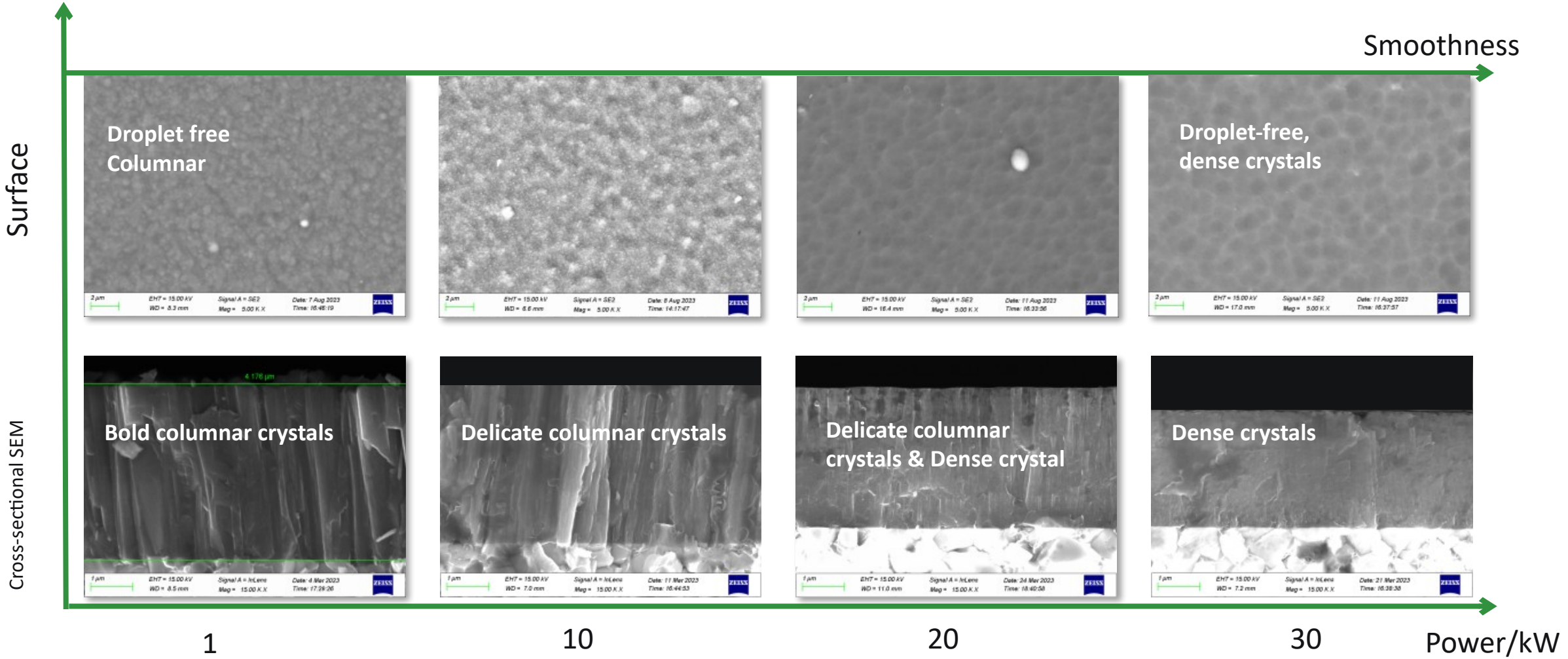


Magnetron-smooth, low-stress coating



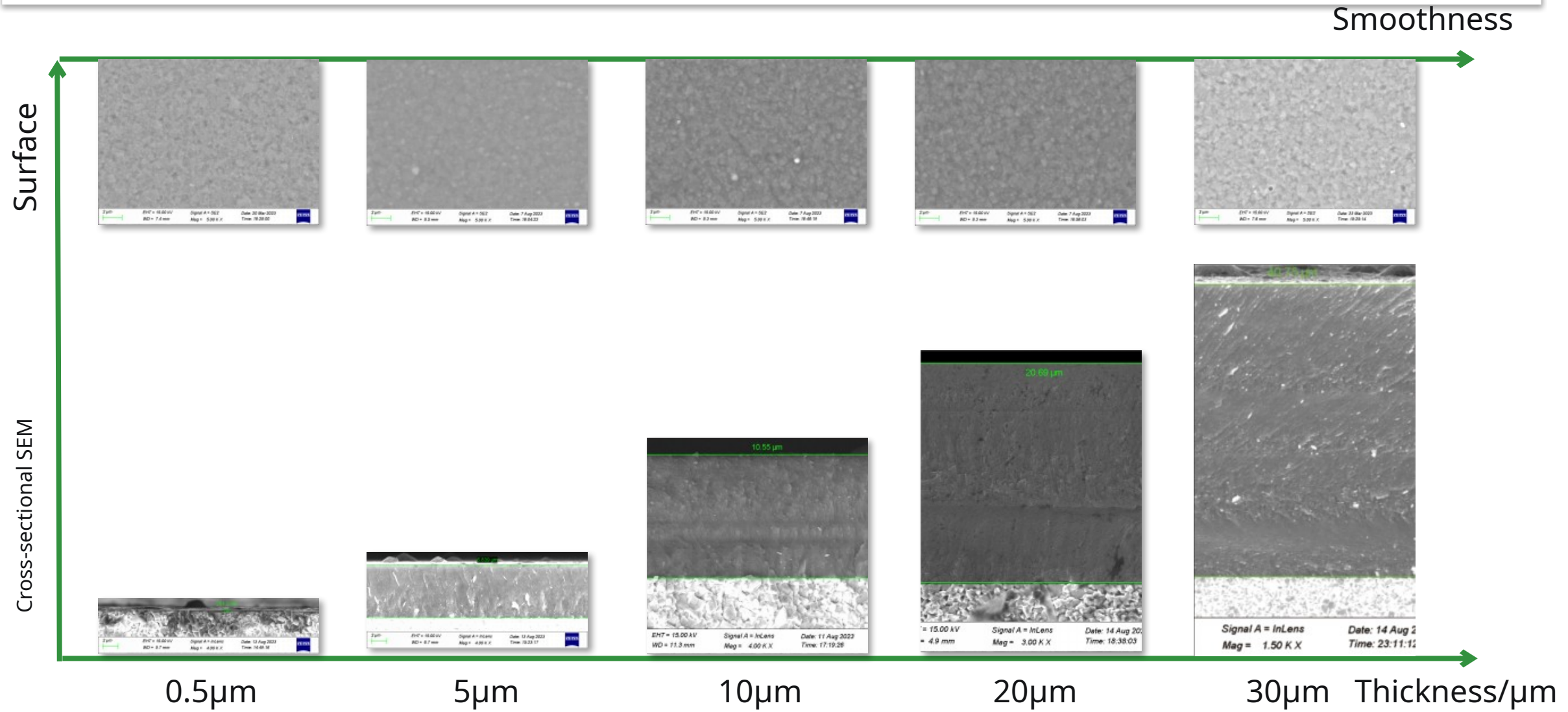
Equipment Technical Features-GFOUR

Tunable density — freely combine columnar and dense crystals



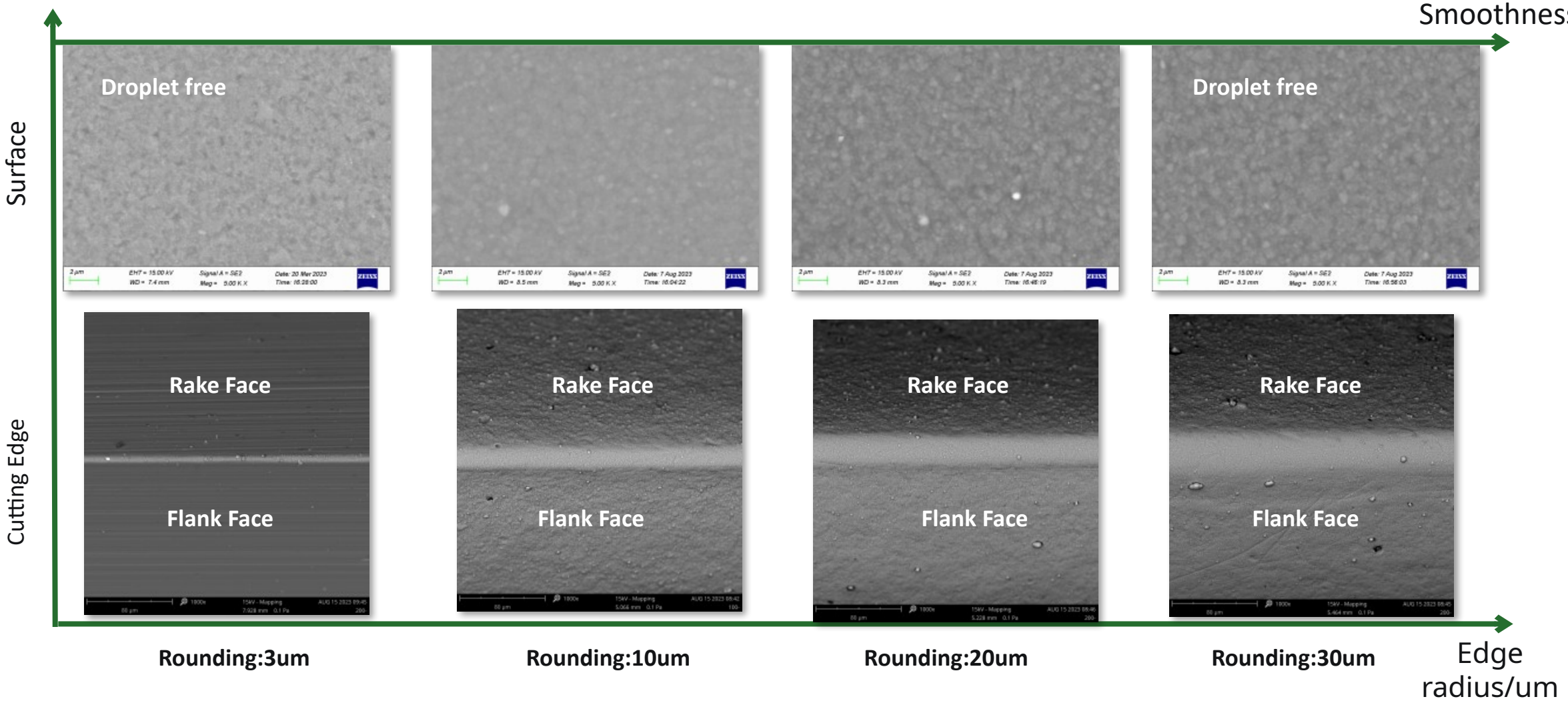
Equipment Technical Features-GFOUR

Thickness: tunable from 0.5 μm to 30 μm, maintaining consistently smooth performance.



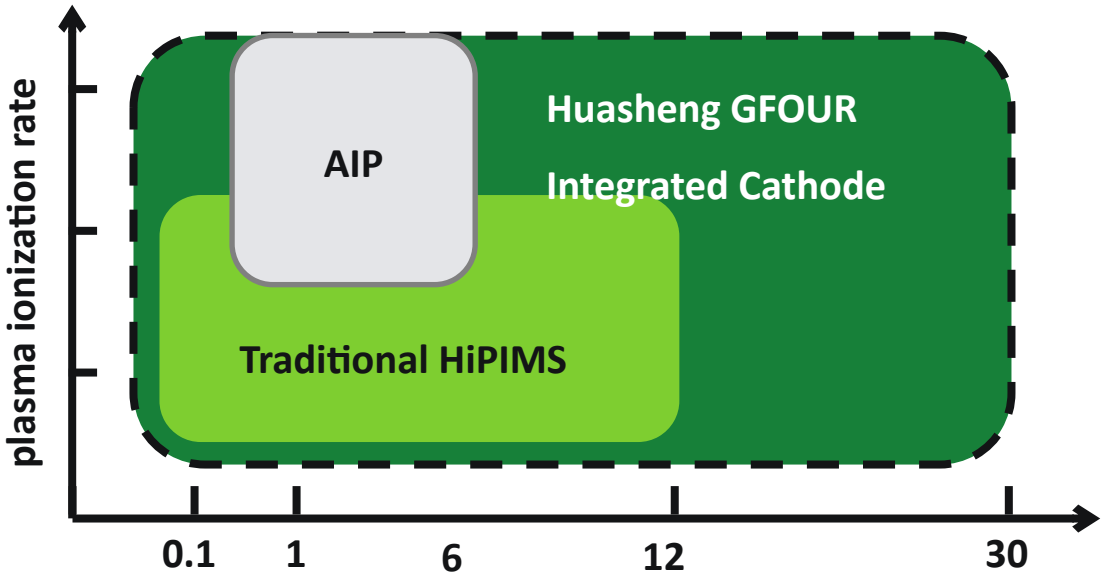
Equipment Technical Features-GFOUR

Edge rounding: tunable from as low as 3 μm while maintaining edge integrity and protection

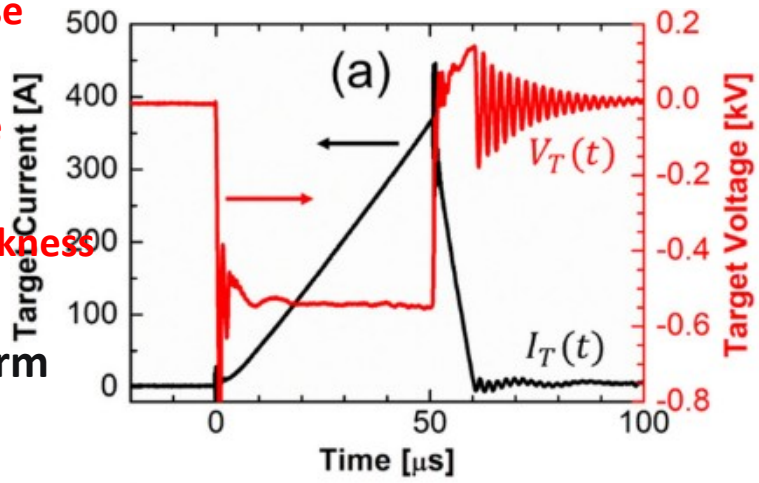


Equipment Technical Features-GFOUR

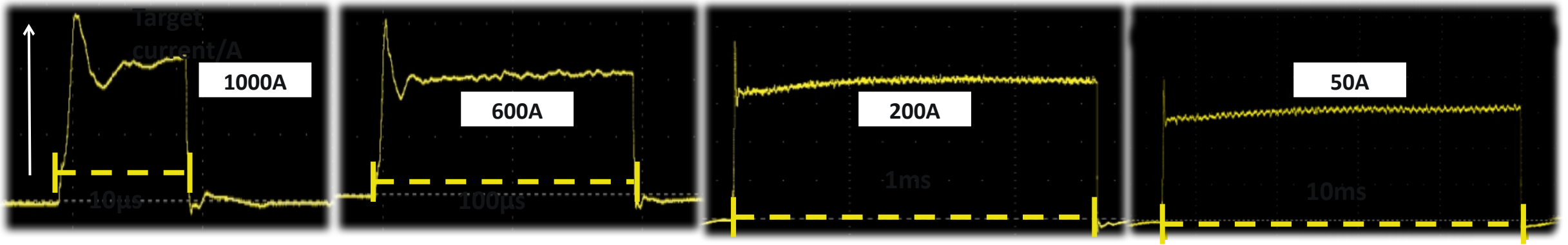
A fully tunable coating technology, enabling tailor-made process development.



- **Tunable Discharge Pulse**
- **Tunable ionization rate**
- **Flexible stress and thickness**
- **More stable waveform**
- **More stable Plasma**



Traditional HiPIMS current waveform

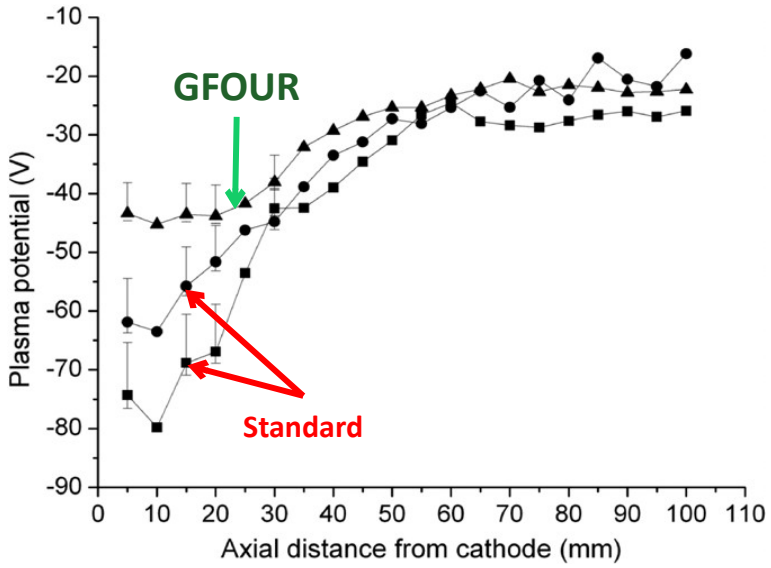


Huasheng GFOUR Integrated Cathode Discharge Waveform Diagram

Equipment Technical Features-GFOUR

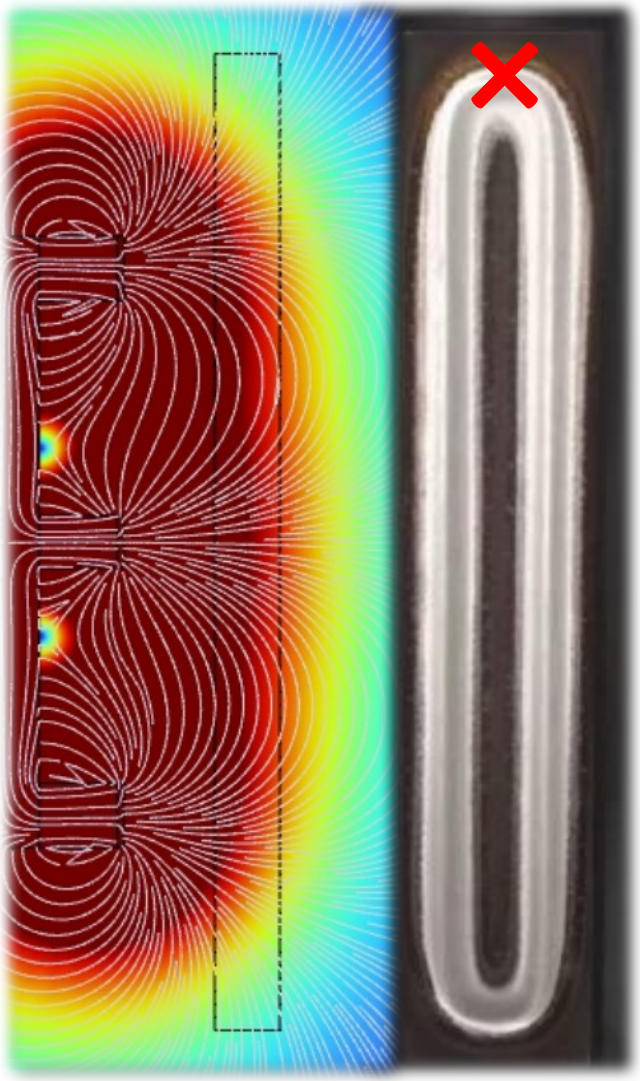
GFOUR proprietary magnetic field design ：

- **Minimizes ion back-flow near the target**
- **Boosts sputtering efficiency and deposition speed**
- **Expands the erosion area for better target usage**



Sheath voltage - magnetic field strength

Standard



GFOUR magnetic field design

Sputtering area becomes wider

magnetic field

Equipment Technical Features-GFOUR

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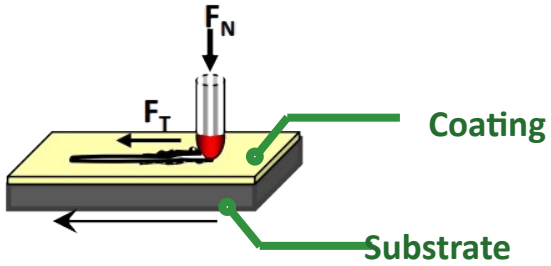
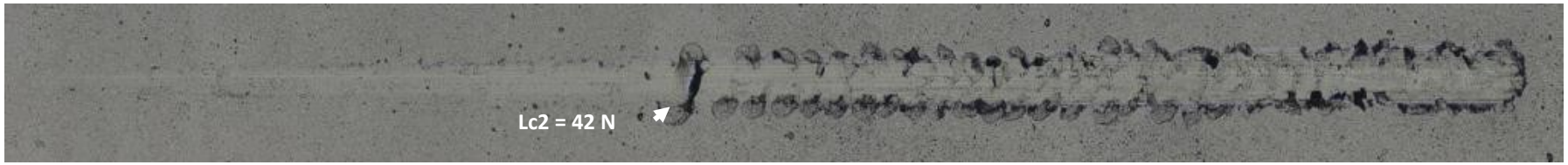
Excellent coating adhesion



0

3mm

DCMS



Bad adhesion

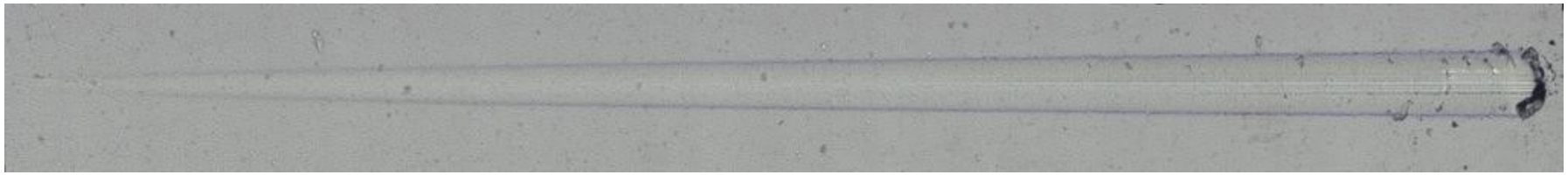
50N

MA-ARC

Good adhesion

> 100N

GFOUR coating



Good adhesion

> 100N

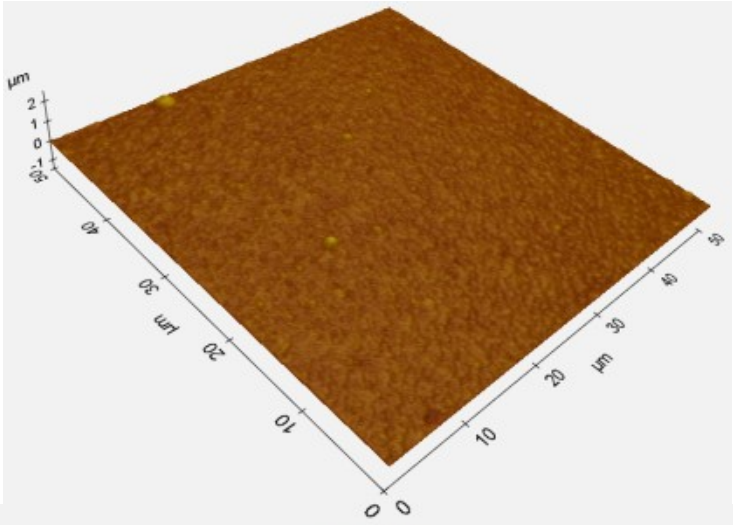
0

120 N

Equipment Technical Features-GFOUR

No droplets, smoother surface

GFOUR coatings



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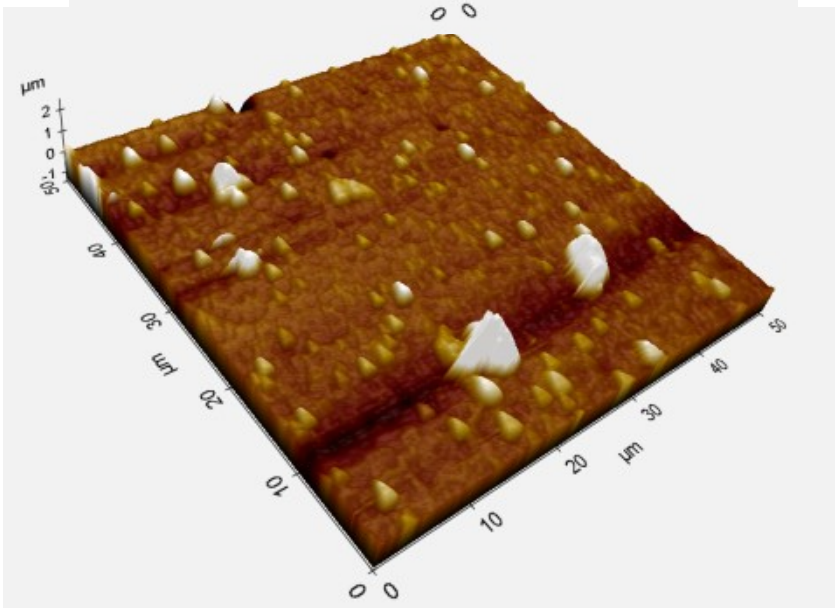
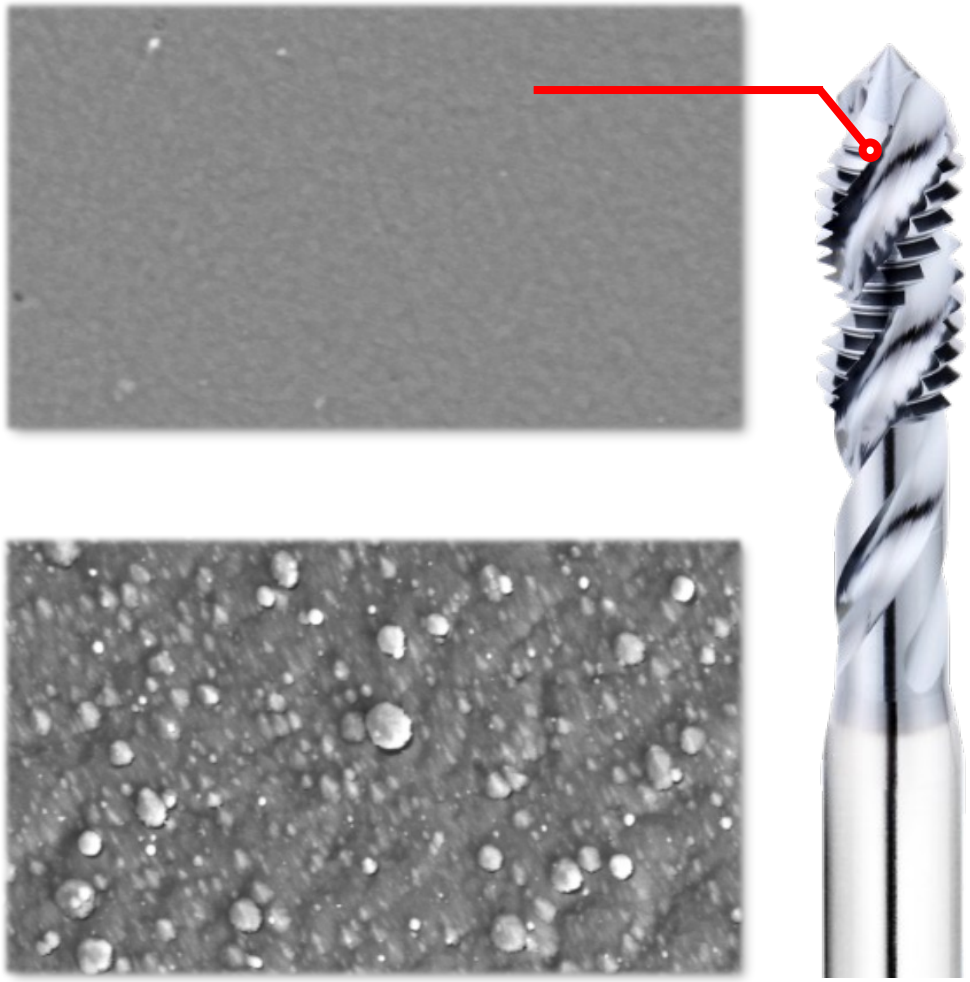
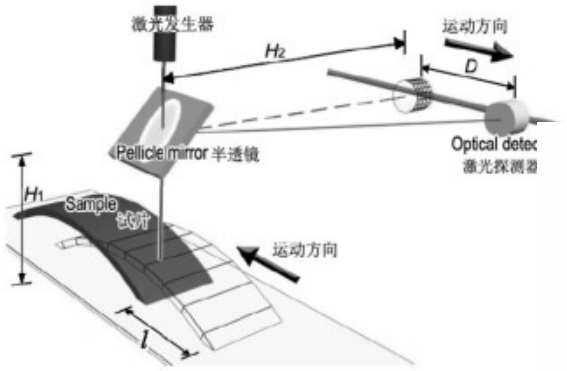
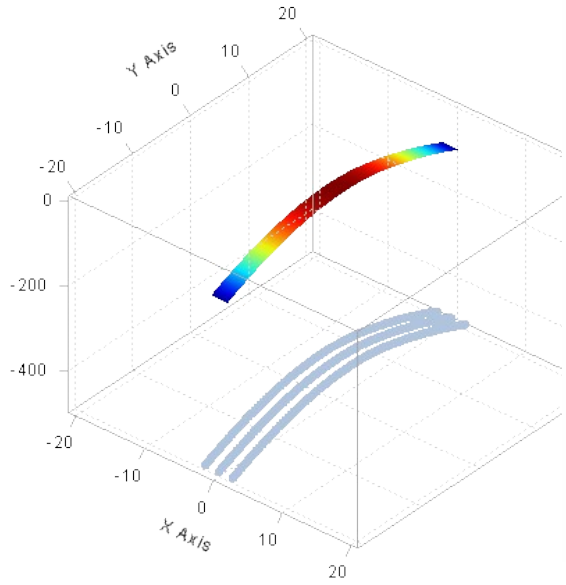


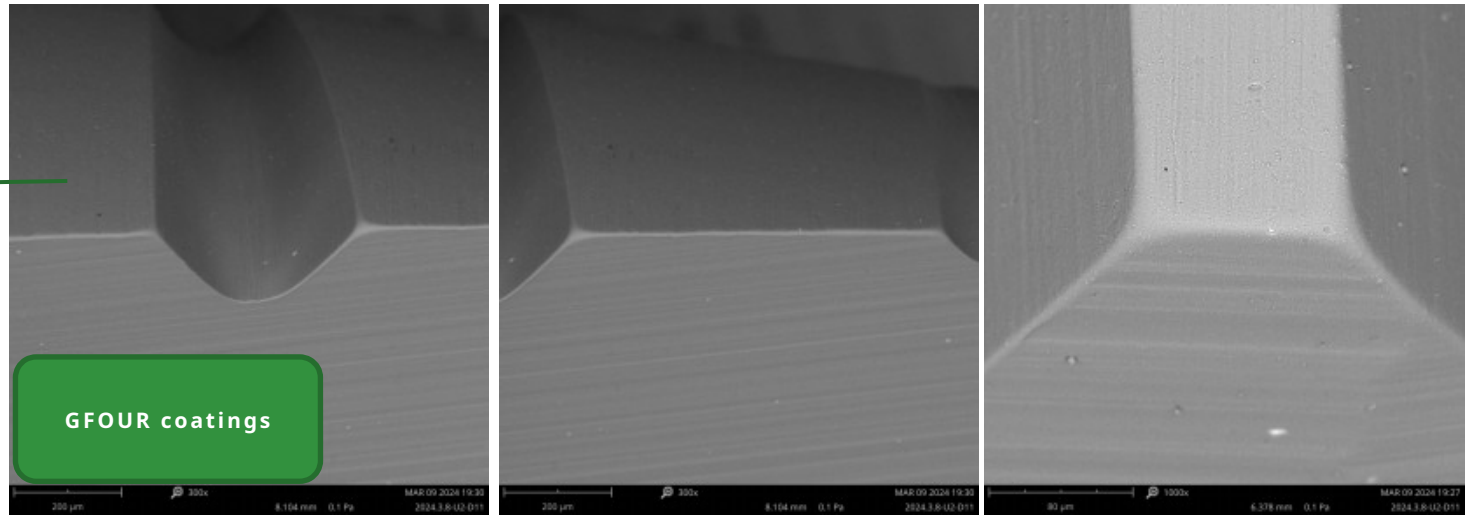


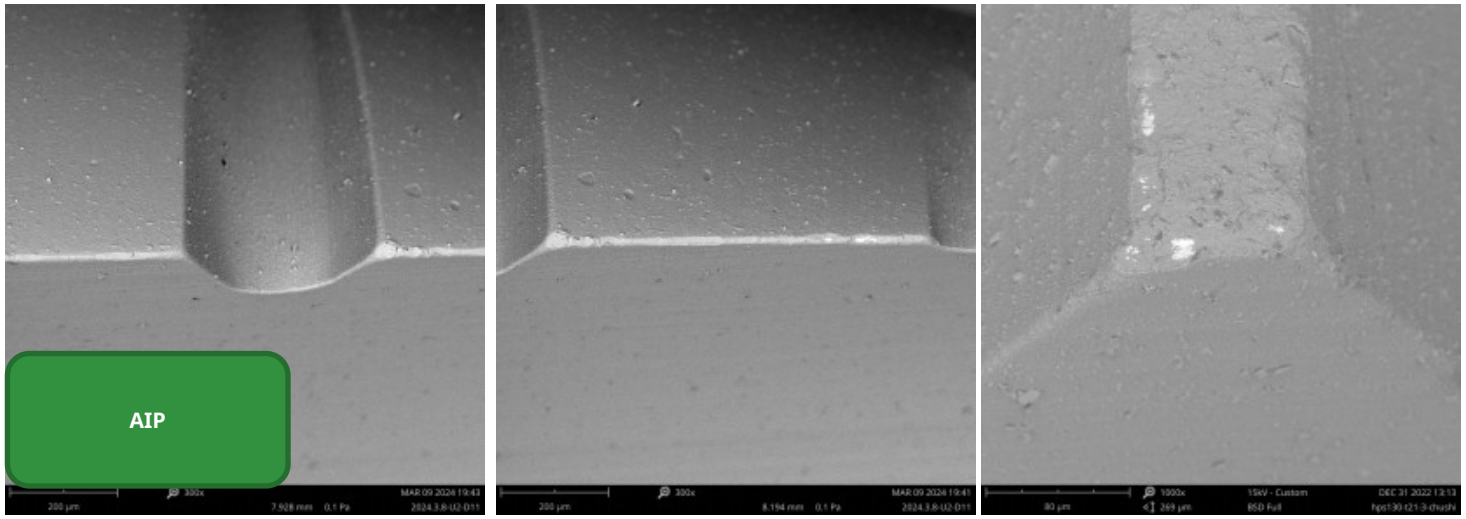
Equipment Technical Features-GFOUR

Low stress. Strong edge integrity





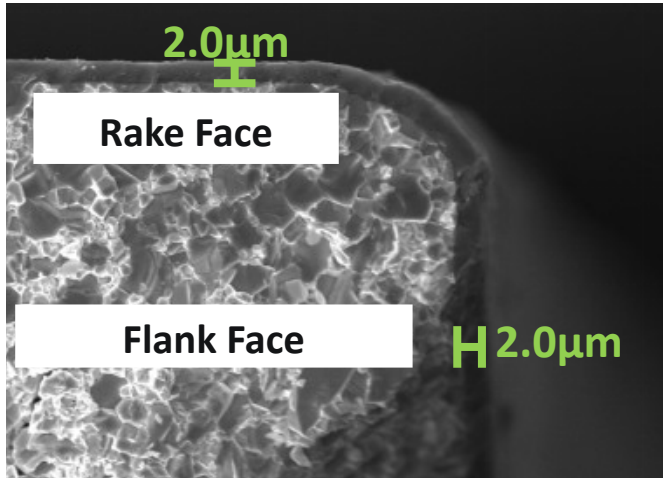


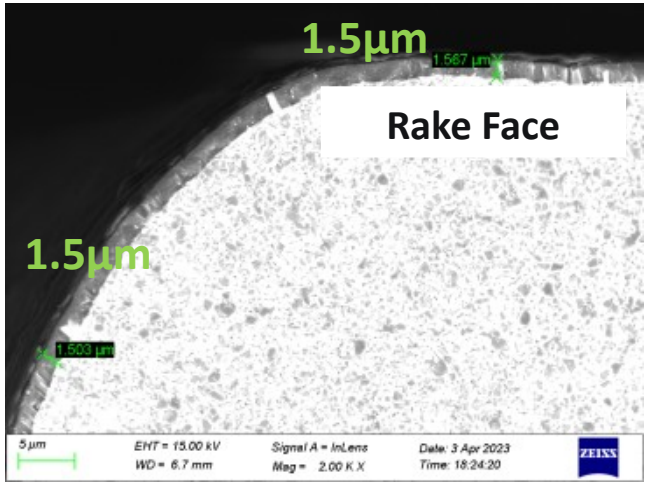


Equipment Technical Features-GFOUR

Excellent coating conformality with uniform and precisely controllable thickness

GFOUR coatings





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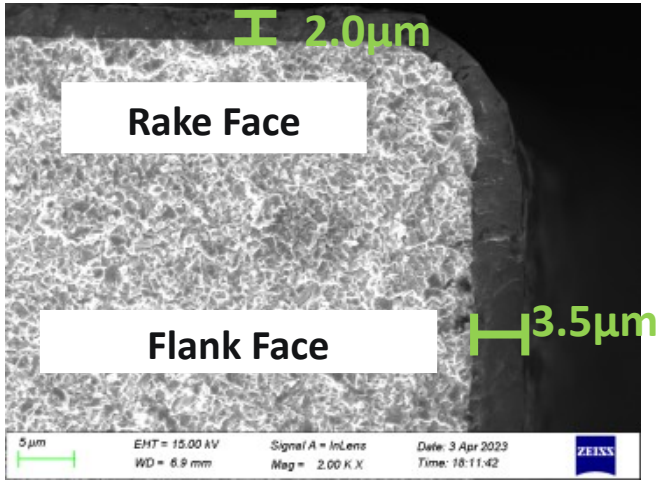

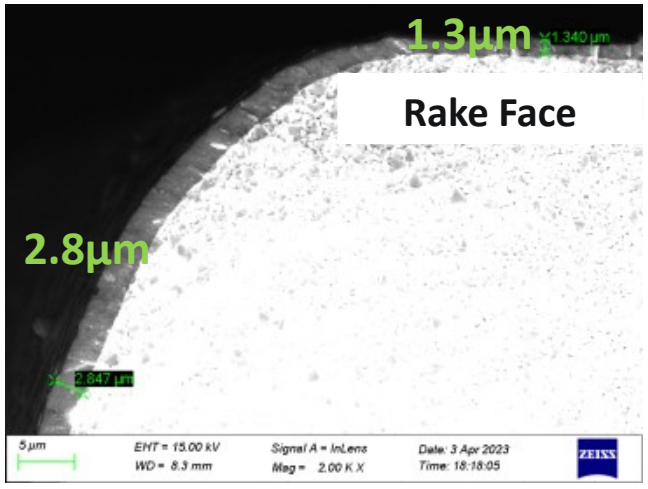

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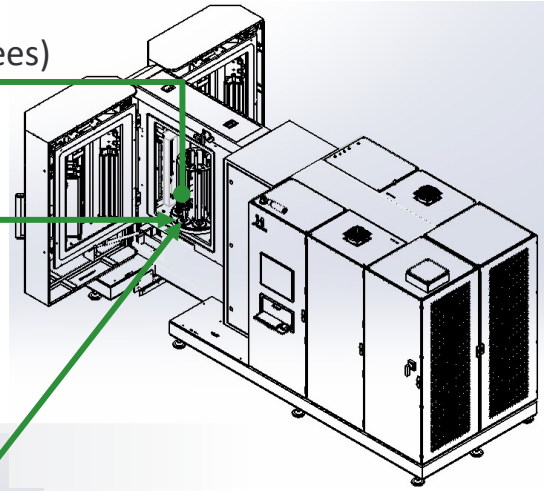
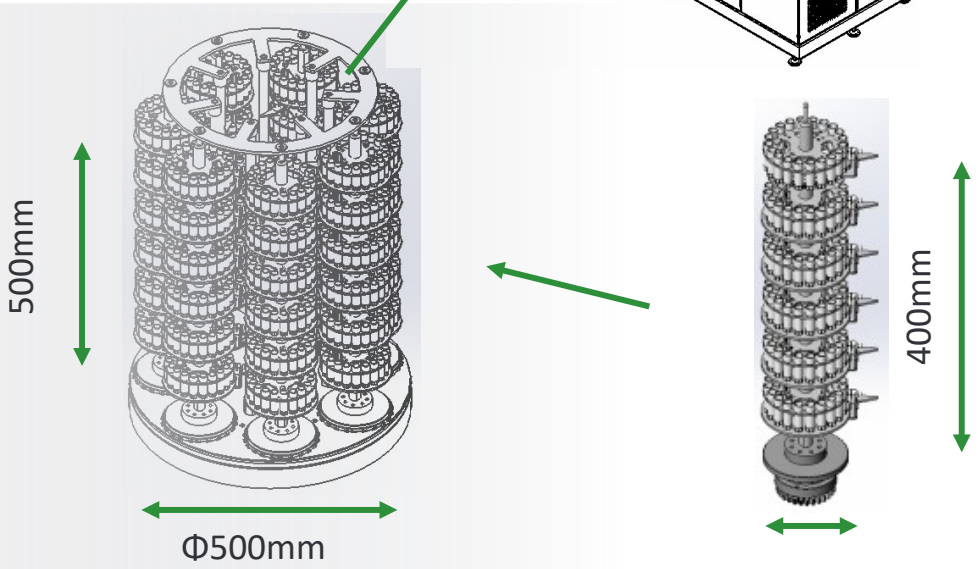
03

Parameters

Parameters



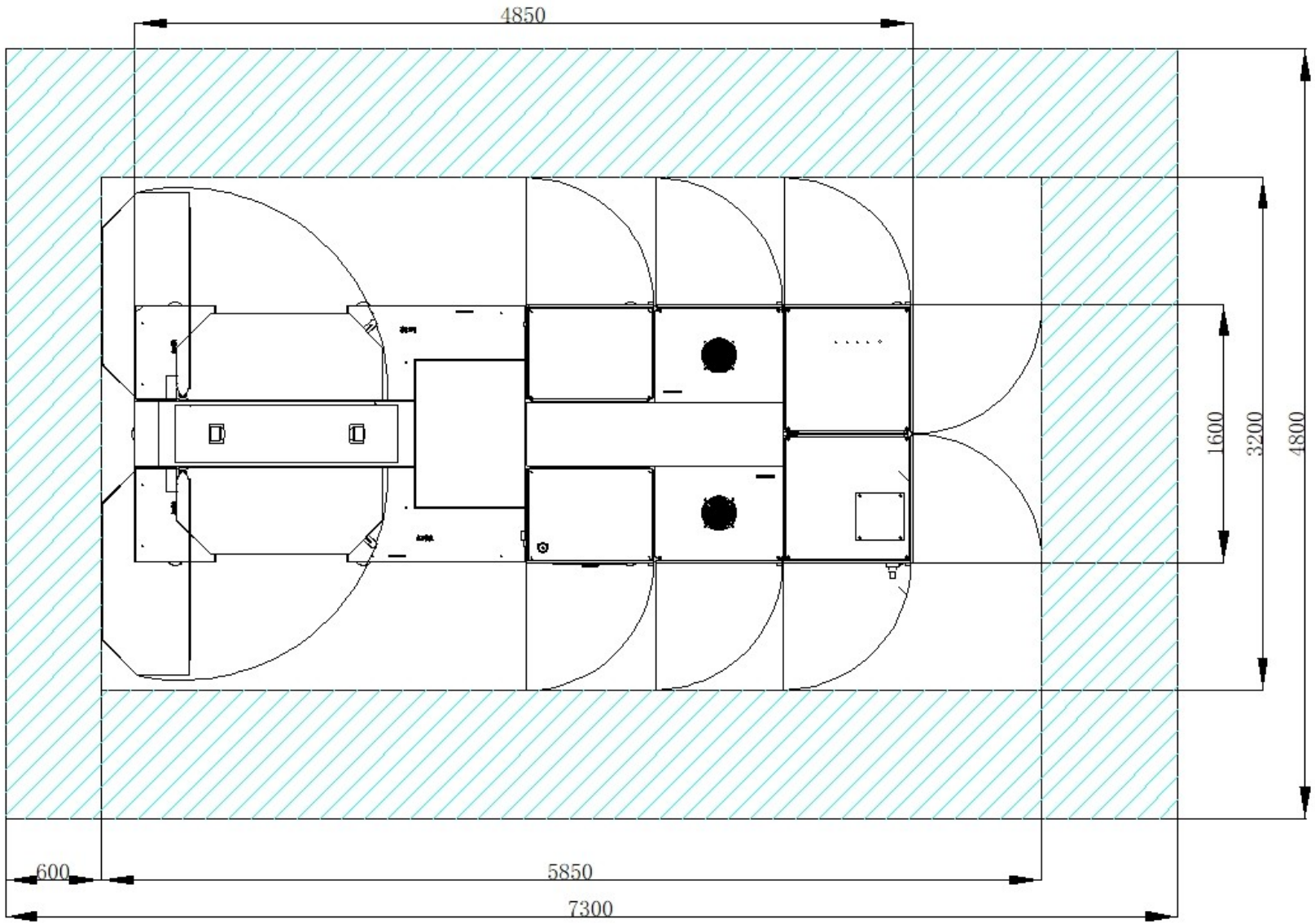


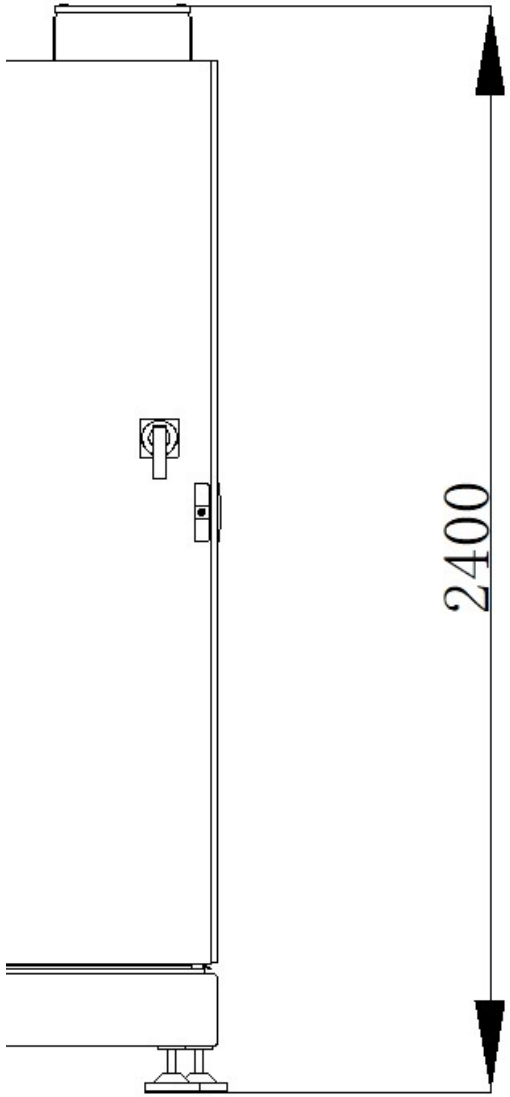
Loading Area

Parameters

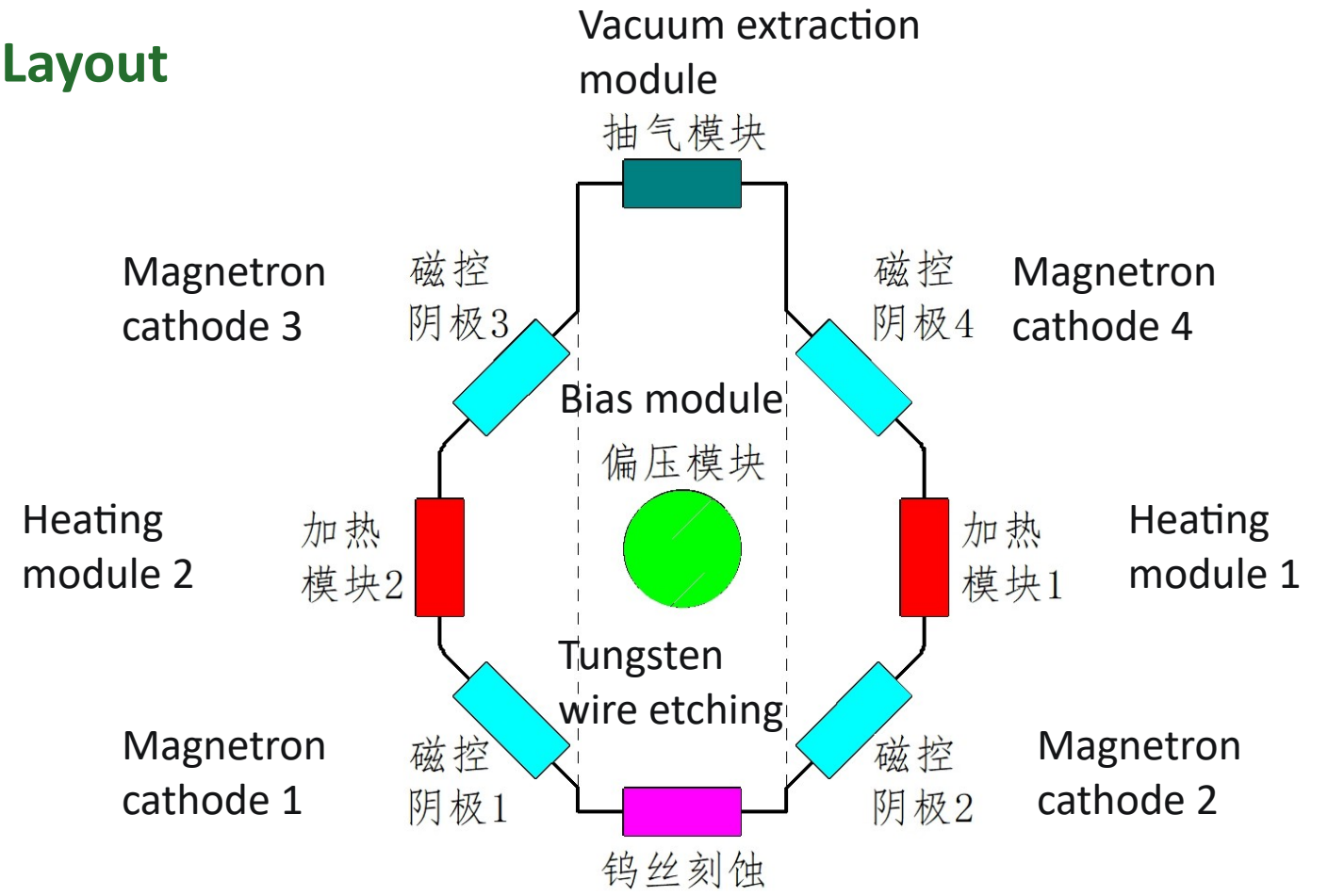
Model No.	GFOUR
Coating Technology	4th generation hybrid coating technology
Etching	WET Lateral Etching
Dimension（ mm ）	L4850*W1600*H2400
Chamber volume（ m^3 ）	0.76
Effective Coating Area（ mm ）	Φ500*400
Max Working Temp.（℃）	650
Capacity（ trees ）	7
Insert Load（ APMT1135 ）	8400pcs
Round tool Load（ D4*50L ）	2520pcs
Max Load（ KG ）	300
Spindle diameter（ mm ）	Φ130
Process Time（ h ）	AlTiN:6~8

Footprint





Equipment Layout



Parts	GFOUR
Ion Source	1set
Number of cathodes	4
Cathode arrangement	Symmetrical arrangement
Equipment advantages	Integrated cathode technology upgrade Quality improved by 50%+

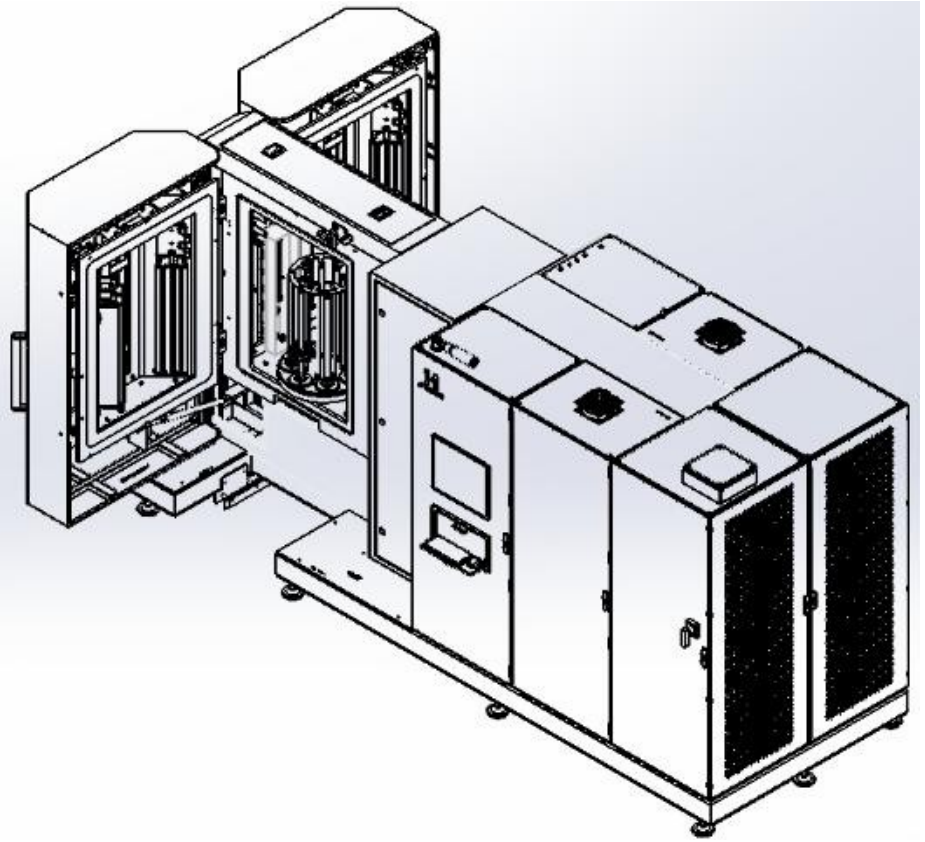
Equipment Parameters

Model	GFOUR
Voltage	3*380/220V（ 3L+N+PE ）
Current	3*200A
Power	130kW
Frequency	50/60Hz
Cooling Water: 22~26℃	5-5.5bar
Compressed air	5-6.5bar
Process gas ： $Ar/N_2/H_2$	1.0-1.2bar

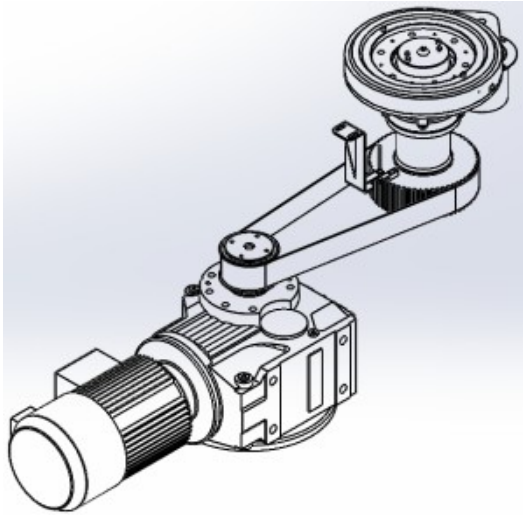
GFOUR system consumption

Model	GFOUR
Minimum purity	(Ar) 99.9992%
	(N_2) 99.9992%
	(H_2) 99.9992%
	Standard nitrogen (N_2) 99.996%
Consumption per batch	(Ar) 80L per batch
	(N_2) 50L per batch
	(H_2) 10L per batch
	Standard nitrogen (N_2) 70L per batch
Cooling water	Maximum heat dissipation100kW Flow rate150 L/min (Consumption:10 L per batch)
Power consumption	Average power:60kW/h 10 hours per batch (depending on the process)

System components

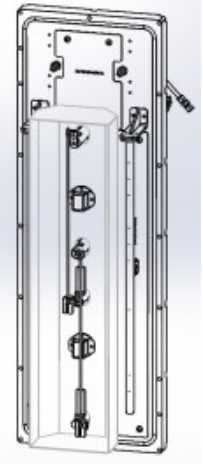


Main Unit

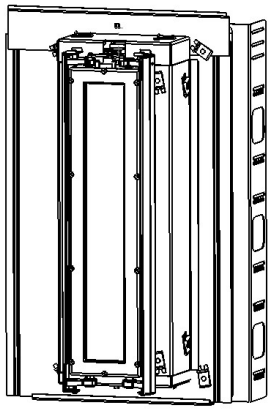


Workpiece holder base

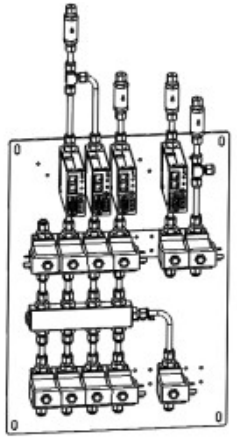
Heating Module



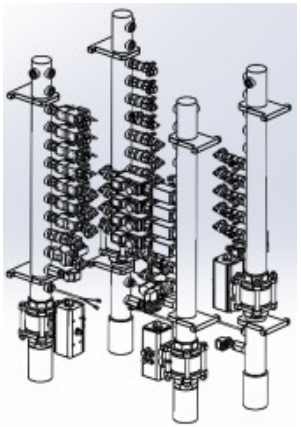
Etching module



Cathode Module



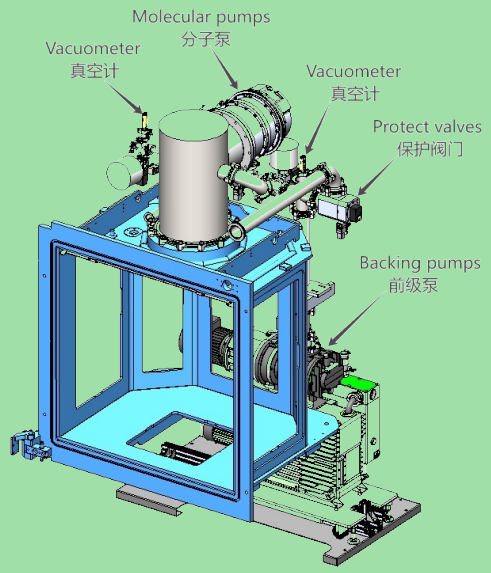
Gas Module



Cooling Water Module

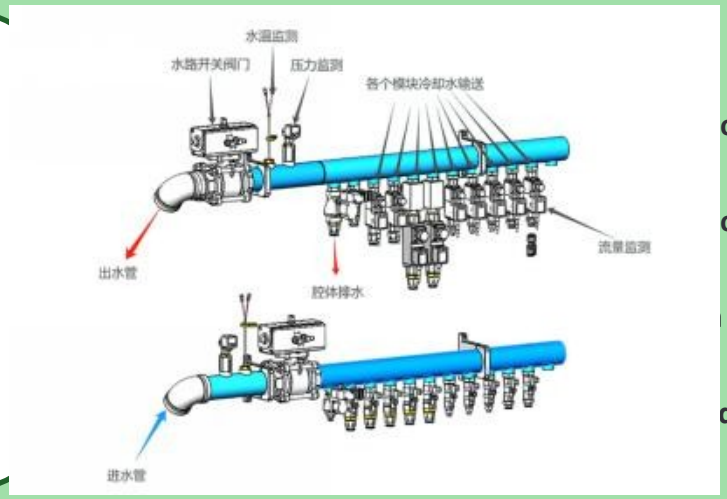
Components and Concepts

Vacuum System



- The vacuum chamber is pumped down to the required coating pressure
- Operators can select either pressure control mode or flow control mode
- Precise gas control is achievable for optimal coating performance

Cooling Water System



- ovides cooling water to each functional module
- otects components and module seals during high-
- perature operation
- dependent flow and temperature monitoring per branch.

Components and Concepts

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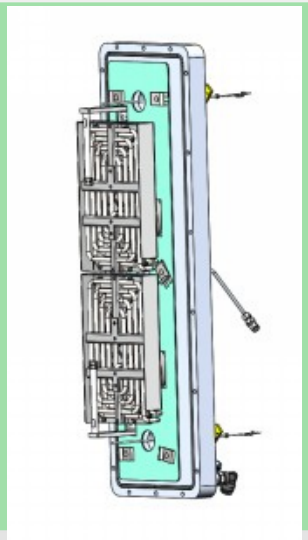
Ion source control system

- Filament-emitted electrons ionize argon gas, and the resulting argon ions are accelerated by a negative bias to bombard the workpiece, cleaning the surface and enhancing coating adhesion

Heater temperature measurement system



- Radiant heating of the workpiece holder and products enables thorough bake-out of moisture and internal gases, with precise chamber temperature control for uniform heating

Components and Concepts

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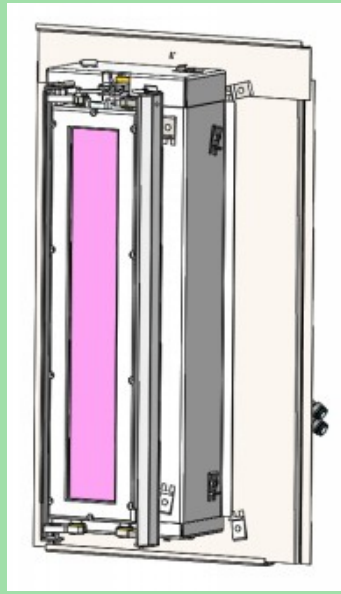
Integrated cathode



- Combines the benefits of magnetron sputtering and arc ion plating
- Enables high ionization of refractory metal targets
- Effectively resolves the hardness-stress conflict.

Drive system and rotating platform

- Variable-speed rotation: 1–3 rpm
- Magnetic fluid-sealed main shaft
- Gear-driven platform: disk revolution + individual holder rotation

Integrated cathode power supply (Hüttinger)

- Compared with DC sputtering, the integrated cathode provides higher ionization and more active plasma
- Square-wave mode allows faster deposition and superior coating quality.
- Constant-current output ensures stable ionization rates

Item	Parameters
Voltage range	20-1000VDC
Power	20kW
Frequency	0.02~10KHz
Duty cycle range	0~99%
Current	1000A

Bias Power Supply （ Hüttinger ）

- Constant-voltage output provides a negative bias to the workpiece holder
- During etching, argon ions are accelerated to bombard the workpiece surface

- Ensures more thorough workpiece cleaning, enhancing coating adhesion
- Coating properties can be adjusted by varying the negative bias

Item	Parameter
Voltage range	20-1000VDC
Power	20kW
Frequency	0.02~10KHz
Duty Cycel Range	0~99%
Current	1000A

List of core components

No.	Components	Brand	Qty	Parameter
1	Molecular pump	Leybold	2	Pumping speed 2200L/s^{-1} Ultimate pressure <10^{-8}mbar
2	Backing pump	Leybold	1	D63L+WAU501（dual-stage rotary vane pump + Roots pump combination） Pumping speed：500m^3/h
3	Bias power supply	**Hüttinger**	1	4001 G2，20kW/set，Pulsed DC，DC1000V
4	Integrated Cathode	HUASHENG	4	Dimensions L650*W100*T10mm，With baffle to prevent contamination
5	Cathode Power supply	**Hüttinger**	4	4001 G2，20kW/set，Pulsed DC，DC1000V
6	Ion Source	HUASHENG	1	WET lateral etching ion source
7	Flow Meter	Azbil	4	0.5L:2sets，0.2L:2sets

List of core components

No.	Components	Brand	Qty	Parameter
8	Automation system	HUASHENG	1	Beckhoff IPC, Siemens 19-inch touchscreen
9	Chamber	HUASHENG	1	304Stainess Steel ， 0.76m³
10	Rotation Platform	HUASHENG	1	Variable-frequency motor, 1–3 rpm ， 300kg load capacity ， Magnetic fluid seal
11	Temperature control system	HUASHENG	1	Power/temperature control models ， Dual-layer high-density power heaters ， total power 30kW
12	Vacuum Gauge	Inficon	1	BTN:CDG100D ， PKR:MPG400 ， Pirani gauge:PSG500
13	Gas Control	SMC	1	Solenoid valves, cylinders, sensors
14	Cooling system	SMC/NNT	1	Water temperature, flow sensors, pressure sensors

Brands of the Main Components

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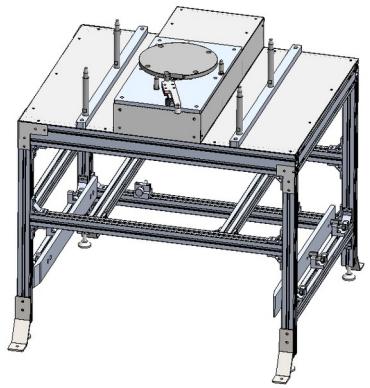
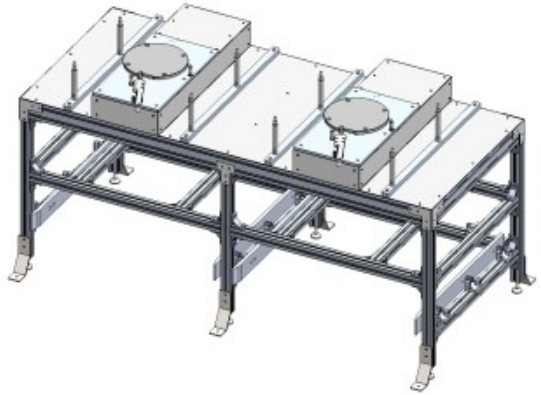
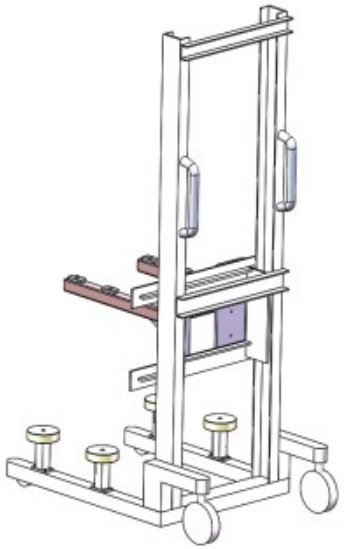
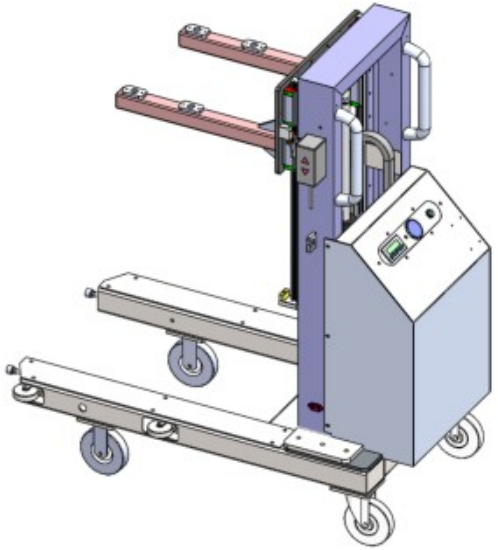
No.	Component	Brand
1	Molecular pump	Leybold
2	Backing pump	Leybold
3	Cathode power supply	Hüttinger
4	Bias power supply	Hüttinger
5	Flow meter	Azbil
6	Vaccum Gauge	Inficon
7	Automation System	Beckhoff
8	Main Electronic Components	Siemens

Optional Accessories

● Single-station worktable	● Double-station worktable	● Forklift(manual)	● Forklift(Semi-auto)
			

Pictures for reference only,subject to the actual order requirements

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04

Process

HuangSheng®GFOUR Coating Process List

GFOUR Recommended Coating Process List							
Process	**Composition**	**Color**	**Thickness/um**	**Hardness/GPa**	**Residual Stress/GPa**	**CoF/Steel Ball**	**Application**
U1 Series	AlTiN	Dark Grey	1-6	38±3	-3.0±1	0.3	Suitable for Finish & Rough Machining
U3	AlTiN	Dark Grey	9.0±20%	38±3	-3.0±1	0.3	Heavy Milling
U1Pro	AlTiN	Dark Grey	3.0±20%	38±3	-3.5±1	0.3	Semi-Finishing / Rough Turning & Milling of Stainless Steel
S2 Series	AlTiSiN	Antique Bronze	1-3	40±3	-4.0±1	0.3	Finish / Hard Milling, Stainless Steel Turning, Tapping
HSN3	AlTiSiN	Deep Reddish Purple	3.0±20%	40±3	-4.0±1	0.3	Hard Milling / Stainless Steel Turning
HTB	TiB2	Silvery White	1.5±20%	35±3	-3.5±1	0.25	General Machining of Titanium Alloys
R2	ALCrN	Dark Grey	3±20%	35±3	-4.5±1	0.4	Tapping/Tapping/Milling & Drilling of Steel
T1	TiN	Golden	4.5±20%	32±3	-3.0±1	0.3	Tapping / Steel Machining
T5	TiCN	Antique Bronze	3±20%	32±3	-4.0±1	0.2	Tapping / Steel Frame Machining / Difficult-to-Machine Materials

GFOUR®U1 Series

Application Case 1: Heavy Milling

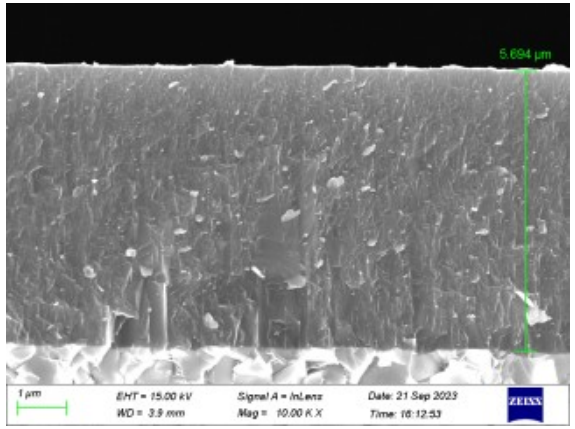
Insert ： APMT1604

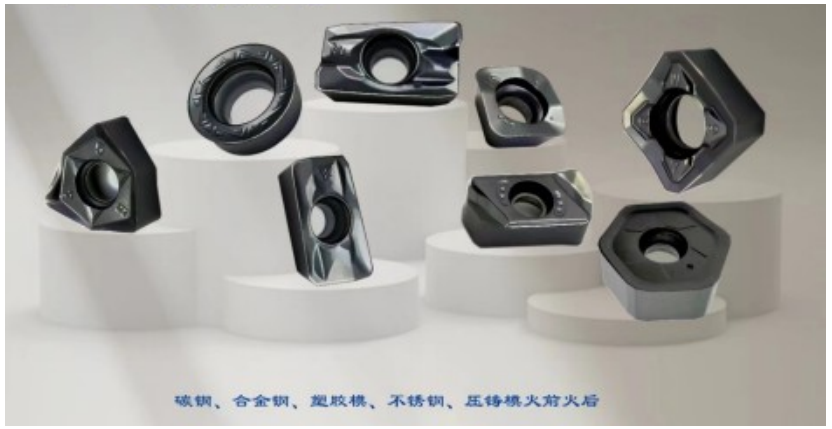
workpiece ：
- **S136 (~52HRC)**

Test Conditions ：
- **Machining Method: Rough Milling**

Test Results ：
- **Passed, Significantly Better than LM**

Data Source ：
- **Tool Manufacturer**





Inspection Item	Standard
Appearance	Black
Tool Passivation Value (μm)	20-30
Thickness (μm)	5-6
Hardness (GPa)	33-36
Adhesion(N)	> 90
Residual Stress(GPa)	-3 to -5

GFOUR®U1 Series

Application Case 2 ： Turning of Train Wheel Hubs

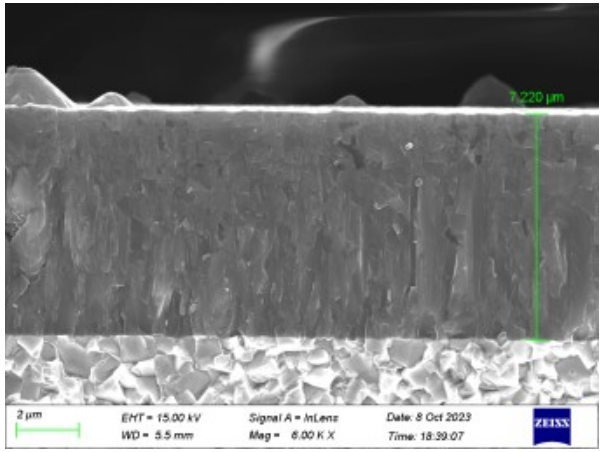
Insert ： Turning of Train Wheel Hubs

Workpiece ：
- Alloy Steel

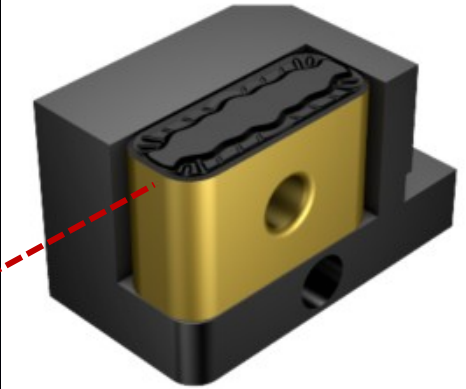
Test Conditions ：
- Machining Method ： Continuous External Turning

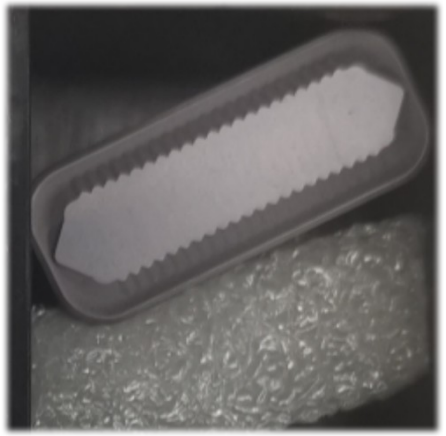
Test Results ：
- Passed ，
- Achieves CVD Performance Comparable to Ion bond

Data Source ：
- Tool Manufacturer



Inspection Item	Standard
Appearance	Black
Tool Passivation Value (µm)	60-80
Thickness(µm)	6-8
Hardness(GPa)	33-36
Adhesion(N)	> 90
Residual stress(GPa)	-4±1





GFOUR®U1 Series

Application Case 3 ：

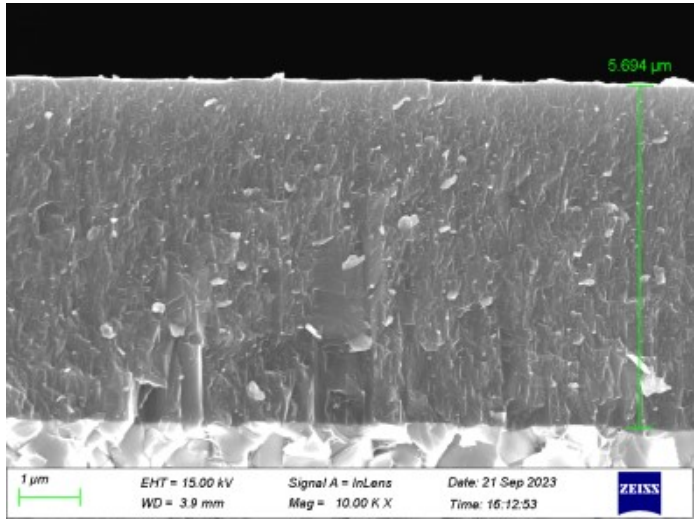
Insert ： Gear Milling Insert DE901

Workpiece ：
- **Carbon Steel**

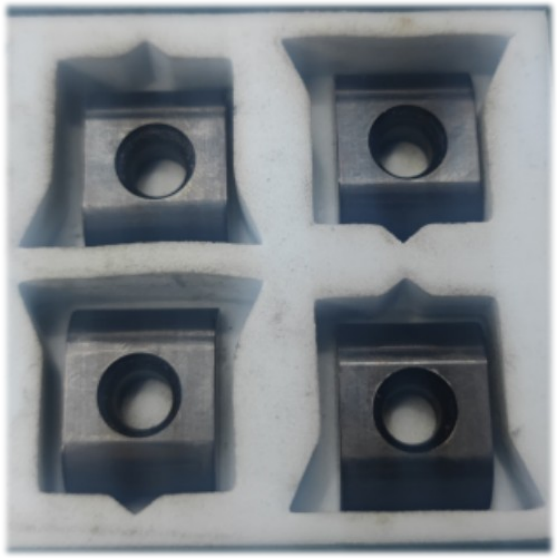
Test Conditions ：
- **Machining Method ： Gear Milling**

Test Results ：
- **Passed ， 40% Better than DR Coating**

Data Source ：
- **Tool Manufacturer**



Inspection Item	Standard
Appearance	Black
Tool Passivation Value (µm)	20-30
Thickness(µm)	5-6
Hardness(GPa)	33-36
Adhesion(N)	> 90
Residual stress(GPa)	-3 to -5



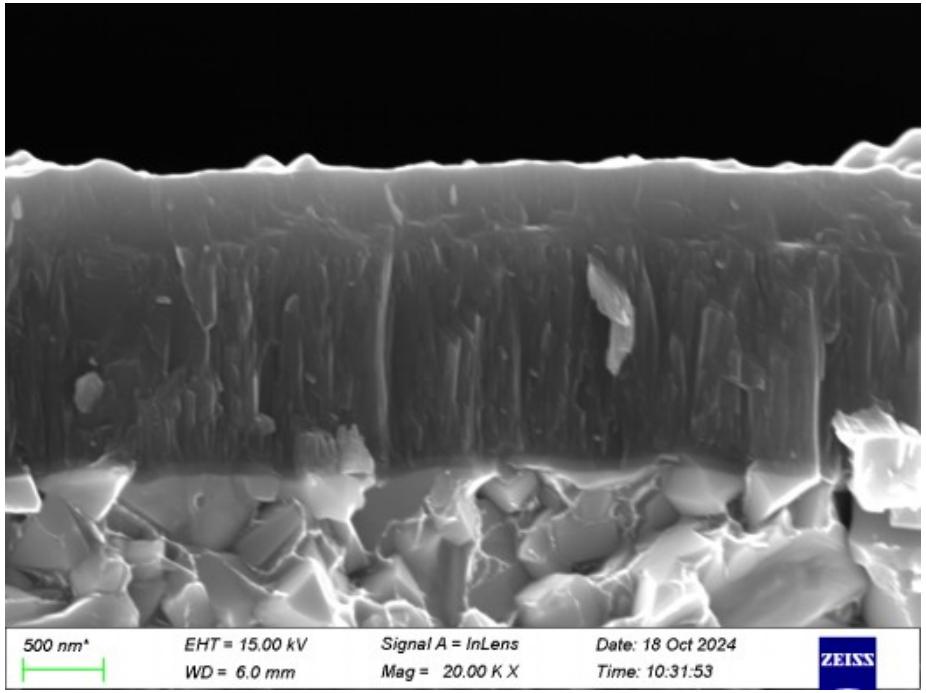
GFOUR®U1Pro

GFOUR®U1Pro

Application

Stainless Steel Turning

Stainless Steel Milling

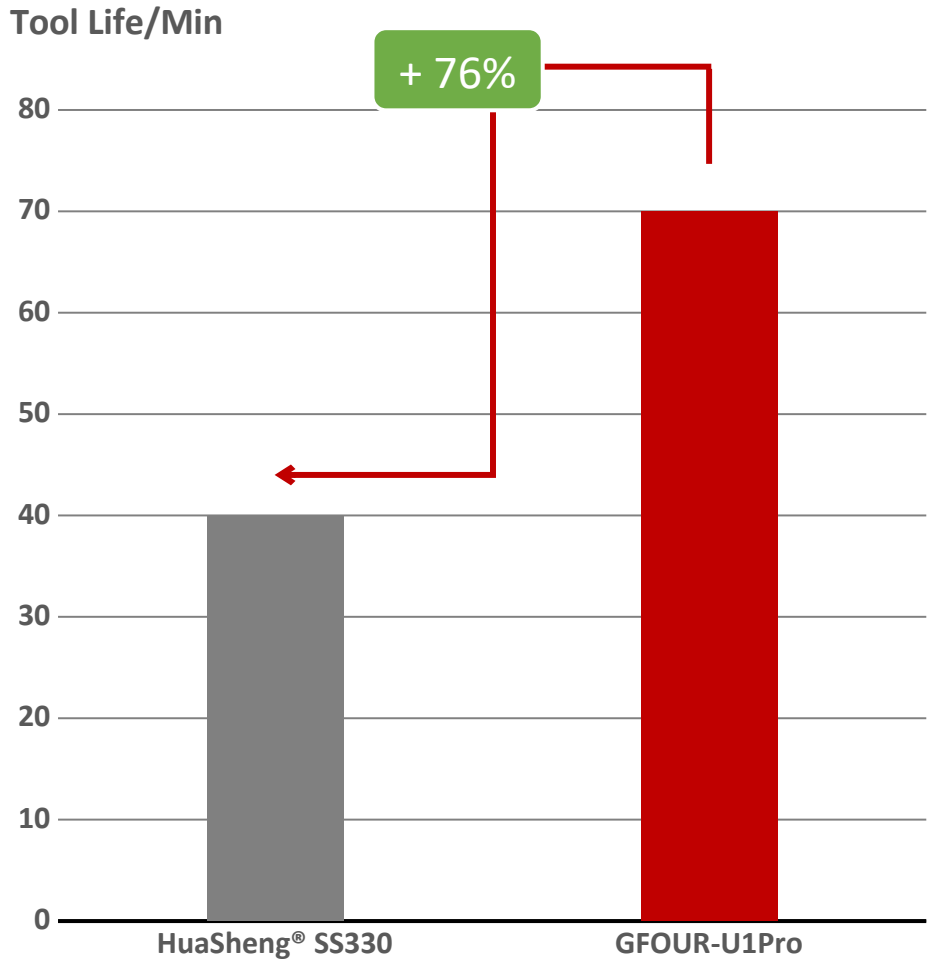


Coating	AlTiN-Based
Coating Appearance	Dark Black
Thickness （ μm ）	3.0±20%
Hardness （ GPa ）	38.0±3.0
Residual Stress （ GPa ）	-3.5±1.0
Deposition Temperature （℃）	< 550
Max working Temperature （℃）	1100

Coating Structure	Performance
High-ionization “Integrated Cathode” Technology – precise control of coating crystal structure	High adhesion, high hardness, excellent high-temperature stability, and oxidation resistance
Super HiPIMS Technology – produces droplet-free, smooth coatings	Low coefficient of friction, reduced cutting torque, excellent wear resistance
Special Parameter Optimization – achieving high hardness with low stress	High toughness and excellent resistance to crack propagation, protecting the integrity of sharp cutting edges

GFOUR®U1Pro

- **Application Case 4 ： Stainless Steel Millin**



Insert ：

- **APMT1135PDER ， holder D17**

Workpiece:

- **304 Stainless Steel (150-180HB)**

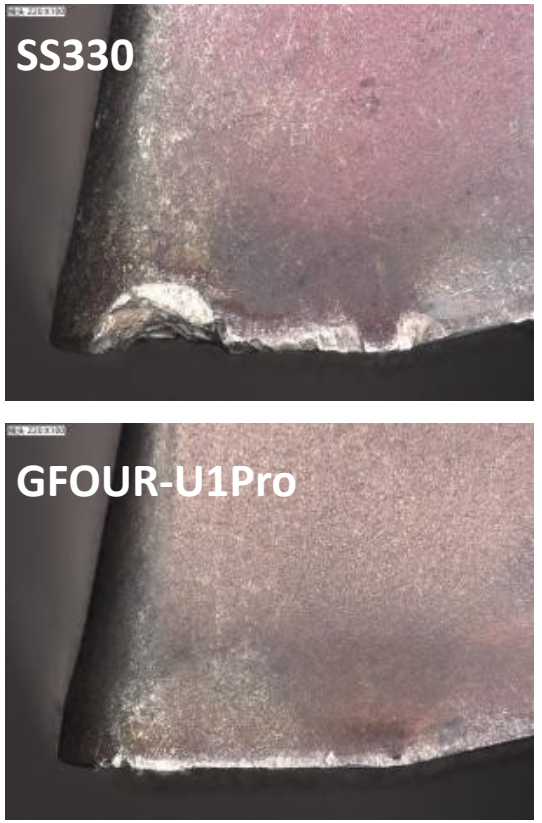
Test Conditions ： Face Milling

- **Cutting Speed ： Vc = 160m/min**
- **Feed per Tooth ： Fz = 0.5mm/z**
- **Depth of Cut ： ap = 0.2mm**
- **Width of Cut ： ae = 12.75mm**
- **Cooling Method ： Air Cooling**

Test Results ：

- **Tool Life Criteria: Flank Wear (Vb): > 0.3 mm**
- **Result: GFOUR-U1Pro coating achieves 76% longer cutting life than SS330 coating**

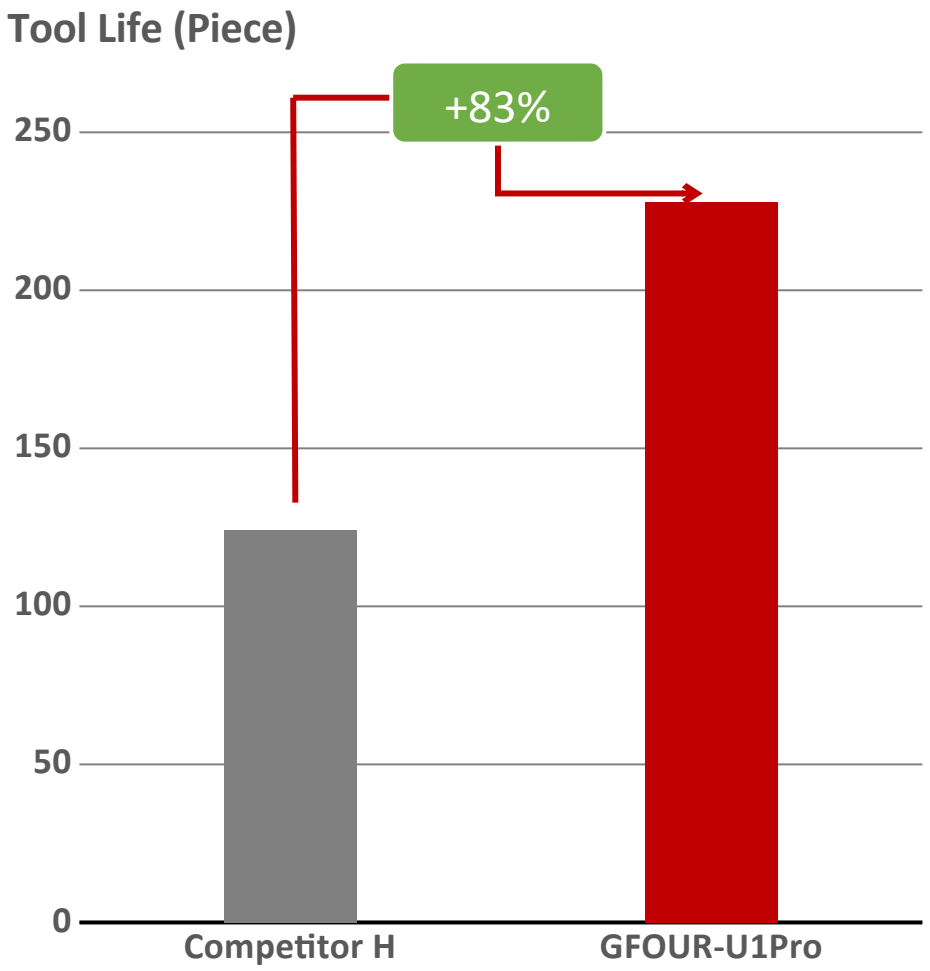
Data Source ： Huasheng Cutting Laboratory



Turning: 40min

GFOUR®U1Pro

Application Case 5 ： Stainless Steel Turning



Insert ：
- **WNMG080408-BF**

Workpiece:
- **304 Stainless Steel （ 150-180HB ）**

Test Conditions ： Interrupted OD Turning
- **Cutting Speed: Vc = 116m/min**
- **Feed per Tooth: Fn = 0.12mm/r**
- **Depth of Cut: ap = 0.5mm**
- **Cooling Method ： Emulsion Water Cooling**

Test Results:
- **GFOUR-U1Pro Coated Tool (Huasheng): 228 parts machined**
- **Competitor Tool (H Brand Coating): 124 parts machined**
- **Result: tool life increased by 83%**

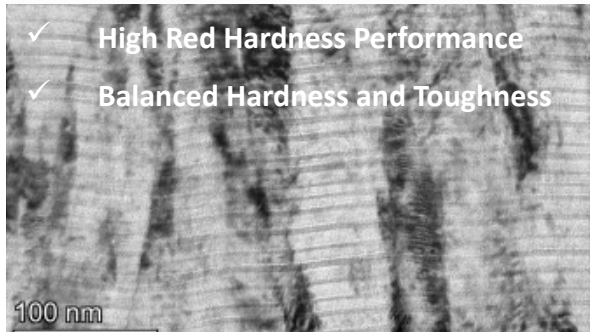
Data Source ： Tool Manufacturer

GFOUR®HSN3

GFOUR® HSN3

Application

- High-Hardness Mold Steel and Stainless Steel
- Precision Milling

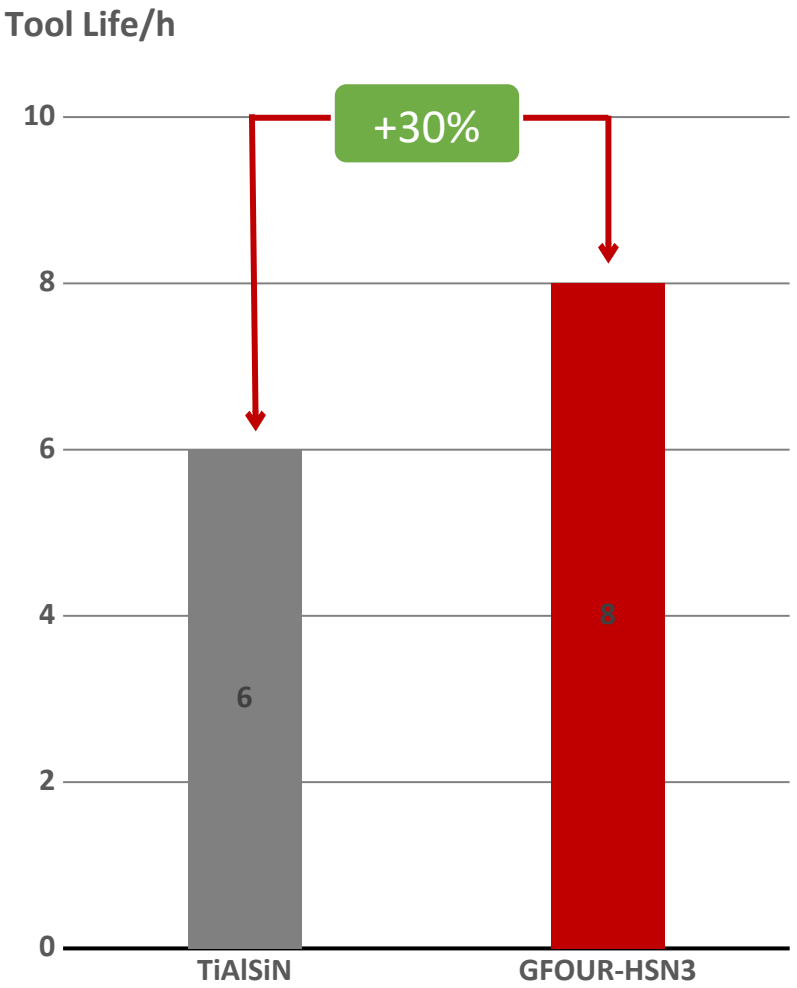


Coating	CrAlTiXN
Appearance	Deep Reddish Purple
Thickness （ μm ）	3±20%
Hardness （ GPa ）	40±3
Residual Stress （ Gpa ）	-4±1
Deposition Temperature （℃）	< 600
Max working Temperature （℃）	1100

Coating Structure	Performance
High-ionization “Integrated Cathode” Technology – precise control of coating crystal structure	High adhesion, high hardness, excellent high-temperature stability, and oxidation resistance
Precision AlTiN/TiXN Nano-Multilayer Design – unique layer ratios and introduction of special element X	Excellent impact resistance and crack propagation resistance; enhanced red hardness at high temperature while maintaining toughness
Super HiPIMS Technology – produces droplet-free, smooth coatings	Low coefficient of friction, reduced cutting torque, and excellent wear resistance

GFOUR®HSN3

- **Application Case 6: Hard Milling**



Insert ： R3

Workpiece:

- **DC53 （ ~62HRC ）**

Test Conditions ：

3D Contour Milling

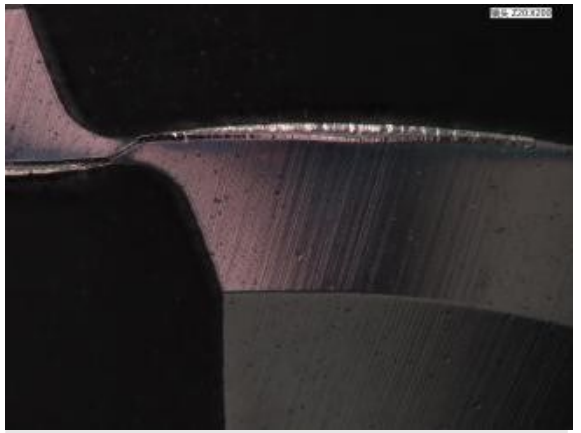
- **Vc = 170m/s**
- **F = 1500mm/min**
- **ap = 0.03mm**
- **ae = 0.1mm**
- **Cooling Method ： Oil Cooling**

Test Results ：

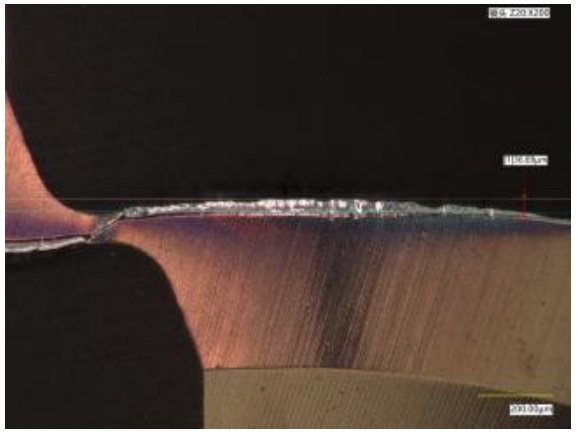
Post-Processing Standard:

- **Workpiece Surface Roughness (Ra): > 1 µm**
- **Conclusion / Analysis:**
- **GFOUR-HSN3 coating achieves 30% longer cutting life compared to competitor AIP-TiAlSiN coating, with more uniform flank wear.**

Data Source ： Tool Manufacturer



HSN3 8h Processing



TiAlSiN 6h Processing

GFOUR®HSN3

- **Application Case 7 ： Hard Milling**

Insert ： D4R0.5

Workpiece:

- **V-4E （ ~53HRC ）**

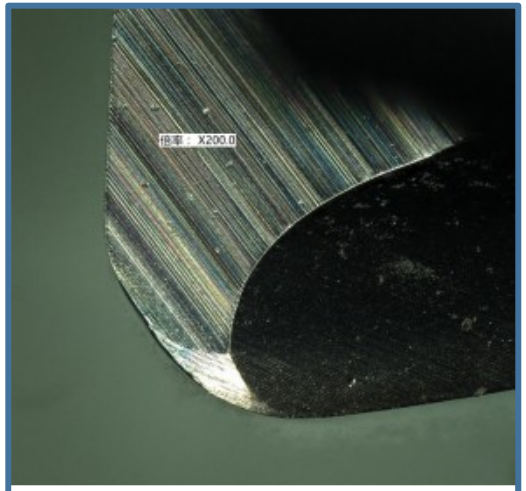
Test Conditions ： Chamfer Milling

- **Cutting Speed Vc = 125m/s**
- **Feed per Tooth Fz = 0.0375**
- **Depth of Cut ap = 0.05mm**
- **Width of Cut ae = 0.05mm**
- **Cooling Method ： Water Cooling**

Test Results ：

- **Post-Processing Standard ： Surface Finish Standard**
- **GFOUR-HSN3 coating and competitor ODU coating both achieved 128 min cutting time, with similar cutting edge wear.**

Data Source ： Tool Manufacturer



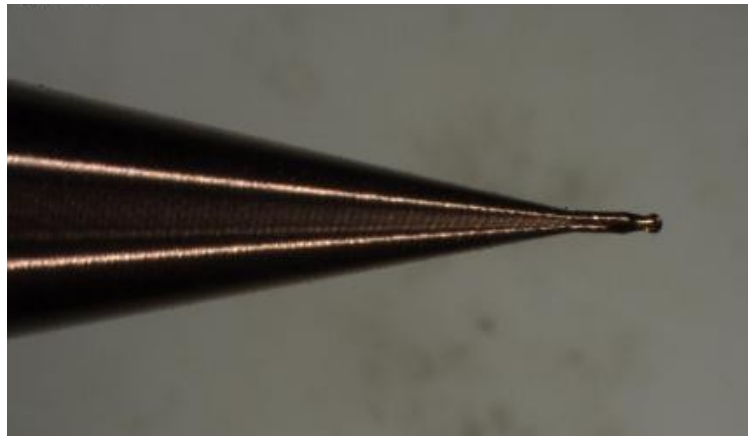
GFOUR-HSN3

ODU

GFOUR®S2 Series

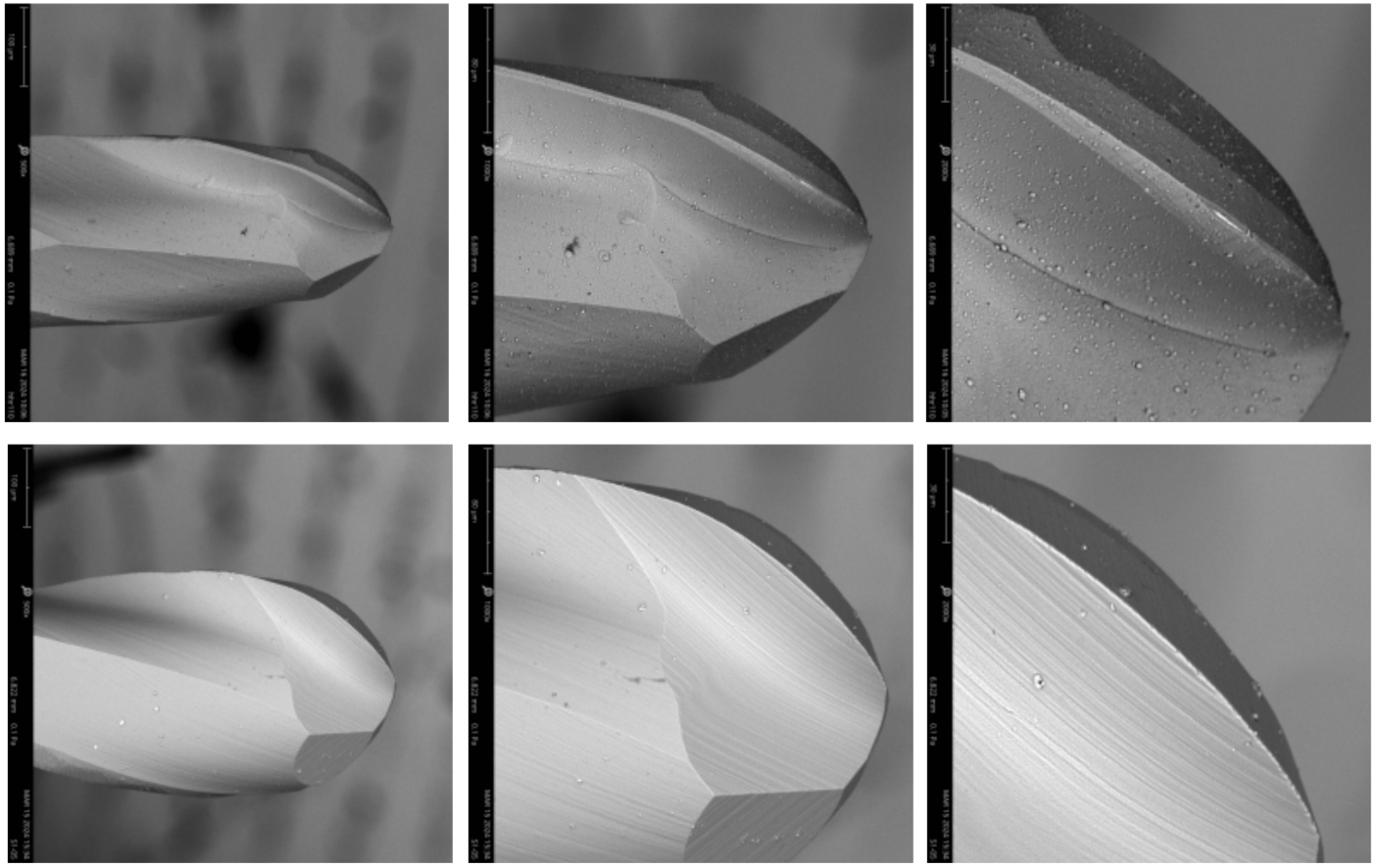
- **GFOUR coating exhibits low internal stress and droplet-free deposition, effectively addressing edge droplet formation and coating delamination on small-diameter tools**

D0.3R0.15 Micro tool
Micro tool: D0.3 R0.15



Arc coating

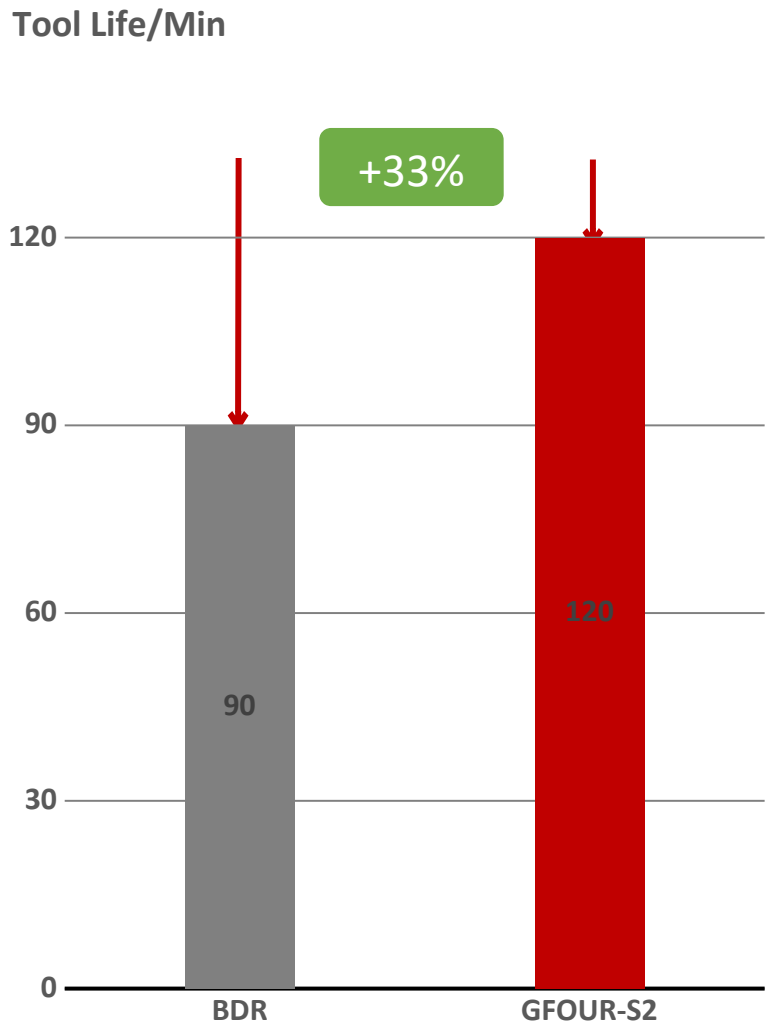
GFOUR coating



300×　　500×　　1000×

GFOUR®S2 Series

- **Application Case 8 ： Micro-Diameter Tools**



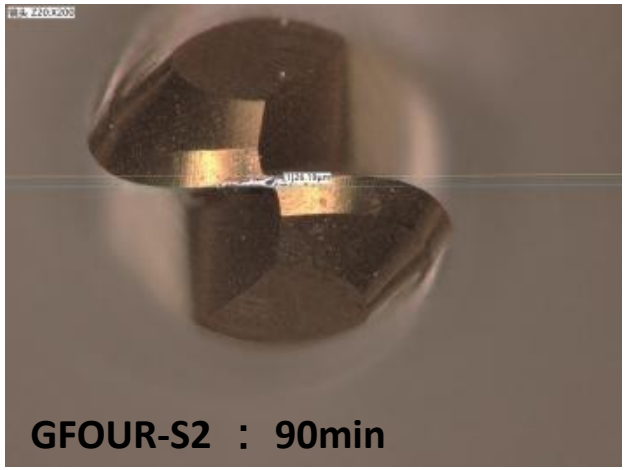
Insert ：
- **D1R0.5 Ball Nose End Mill**

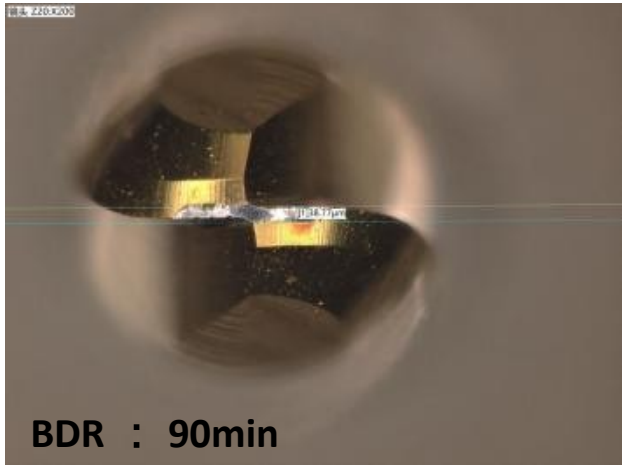
Workpiece:
- **SKD11 （ 60HRC ）**

Test Conditions ： Face Milling
- **Cutting Speed Vc = 56.52m/min**
- **Feed per Tooth Fz =0.022mm/r**
- **Depth of Cut: ap = 0.02mm**
- **Width of Cut: ae = 0.025mm**
- **Cooling Method ： Air Cooling**

Test Results ：
- **Post-Processing Standard ： Flank wear (Vb) > 30 μm**
- **Conclusion / Analysis: GFOUR-S2 coating increases tool life by 33% compared with the competitor BDR and shows lower wear.**

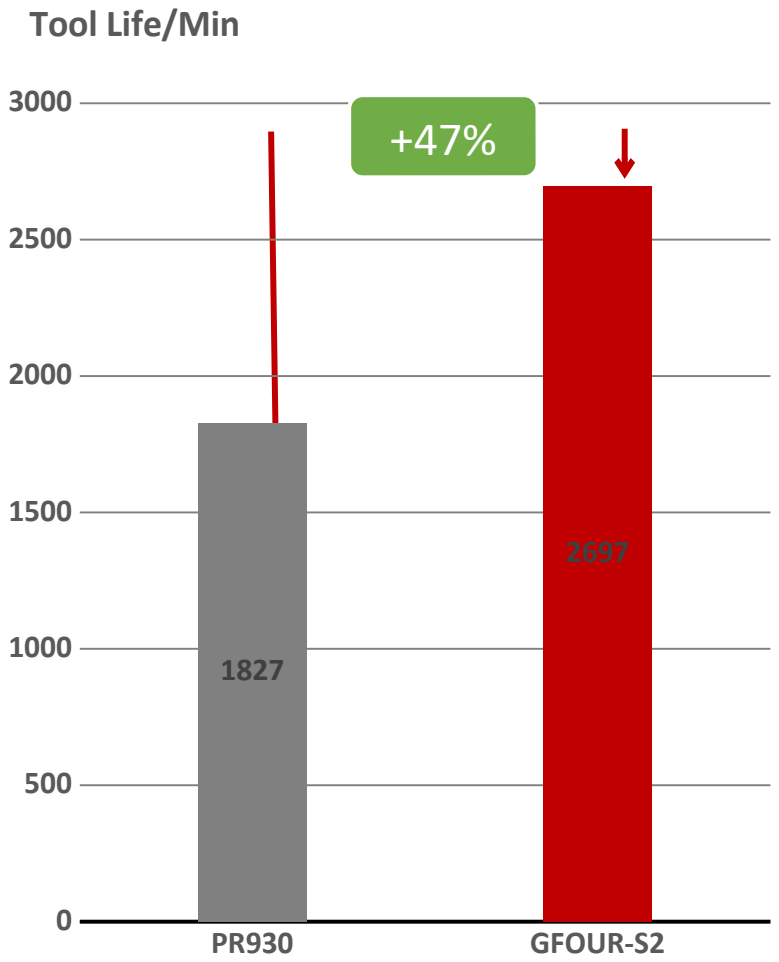
Data Source ： Huasheng Cutting Laboratory





GFOUR®S2 Series

- **Application Case 9 ： Finishing Inserts**



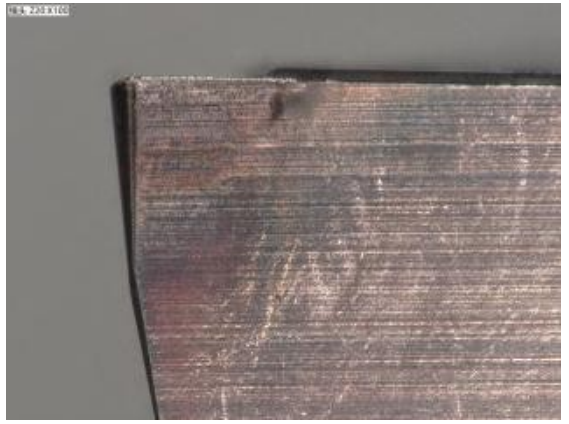
Insert ：
- **DCGT11T302FR-U**

Workpiece:
- **304 Stainless Steel （ ~30HRC ）**

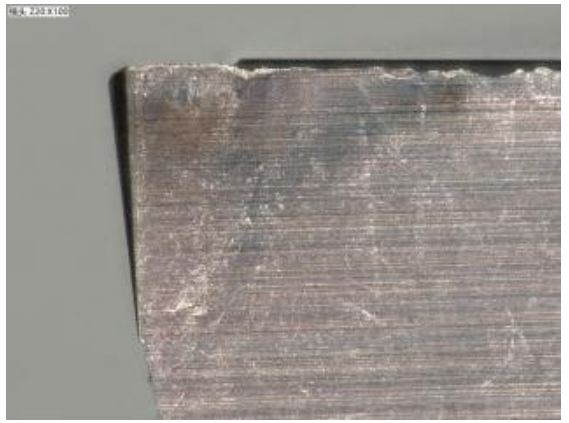
Test Conditions ： Precision Turning
- **Cutting Speed Vc = 100m/min**
- **Feed per Tooth Fz = 0.05mm/z**
- **Depth of Cut ap = 1.0mm**
- **Cooling Method ： Oil Cooling**

Test Results ：
- **Post-Processing Standard ： Workpiece Surface Roughness (Ra): ≤ 1 μm**
- **Result / Analysis ： GFOUR-S2 coating achieves 47% longer tool life compared to competitor PR930, with smaller flank wear**

Data Source ： Huasheng Cutting Laboratory



GFOUR-S2 ： 1827m(Ra=0.681μm)



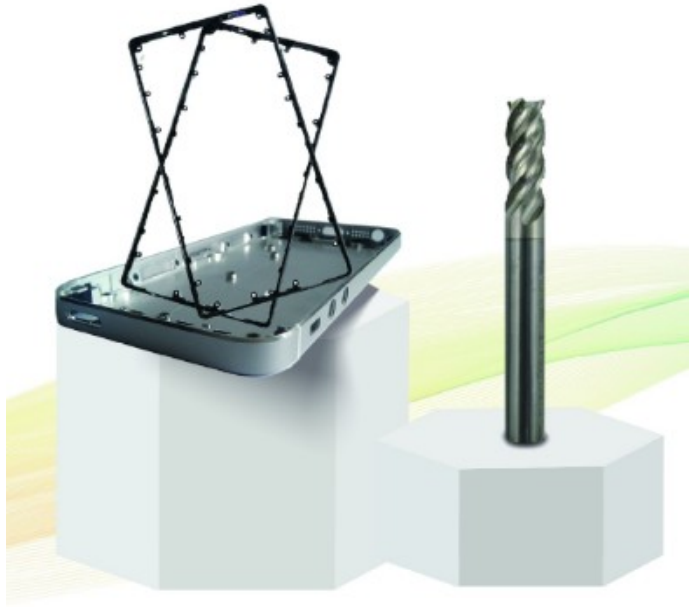
PR930 ： 1827m(Ra=1.281μm)

GFOUR®HTB

GFOUR® HTB

Application

- Non-Ferrous
- Titanium Alloy

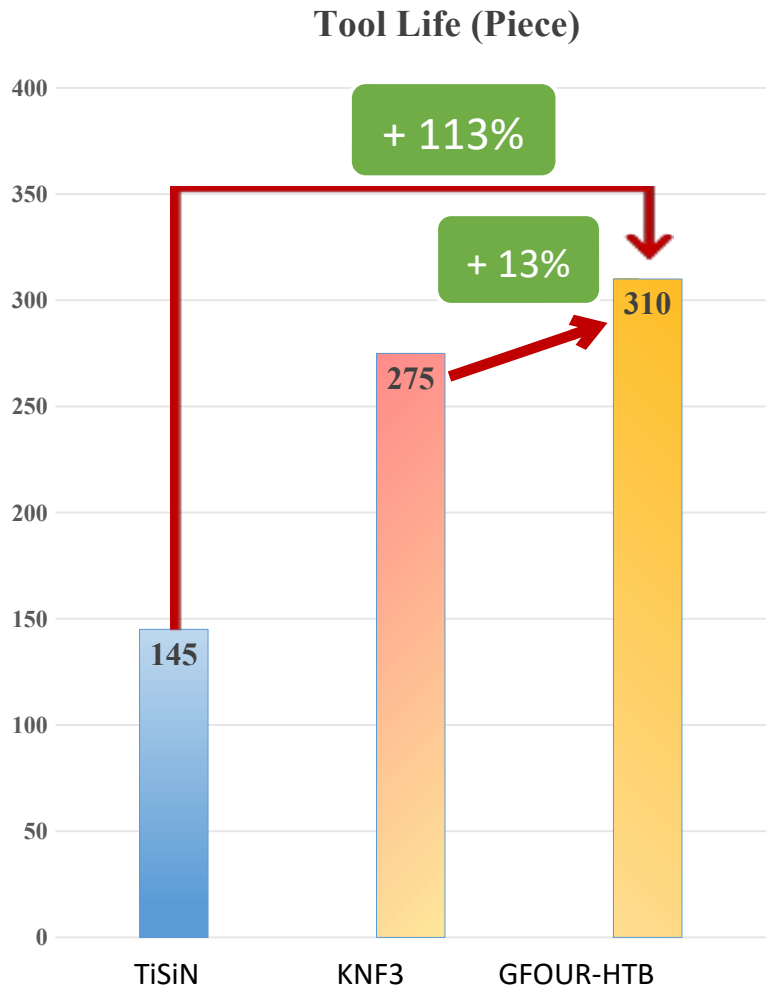


Coating	TiB2
Appearance	Silvery White
Thickness （ μm ）	1.5±20%
Hardness （ GPa ）	35±3
Residual Stress （ GPa ）	-4±1
Deposition Temperature （℃）	< 600
Max Working Temperature （℃）	1100

Coating Structure	Performance
High-Ionization “Integrated Cathode” Technology – precise control of coating crystal structure	High adhesion, high hardness, excellent high-temperature stability, and oxidation resistance
Super HiPIMS Technology – produces droplet-free, smooth coatings	Low coefficient of friction, reduced cutting torque, excellent wear resistance
Unique composition and the incorporation of element B	Effectively prevents chemical adhesion and diffusion wear

GFOUR®HTB

- **Application Case 10 ： Titanium Alloy**



Insert ： Ball Nose End Mill

- D17.44-21.87H-5E-D20-70L-T1

Workpiece:

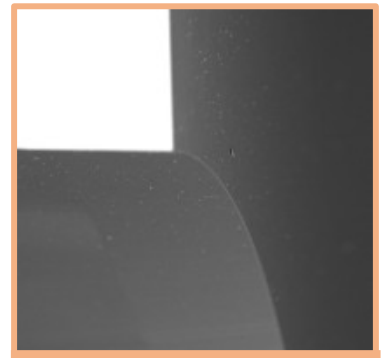
- TC4 (Ti6Al4V)
- Harness ： 30HRC

Milling Method:
Side Milling – Finishing

- **Test Results** ：
- HTB coating prepared with GFOUR technology achieved 113% improvement compared to standard Arc TiSiN coating

Data Source ： Huasheng Cutting Laboratory

Flank Face



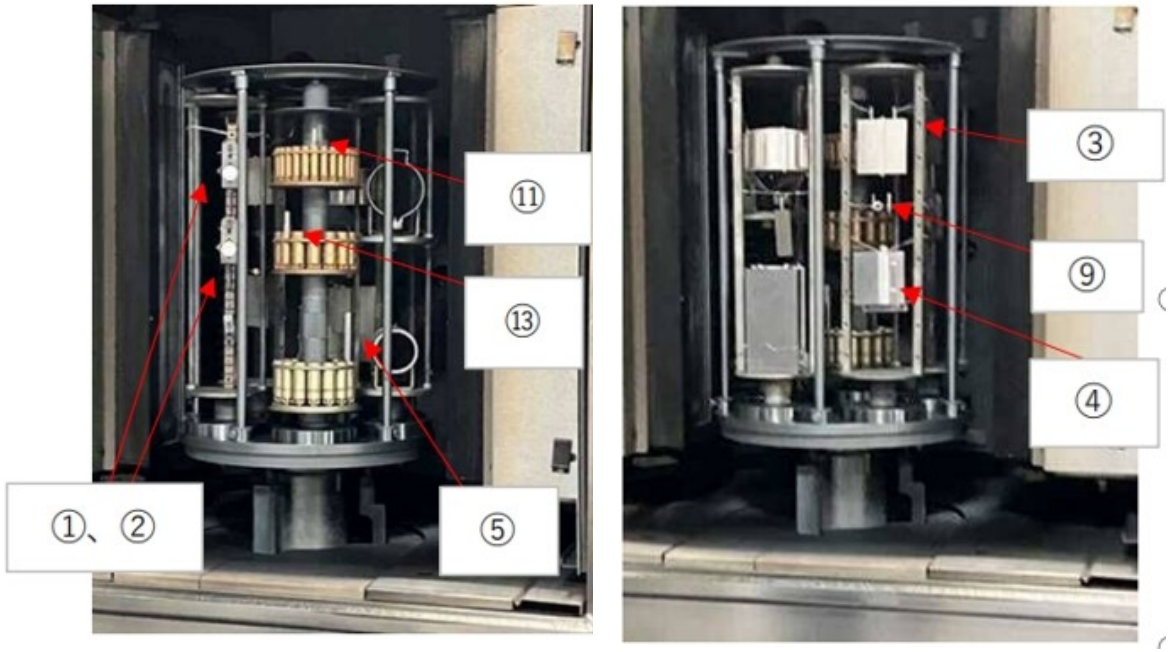
Profiled Cutting Edge

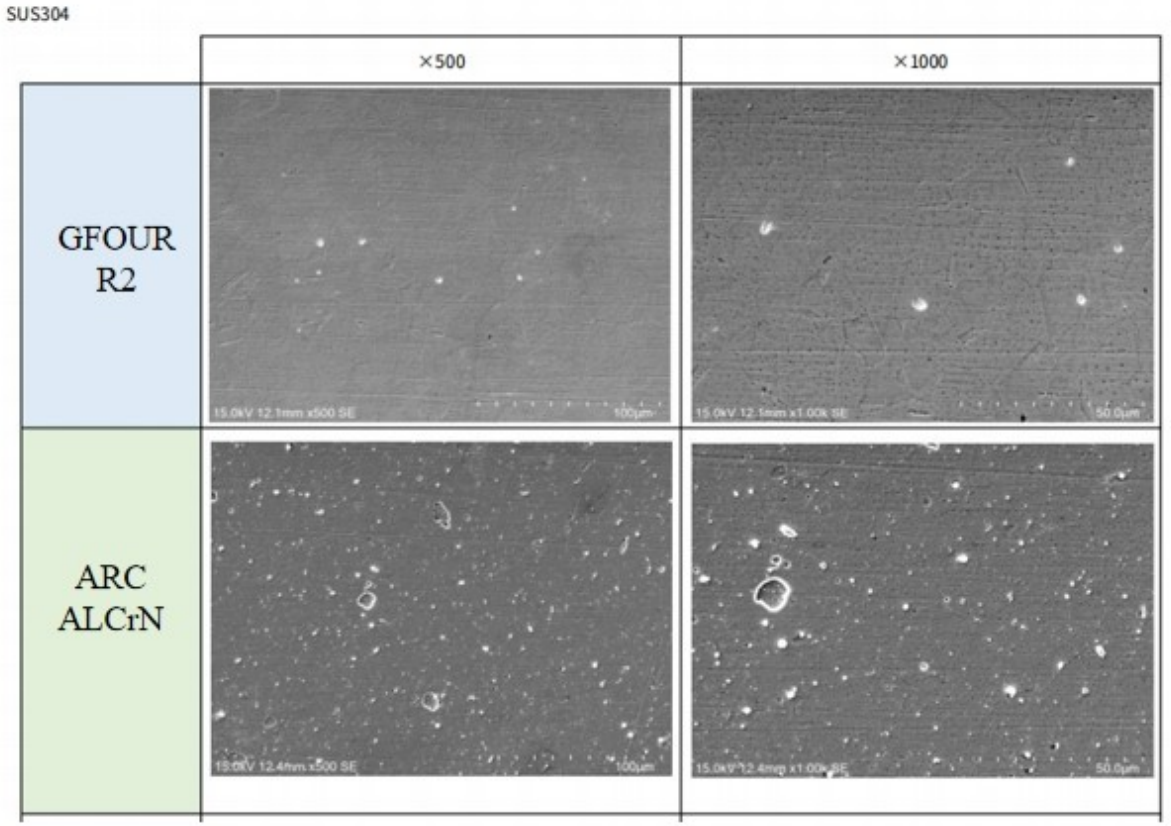
- Dense, defect-free coating
- Smooth surface, prevents built-up edge (BUE)
- High hardness, low internal stress

Suitable for finishing of titanium alloys 。

GFOUR®R2

- **Application Case 11 ： Precision Molds**



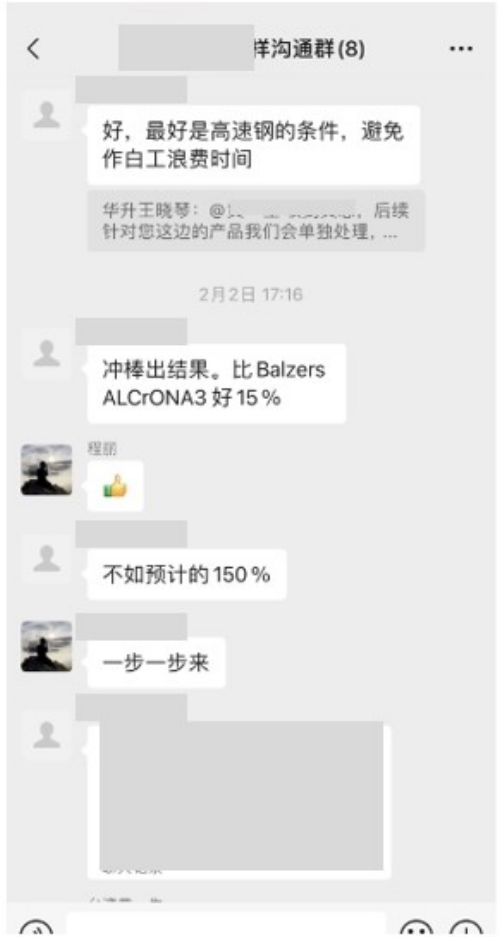


Customer Feedback:
R2 (AlCrN) coating prepared with GFOUR technology shows:
Smoother surface, Improved wear resistance,Better coating diffraction performance,
Excellent coverage on complex geometries, Superior adhesion

GFOUR®R2

- **Application Case 12 ： Punches/Punch Rods**

Item ： **Punches/Punch Rods**
Workpiece ： • **Mold Steel / High-Speed Steel (HSS)**
Test Conditions ： ➢ **Machining parameters: Not specified**
Test Results ： Compared to AlCrONA3, GFOUR coating shows 15% improvement
Data Source ： Tool Manufacturer

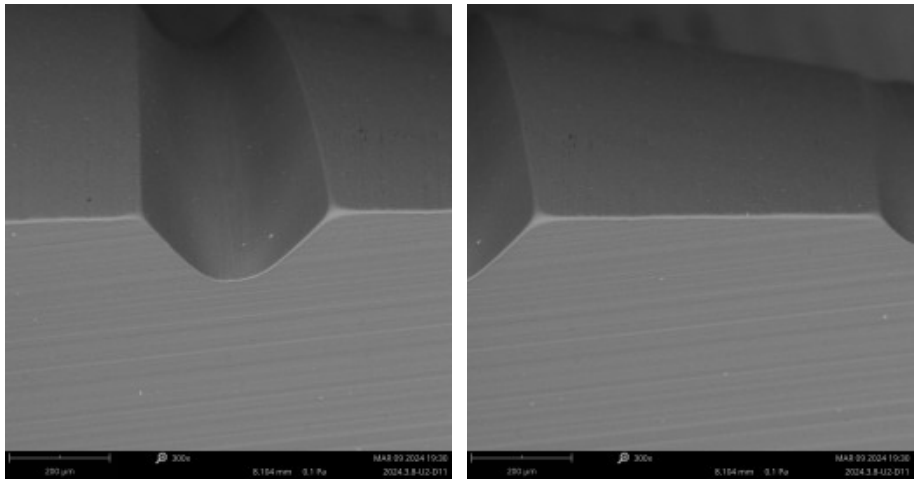


GFOUR®T1

HuaSheng® GFOUR-T1

Application

- Steel 、 Iron Cast 、 Stainless Steel
- Medium-to-Low Speed Machining



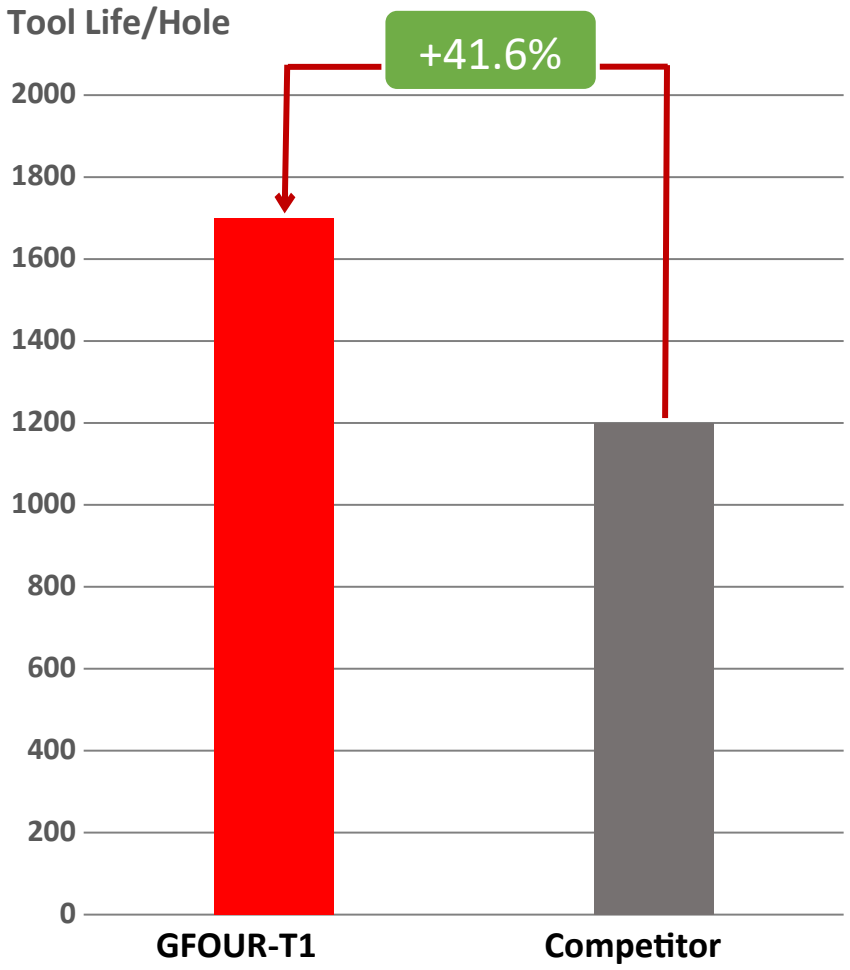
Coated Thread Tap Edge Appearance

Coating	GFOUR-T1
Appearance	Gold
Thickness （ μm ）	4.5±20%
Hardness （ GPa ）	32±3
Residual Stress （ GPa ）	-6±1
Deposition Temperature （℃）	< 600
Max Working Temperature	1100

Coating Structure	Performance
Latest HiPIMS Technology – high ionization rate and excellent surface quality	High-density, uniform coating with superior adhesion and toughness
Precise TiN Gradient / High-Density Structure	Combines high hardness and wear resistance with strong bonding and high toughness
Smooth Top Layer Design	Low friction coefficient, reduced cutting resistance, and prevention of chip clogging in taps

GFOUR®T1

- **Application Case 13 ： 42CrMo**



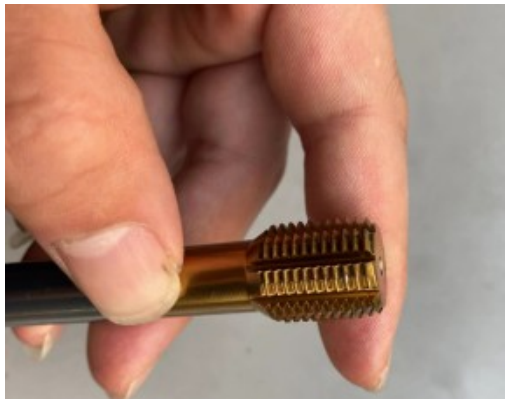
Insert ：
- **M16 Extrusion Thread Tap**

Workpiece:
- **42CrMo(~32 HRC)**

Test Conditions ： Blind Hole Tapping
- **Cutting Speed Vc = 12 m/min**
- **Feedf per Tooth Fn =1.5 mm/r**
- **Cooling Method ： External Cooling (Emulsion Coolant)**

Test Results ：
- **GFOUR-T1 coating achieved 1,700 holes**
- **Cutting life increased by 41.6% compared to the competitor**
- **Cutting life increased by 41.6% compared to the competitor**

Data Source ： Tool Manufacturer



Wear Progression Chart

HUASHENG

Your Ideas, Our Solution

THANKS