CONPROFE

Supercritical CO_2 Cryogenic Cooling System

Professional Manufacturer of Ultrasonic Equipment and High-Performance Tool

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Connotation

Converging of Global Resources

Professional as Industry Leader

“CONPROFE”

Overview

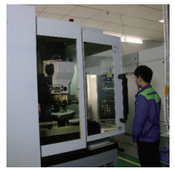
With its roots back to 2003, Conprofe is a Provider of Efficient, Green and Intelligent Manufacturing Solutions and Key Units. It has been holding on to the idea of “Converging of Global Resources, Professional as Industry Leader” in the past two decades. Revolving around “Efficient, Green and Intelligent Manufacturing”, the company has achieved a giant leap from parts, units to machines and developed a product portfolio with three major industries - Precision Tools, Key Units and CNC Machine Tools, which covers eight categories of products, including Super-hard Tools, Tapping Tools, Precision Tool Holders, Ultrasonic Technologies, Green Technologies, Precision Units, Ultrasonic-Green CNC Machine Tools and Automation. Its customers have spread across diverse sectors, such as consumable electronics, semiconductors, automotive, aviation & aerospace, medical, education and general precision manufacturing, etc.

Conprofe perseveres in laying a solid foundation in the domestic market while keeping its eyes open to the world. Headquartered in Guangzhou Science City, the company has established sales and service centers in seven domestic regions and forged a network of R&D, sales and service based in Hong Kong, Taiwan, the United States, South Korea, India and Vietnam, etc. With its products being exported to over 70 countries and regions across six continents, Conprofe's integrated distribution of R&D, production, sales and service around the globe has gradually come into being.

Conprofe persists in innovation-driven developing strategy and owns two National High-tech Enterprises under the Group. The company”s Frontier Technology Research Institute (FTRI) and Guangdong Province Engineering Technology Center (GPETC) has developed over 850 core technology patents. Its primary product technologies have reached an internationally advanced level, as assessed and acknowledged by experts led by members of the Chinese Academy of Engineering (CAE). Furthermore, Conprofe has successively been granted the Guangdong Scientific and Technological Progress Award (First Prize 2020, Second Prize 2021), Guangdong Patent Award (Silver), China Patent Award (Excellence) and has been honored as Enterprise with Significant Contribution to Guangdong”s Supplies for COVID-19 Prevention and Control, Guangzhou Pioneering Private Enterprise, etc.

Manufacturing and Testing Equipment









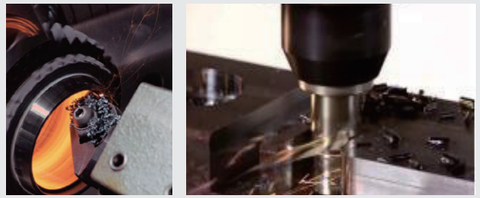

Supercritical CO_2 Cryogenic Cooling System

Innovative Supercritical CO_2 Cryogenic Cooling Technology

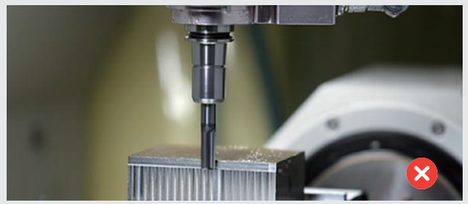
With the rapid development of modern manufacturing technology, all kinds of new materials and processes came in to being, which puts higher requirements for cutting speed, tool life and machining efficiency. Clean production and green manufacturing have become one of the themes in the development of advanced manufacturing technology. Based on over a decade of R&D, production and sales of metal cutting and cutting tools, Conprofe has developed Supercritical CO_2 Cryogenic Cooling System, achieving high-efficiency machining.

It boasts different kinds of high-performance tool manufacturing, efficient cutting technologies and the high-quality cutting tools to provide customers with the most ideal green cutting solutions for difficult-to-machine materials, thus achieving clean production with lower cost and higher efficiency.

Waste of cutting fluids

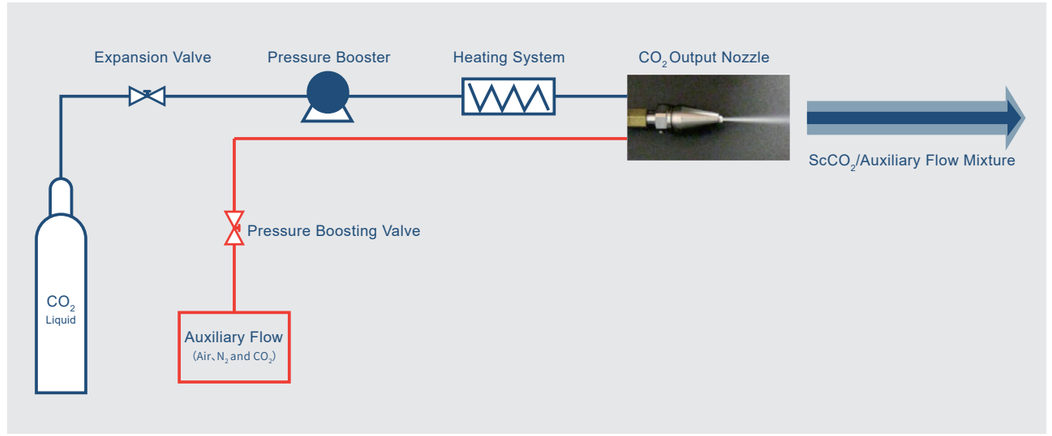


Challenges in machining hard-to-cut materials - High cutting temperature, severe tool wear and unstable machining quality



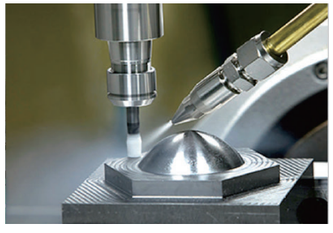
Technical Principle

Supercritical CO_2 Cryogenic Cooling System transforms supercritical CO_2 fluid into a low-temperature medium (-78°C) for cooling and lubrication to the cutting tools. When CO_2 at 31°C is pressurized to more than 74bar (1070psi) , it becomes a kind of supercritical fluid. In this state, it fills up the container like gas, but with a similar density to liquid. When transported to the cutting area, it will rapidly expand, absorb heat and form low-temperature dry ice particles and CO_2 gaseous mixture to achieve rapid cooling and lubrication to the cutting area.



Supercritical CO_2 Cryogenic Cooling System

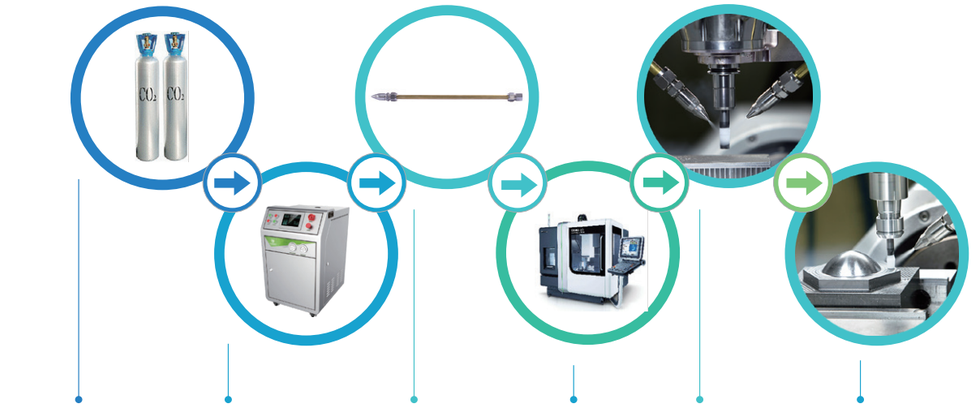
- The innovative Supercritical CO_2 Cryogenic Cooling Technology adopts a unique system, which transforms the purified low-pressure CO_2 collected from petrochemical, steel, food and other industrial manufacturing into supercritical CO_2 fluid, and then convert it into a -78°C cryogenic cooling medium for efficient cooling and lubrication.
- A special output control system and dedicated nozzle unit ensure continuous and accurate ejection of supercritical CO_2 fluid to the cutting area at room temperature.
- The fine solid dry ice particles and CO_2 gas mixture continuously blowing to the cutting area ensures the clean and dry machining area, achieves swift cooling and further reduces the cutting heat, thereby extending tool life and improving machining efficiency.
- Compared with conventional low-temperature cooling mediums, the supercritical CO_2 fluid can only be transported at room temperature without complex insulation measures, to achieve low-temperature cutting.



Components of Supercritical CO_2 Cyrogenic Cooling System

- CO_2 Pressure Booster ------ to pressurize the low-pressure CO_2 that has collected and purified
- Temperature Control System ------ to precisely control the temperature, thus achieving 100% CO_2 fluid conversion
- Air-Pressure Control System ------ to monitor and control the pressure for safety and reliability
- PLC Control System ------ to achieve automatic control, thus ensuring stable operation of the system.
- CO_2 Output System ------ to achieve stable and safe output of supercritical fluid collected a precision pipeline design
- CO_2 Dedicated Nozzle ------ to ensure precise, uniform and controllable flow ejection of the supercritical fluid with a special structure design
- MQL System (optional) ------ to seamlessly combine low-temperature cutting technology and Minimum Quantity Lubrication cutting technology

Characteristics



- Coaxial Pipe ------ to transport the high-pressure supercritical CO_2 fluid and low-pressure auxiliary gas, thus minimizing the heat loss of supercritical fluid and ensuring its performance
- The Multi-Channel Nozzle ------ to ensure that there is no condensation, frost and blockage and achieve even and precise ejection
- Flexible Output and Control ------ to be equipped with one or more nozzles that allow different orientations, and provide specific on/off switch
- Automatic CNC Machine Tool Control ------ to control with CNC machine tool I/O interface so that it could stop and start during the cutting by itself
- Minimum Quantity Lubrication (MQL) System ------ to mix MQL with supercritical CO_2 fluid for special machining, further enhancing the lubrication performance
- Easy Equipment Installation ------ only to connect the CO_2 air source and auxiliary air source to the system without any modification to the machine equipment and CO_2 special nozzle to the spindle of the machine tool, and then turn on the machine

Technical Parameter

Supercritical CO_2 Cryogenic Cooling System			
Model	CEA401	CIA401	CMA401
Dimension (mm)	560x650x900	560x650x900	560x650x900
Weight (Kg)	60	60	65
Power Supply (V/HZ)	AC220/50	AC220/50	AC220/50
Equipment Power (kw)	0.5	0.5	0.5
Liquid CO_2 (Mpa)	≧3	≧3	≧3
CO_2 Consumption (kg/h)	3-6 *	3-6 *	3-6 *
Compressed Air (Mpa)	0.5-1	0.5-1	0.5-1
Compressed Air Consumption (L/min)	50-300*	50-300*	50-300*
CO_2 Nozzle	1-3	—	1-2
Terminal Control Box	—	●	●
Lubricant Supply	○	—	○

Notes: * Refer to the specific machining process - N/A ● Standard ○ Optional

Supercritical CO_2 Cryogenic Cooling System			
Model	CEA401	CIA401	CMA401
Application	Add-On Nozzle	Coolant-Through Spindle	Add-On Nozzle or Coolant-Through Spindle
CO_2	1-3 Nozzles, Separately Control	Single Coolant-Through Spindle	1-2 Nozzles, Single Control/ Coolant-Through Spindle
Control System	PLC Control	PLC Control	PLC Control
Parameter Adjustment	Touch Panel	Touch Panel	Touch Panel
CO_2 Ejection	M Code Control	M Code Control	M Code Control
CO_2 Regulator	Manual	—	Manual (only for add-on nozzle)

Recommendation

Supercritical CO_2 Cryogenic Cooling System			
Model	CEA401	CIA401	CMA401
Turning Center	√	○	○
Milling Center	√	√	√
Drilling Center	×	√	×
Machining Center	√	√	√
Gantry Milling Center	√	○	○

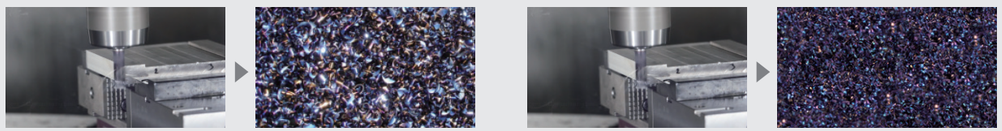
Note: √ Excellent ○ Optional × Not Recommended

Advantages of Supercritical CO_2 Cryogenic Cooling System

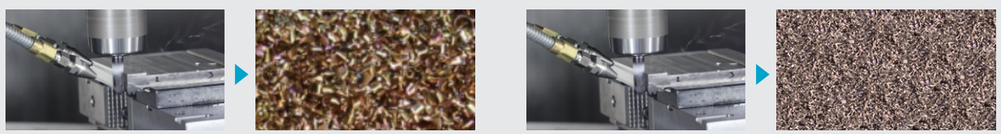
- Lower Cutting Temperature ------ to make high-efficient cooling performance on the machining area by blasting it with cryogenic gas as cool as -78°C.
- Longer Tool Life ------ to reduce friction between tool, workpiece and chips, thus extending tool life.
- Higher Machining Efficiency ------ to allow for faster cutting speed and better feed rate, thus increasing machining efficiency.
- Better Surface Quality ------ to effectively reduce burrs by low-temperature cutting, thus improving the workpiece surface quality.
- Higher Machining Accuracy ------ to reduce machining residual stress by low-temperature cutting and avoid grain boundary distortion and white layer, thus ensuring the machining accuracy.
- Neater Machining Environment ------ to aviod cutting fluid splash and oil fumes, leading to clean and tidy work site, which is conducive to the workshop environment and worker health.

Comparison of Traditional Cutting and Low-Temperature Cutting

Traditional Cutting



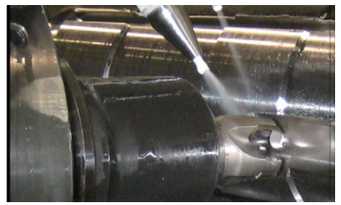
Low-Temperature Cutting



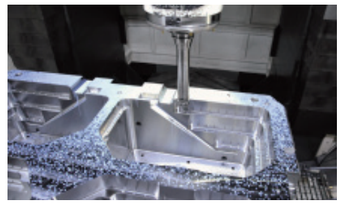
Application Range

The Supercritical CO_2 Cryogenic Cooling System features excellent cooling and lubrication performance, especially suitable for turning, milling, drilling or grinding all kinds of hard-to-machine materials. It can be applied in aerospace industry, customer electronics, general precision manufacturing, automotive industry, medical field and others, including aviation engine parts machining, precision shaft parts machining, complex mold machining, auto parts machining and medical surgical instruments machining, etc.

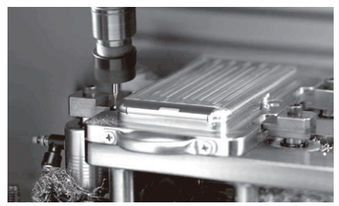
Turbine Blade Machining



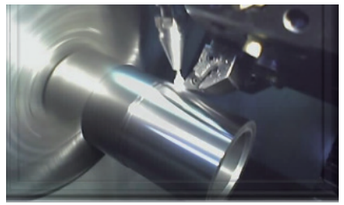
Shaft Parts Machining



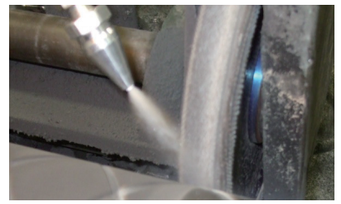
Complex Mold Machining



3C Parts Machining



Automotive Parts Machining

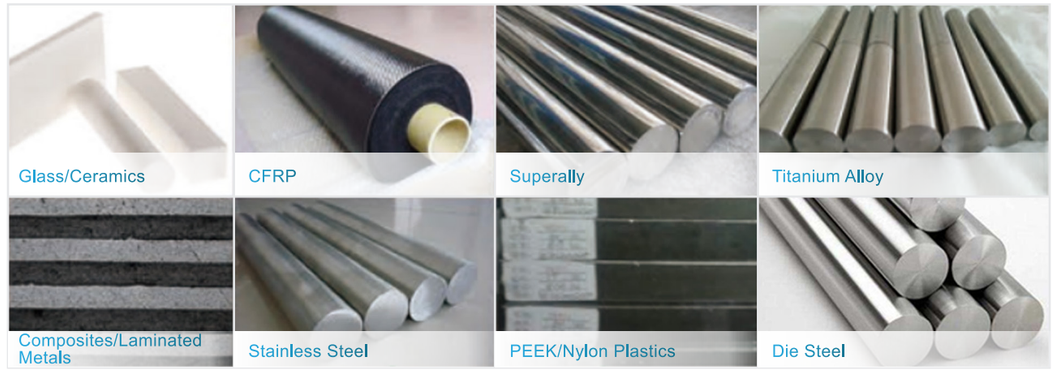


Nylon/Plastics Machining

Machining Solutions

- For Stainless Steel
- For Titaninum Alloy
- For Superalloy
- For Die Steel
- For Ductile Iron
- For Glass/Ceramics
- For CFRP
- For PEEK/Nylon Plastics
- For Composites/Laminated Metals

Applicable Materials

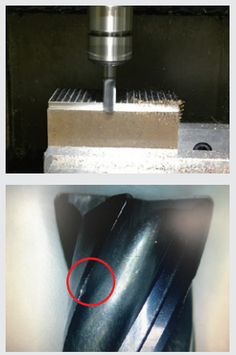


Application Cases

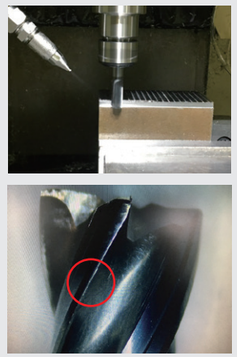
Tool Life of Mills

- Workpiece: Cr12Mo1V1，HRC 61
- Cutting Tool: Carbide End Mill D10,TiAlN
- Rotating Speed: S=2000rpm
- Feed Rate: F=900mm/min
- Radial Depth of Cut: a_e=0.5 mm
- Axial Depth of Cut: a_p=5 mm

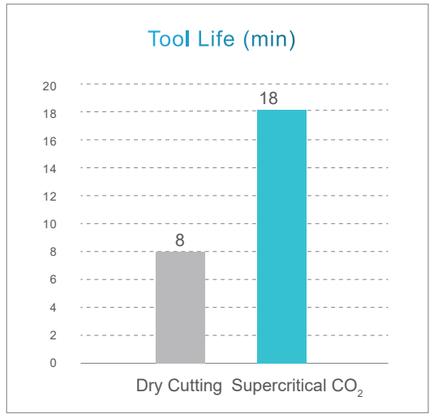
When the tool wear of dry machining reaches VB=0.3mm, the cycle time of the mill is only 8min. However, the milling time with supercritical CO_2 reaches 18min, 2.25 times the tool life of that with dry cutting.



Dry Cutting



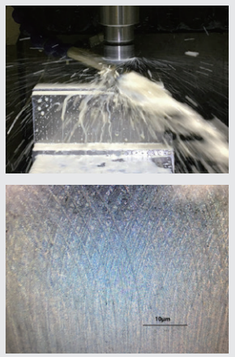
Supercritical CO_2



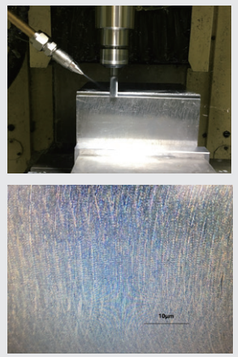
Workpiece Surface Quality

- Workpiece: SUS316
- Cutting Tool: Carbide End Mill D10,TiAlN
- Rotating Speed: S=2000rpm
- Feed Rate: F=1000mm/min
- Radial Depth of Cut: a_e=0.2 mm
- Axial Depth of Cut: a_p=5mm

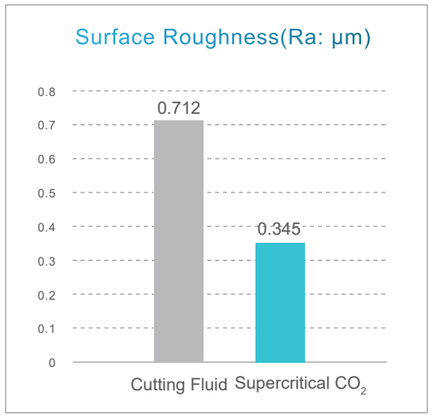
Our Supercritical CO_2 Technology delivers exceptional surface quality, better than the effect with traditional cutting fluid by a wide margin. Under identical conditions, our solutions achieve a remarkable surface roughness of Ra 0.345, compared to Ra 0.712 with traditional solutions.



Cutting Fluid



Supercritical CO_2

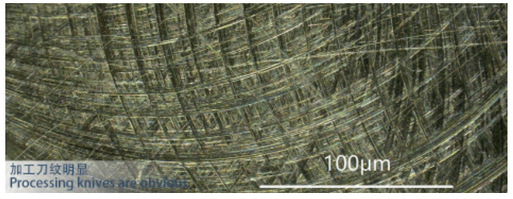


Cooling Effect Comparison

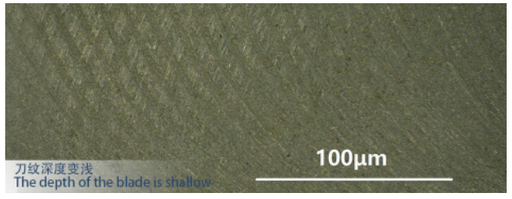
Mould Steel Machining

- Workpiece: Mould Steel Cr12Mo1V HRC61
- Cutting Tool: Carbide Mill D10, TiALN
- Rotating Speed: S=2000rpm
- Feed Rate: F=900mm/min
- Axial Depth of Cut: a_p=5mm
- Radial Depth of Cut: a_e=0.5mm

Dry Cutting VS Supercritical CO_2 Machining



Dry Cutting

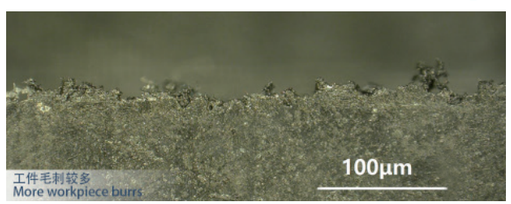


Supercritical CO_2 Machining

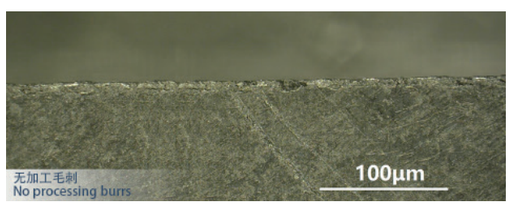
PEEK Machining

- Workpiece: PEEK
- Cutting Tool: Carbide Mill D6
- Rotating Speed: S=4000rpm
- Feed Rate: F=1600mm/min
- Axial Depth of Cut: a_p=0.3mm

Cutting Fluid Machining VS Supercritical CO_2 Machining



Cuttting Fluid Machining

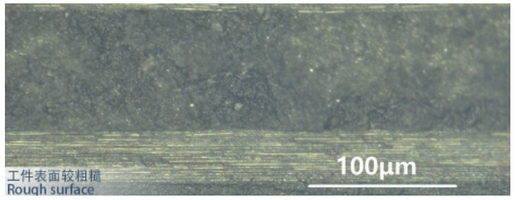


Supercritical CO_2 Machining

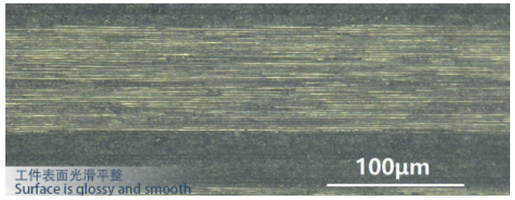
CFRP Machining

- Workpiece: CFRP
- Cutting Tool: Carbide Mill D6
- Rotating Speed: S=12000rpm
- Feed Rate: F=1500mm/min
- Axial Depth of Cut: a_p=1mm
- Radial Depth of Cut: a_e=0.05mm

Cutting Fluid Machining VS Supercritical CO_2 Machining



Cutting Fluid Machining

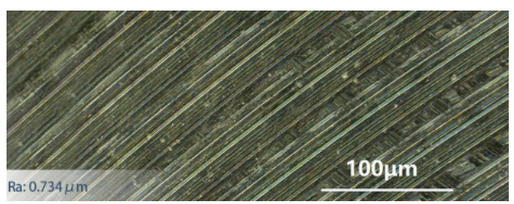


Supercritical CO_2 Machining

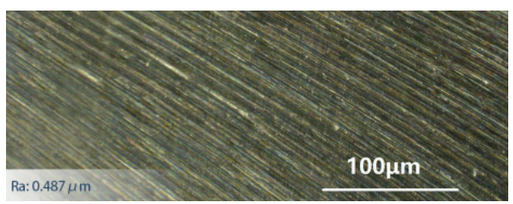
SUS316 Machining

- Workpiece: SUS316
- Cutting Tool: Carbide Mill D6,TiAlN
- Rotating Speed: S=3000rpm
- Feed Rate: F=2000mm/min
- Axial Depth of Cut: a_p=0.3mm

Cutting Fluid Machining VS Supercritical CO_2 Machining



Cuttting Fluid Machining



Supercritical CO_2 Machining