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Boost Productivity with **Ultrasonic** Machine Tools

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Curved Electrode of Single Crystal Silicon

Challenges

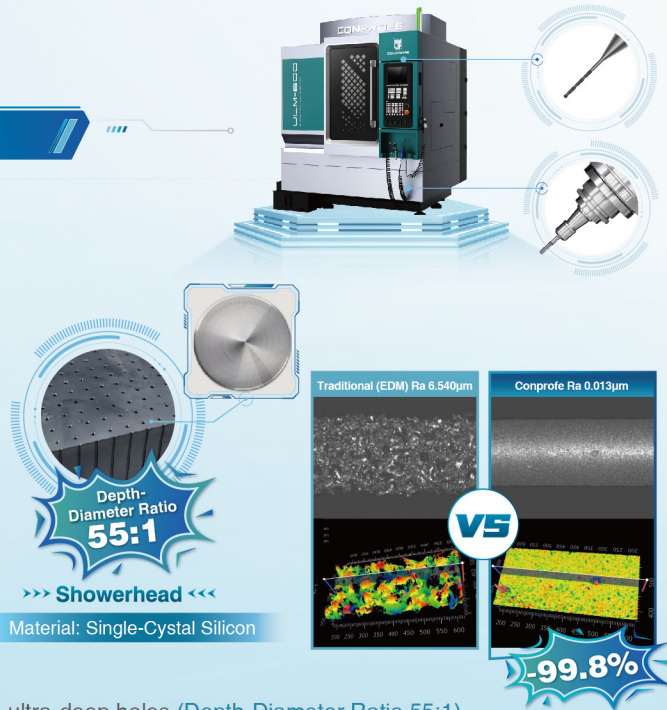
- Immature machining solution
- Hole wall roughness $\geq Ra\ 6.54\mu m$
- Hole roundness $\geq 0.025mm$
- Hard to control hole perpendicularity

Conprofe Solution

- **Ultrasonic Precision Engraving and Milling Center ULM-600**
- + **Ultrasonic** Machining System
- + **Solid PCD Drill**

Conprofe Benefits

- Continuous machining of over **1,000** D0.45x24.75mm ultra-deep holes (Depth-Diameter Ratio 55:1)
- With ultra-deep micro-hole drilling, no obvious chipping around hole edges
- Hole roundness **0.003mm**
- Hole wall roughness down by **99.8%**, from Ra 6.54 μm to Ra **0.013 μm**



AlSiC Threaded Hole Machining

Challenges

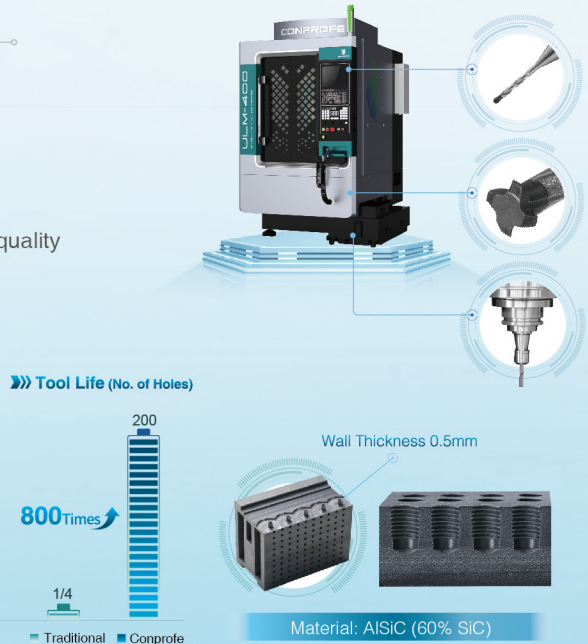
- Cycle time >180s/hole
- Unstable workpiece quality
- Vulnerable to hole edge chipping
- Low precision
- High cost (Tool life <1 hole)

Conprofe Solution

- **Ultrasonic Precision Engraving and Milling Center ULM-400**
- + **Ultrasonic** Machining System
- + **Solid PCD Drill and Thread Mill**

Conprofe Benefits

- M3 threaded holes **without cracking or chipping**
- Tool life improved by **800 times**, from 1/4 hole to 200 holes



Nomex Honeycomb Contouring



Challenges

- Uneven machined surface, severe burrs and excessive dust
- Vulnerable to workpiece deformation, tearing and buckling due to compression

Conprofe Solution

- **Ultrasonic Gantry 5-Axis Machining Center**
MBR6030C-5AXIS

- + Ultrasonic Machining System + Ultrasonic Cutting Disc
- + Ultrasonic Straight-Edge Cutting Blade + Cryogenic Air Blasting Technology



Material: Nomex Honeycomb
Feature: Contour Cutting

Conprofe Benefits

- Efficient 3D contouring of complicated shapes with angles < 18°
- Mitigated dusting and no observable burrs
- Effectively lower cutting force with even stress on the workpiece
- Flat and smooth cutting surface without buckling



Superalloy Blisk Milling



Material: Superalloy (GH4169)
Feature: Blisk Milling

Challenges

- Thin-wall (chord-thickness ratio > 40:1), with obvious chatter marks
- Poor surface roughness (Ra 0.93μm) Blade displacement • Uneven blade edge

Conprofe Solution

- **Ultrasonic Vertical 5-Axis Simultaneous Machining Center**
MVA400-5AXIS

- + Ultrasonic Machining System
- + Supercritical CO₂ (-78°C) Cryogenic Cooling System
- + Minimum Quantity Lubrication (MQL)
- + Ultrasonic Shrink-Fit Tool Holders
- + Coolant-Through Cutting Tools



Conprofe Benefits

- 3-in-1 technology reduces chatter marks on the blade surface and improves contour accuracy
- Blade surface roughness down by 56%, from Ra 0.930μm to Ra 0.408μm, shortening after-polishing time

Tibial Plateau Machining

Challenges

- Long cycle time
- Short tool life
- Low polishing efficiency and high manual labor cost

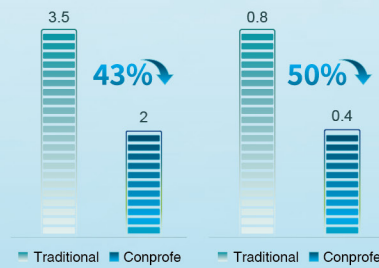
Conprofe Solution

- **Ultrasonic Drilling and Milling Center**
UGT-500
- + **Ultrasonic** Machining System
- + Minimum Quantity Lubrication (**MQL**)
- + Spindle-Through Cutting Tool

Conprofe Benefits

- Only very slight observable cutter marks on the surface
- Grinding and polishing cost down by **45%** vs. traditional machining
- Cycle time shortened by **43%**, from 3.5h to 2h
- Surface roughness down by **50%**, from Ra 0.8 μ m to Ra 0.4 μ m

»» Cycle Time (hour) »» Roughness (μ m)



Tibial Plateau
Material: CoCrMo Alloy
Dimension: 79x51x32.5mm

3D-Printed Titanium Alloy Spinal Cage Milling

Challenges

- Long cycle time
- No cutting fluids allowed
- Short tool life
- Severe burring and poor surface quality with dry cutting

Conprofe Solution

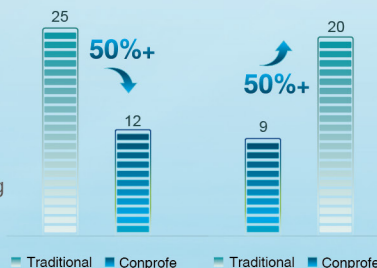
- **Ultrasonic Vertical 5-Axis Machining Center**
UGV200-5AXIS
- + **Ultrasonic** Machining System
- + Supercritical CO₂ Cryogenic Spindle-Through Cooling System (**ScCO₂**)

Conprofe Benefits

- Surface roughness **Ra<0.6 μ m**
- Significant burr reduction, no need for manual deburring
- Achieve efficient, high-quality green processing and reduce workpiece scrap rate



»» Cycle Time (min) »» Tool Life (pcs)



»» Spinal Cage Milling ««
Material:
3D-Printed Titanium Alloy TC4

Sapphire Through-Hole Machining

Challenges

- Poor hole wall surface quality
- Long polishing time for mass production

Conprofe Solution

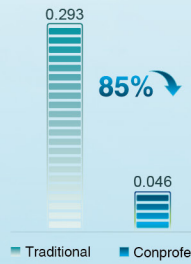
- **Ultrasonic Engraving and Milling Center ULM-400**
- + **Ultrasonic** Machining System
- + **Solid PCD Micro-Edge** Cutting Tool

Conprofe Benefits

- Hole wall roughness Ra down by **85%**, from 0.293 μ m to 0.046 μ m
- No need for polishing



»» Hole Sidewall Roughness Ra (μ m)



Material: Sapphire
Hole: D2.5x0.8mm

Forged Titanium Alloy Deep Blind Cross-Hole Drilling

Challenges

- Long cycle time
- Poor hole wall quality: heat discoloration, high roughness and severe burring

Conprofe Solution

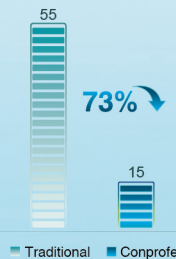
- **Ultrasonic Drilling and Milling Center UGT-500**
- + **Ultrasonic** Machining System
- + **Through-Spindle Cooling** System
- + **Smartguy 5-Axis** Rotary Table

Conprofe Benefits

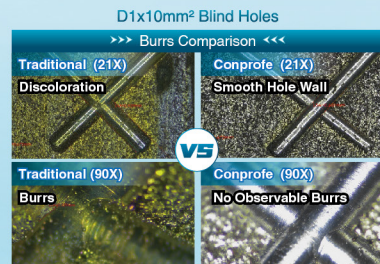
- Cycle time down by **73%**, from 55 seconds to 15 seconds
- Smooth hole wall without discoloration
- No observable burrs and no need for manual deburring



»» Cycle Time (s)



Material: Titanium Alloy



Carbon-Ceramic Brake Disc for New Energy Vehicle

Challenges

- Severe tool wear
- Low machining efficiency (C/T 120 min)
- Chipping, delamination and fiber pull-out and hole edge cracking

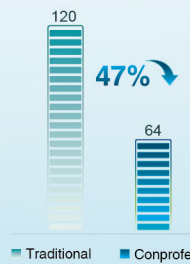
Conprofe Solution

- **Ultrasonic Precision Engraving and Milling Center**
UGM-600
- + Ultrasonic Machining System
- + Solid PCD Drill

Conprofe Benefits

- Improved surface quality without obvious chipping, cracking, delamination or fiber pull-out
- Cycle time down by **47%**, from 120 min to 64 min

»» Cycle Time (min)



Material: Carbon-Ceramic Composite
Dimension: D380x20.5mm
Features: I.D. Contouring, Step Milling and Hole Drilling

General Precision Manufacturing

Deep Hole Drilling in Quartz Glass Optical Fiber Preform

Challenges

- Poor hole side-wall surface quality
- Poor hole parallelism
- Hole edge chipping
- Machining failure due to tool breakage

Conprofe Solution

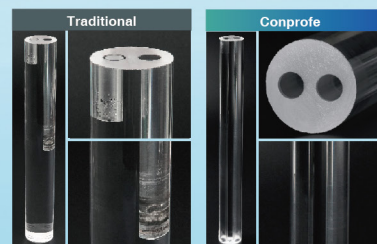
- **Ultrasonic Drilling and Milling Center**
UGT-500
- + Ultrasonic Machining System
- + Through-Spindle Cooling System

Conprofe Benefits

- Hole wall roughness **Sa < 0.122µm**
- Hole parallelism **< 0.0385mm**, meeting customers' requirements



Material: Quartz Glass Feature: Two D7.8x250mm Through-Holes
Hole: D30x250mm Hole Wall Roughness: Sa < 0.8µm



Failure due to tool breakage

Ultrasonic Machining Technology



▲ Intelligent Sensor Ultrasonic Generator

Five Highlight Technologies

- Max. Power: 350W
- Patent Sine Wave Drive Technology
- Amplitude Closed-Loop Linear Control
- Adaptive Control Technology
- CNC System Communication Function



Integrated Structure

- Patent Technology
- Gap: 0.5 ± 0.1 mm
- Effective Interference Resistance

Ultrasonic Vibration

- Max. Amplitude: 20 μ m
- Frequency: 15-70 kHz
- Controllable 3D Vibration

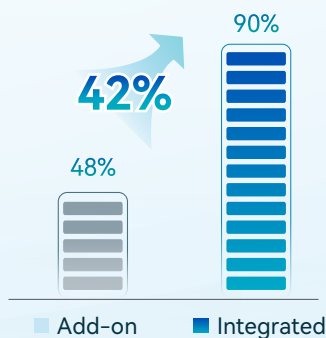
Advantages of Integrated Ultrasonic System over Add-on System

✓ High Intelligence

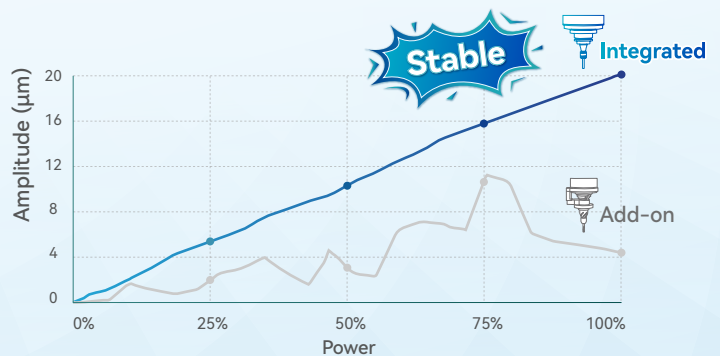
✓ Stable Structure

✓ Superior Ultrasonic Performance

» Transmission Efficiency Comparison



» Amplitude Linearity Comparison

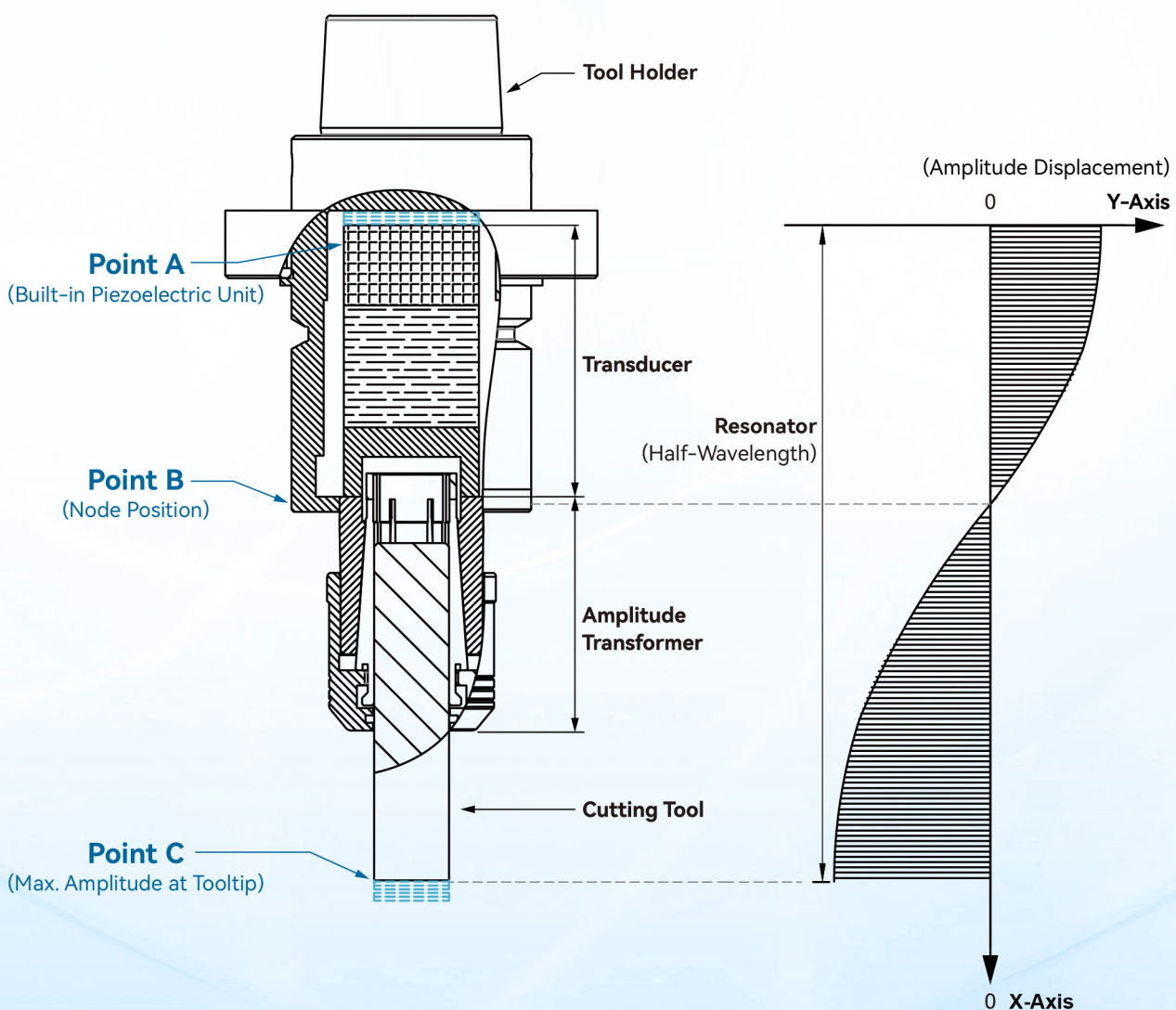


Principle of Ultrasonic Machining

Ultrasonic machining technology converts ultrasonic electrical oscillations into mechanical vibrations. While the tool rotates, it applies vibrations at tens of thousands of times per second, creating periodic separation between the tool and the workpiece during the machining process. This results in smoother chip removal, better cooling, and improved consistency of the processed surface, significantly enhancing machining efficiency, extending tool life, and improving the surface quality of the workpiece.

1. In ultrasonic-assisted machining, the ultrasonic generator is activated by high-frequency alternating electrical energy, driving the transducer and amplitude transformer to resonate as a whole. Energy is transmitted in the form of longitudinal waves from point A through point B to point C.

2. Once activated, the resonator vibrates with minimal elongation and contraction. Points A and C move away from or approach the node of the resonator (point B) simultaneously, while point B remains stationary throughout the vibration process.

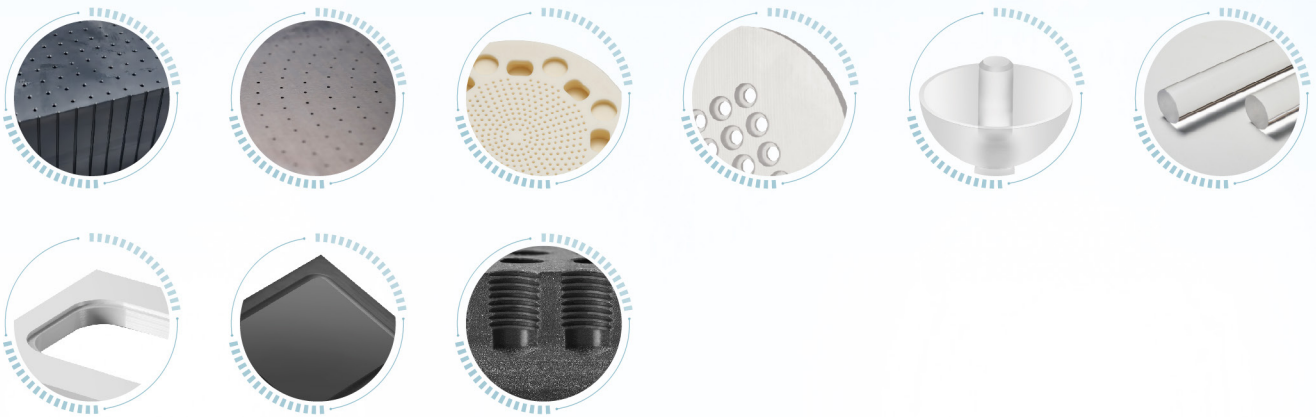


Applicable Materials

Hard-Brittle Materials

Materials: Single-Crystal Silicon, Silicon Carbide (SiC), Alumina (Al₂O₃), Sapphire, Quartz Glass, Silicon Nitride (Si₃N₄), Aluminum-Based Silicon Carbide (AlSiC), etc.

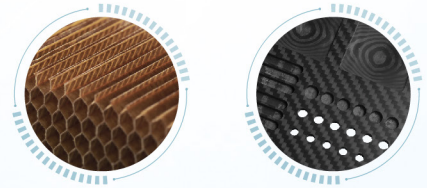
Workpieces: Semiconductor Showerheads, Optical Reflectors, Optical Fiber Preforms, Smartphone and Watch Enclosures, Graphite Molds, Dentures, etc.



Composites

Materials: Nomex Honeycomb Cores, Carbon Fiber Prepreg, Carbon Fiber Preform, Carbon Fiber Composites, etc.

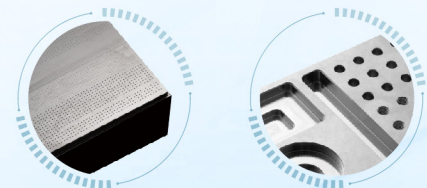
Workpieces: Structural Parts for Aviation, Automotive, Rail Transit Vehicles, etc.



Hard-to-Cut Metals

Materials: Stainless Steel, Titanium Alloy, Superalloy, etc.

Workpieces: Spacecraft Parts, Wear-Resistance Parts, Heat-Resistance Parts, etc.





Unique Advantages of Ultrasonic Machining

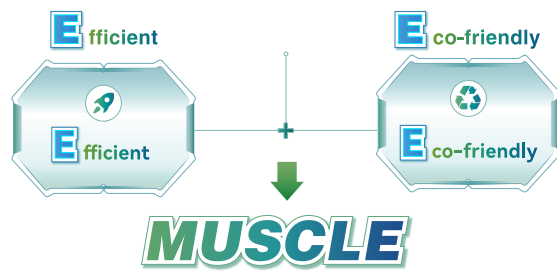
High Frequency Ultrasonic Vibration Acted on Tooltip
(15,000 to 70,000 times per second)

- Effectively reduces main cutting forces and cutting temperature
- Decreases subsurface damage (SSD) and machining stress in hard-brittle materials
- Reduces surface roughness
- Increases tool life
- Enhances the surface integrity of the workpiece

When Ultrasonic Meets Green Technologies



High-End Manufacturing



Advantages in 3+A Application Scenarios

Superior Machining Performance for
3 Material Categories

Hard-Brittle Materials Composite Materials Hard-to-Cut Metals

+

Superior Hole Drilling Performance in
All Materials

PEEK Cast Iron Aluminum Alloy Titanium Alloy HRC56 Mold Steel Carbon-Ceramic Composite Sapphire Silicon Carbide



Definition of CONPROFE

Converging of Global Resources

Professional as Industry Leader

CONPROFE

Company Profile

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 semiconductors, aviation & aerospace, medical field, automotive, consumable electronics, 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.

