



**DRIVING FREEDOM
OF MANUFACTURING**



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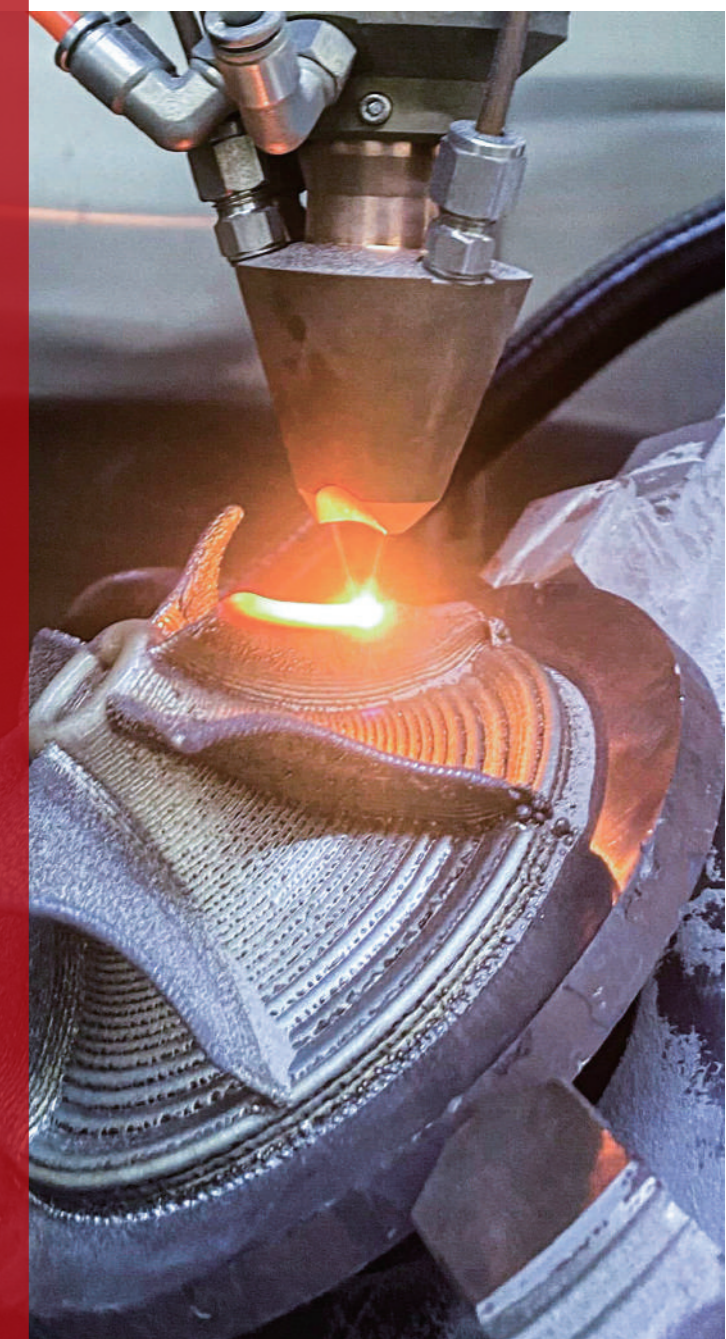
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**HUIRUI
GROUP**

**PROVIDE COMPLETE
SOLUTIONS FOR ADDITIVE
MANUFACTURING OF HIGH
PERFORMANCE METAL PARTS**



■ **NANJING HUIRUI PHOTOELECTRIC TECHNOLOGY CO., LTD.**

HUIRUI's Vision

Driving freedom of manufacturing

Becoming one of the most influential global intelligent manufacturing enterprise

HUIRUI's Mission

To provide professional, high-quality products and service for customers

To satisfy customer's high value demands for advanced manufacturing technology

To establish an efficient value-creating platform for HUIRUI employee

HUIRUI's Values

Practical Excellent Wise Innovative

CATALOGUE

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ABOUT HUIRUI



Founded in 2015, Huirui Group is a Chinese national high-tech enterprise headquartered in Nanjing Jiangsu Province, China. We are committed to the development of green and intelligent laser metal additive manufacturing technology in various industrial applications, providing our clients with customised equipments and service for rapid manufacturing and additive repair of high-performance metal components.

Technical Advantages

Our technical team has long been dedicating in the development and applications of laser metal additive manufacturing technology. Our complete solution of laser additive manufacturing system has successfully provided coating repair service to high value metal parts from various industries, such as hydropower, aeroengine, steel mill and mining machinery. A large database of laser powder deposition process with various high-performance alloys has been established based on a vast of application needs from many different industrial fields.



Qualifications & Honors (Parts)

Huirui's laser cladding equipment and powder feeder have passed CE certification, which is in linewith international, European and American standards.

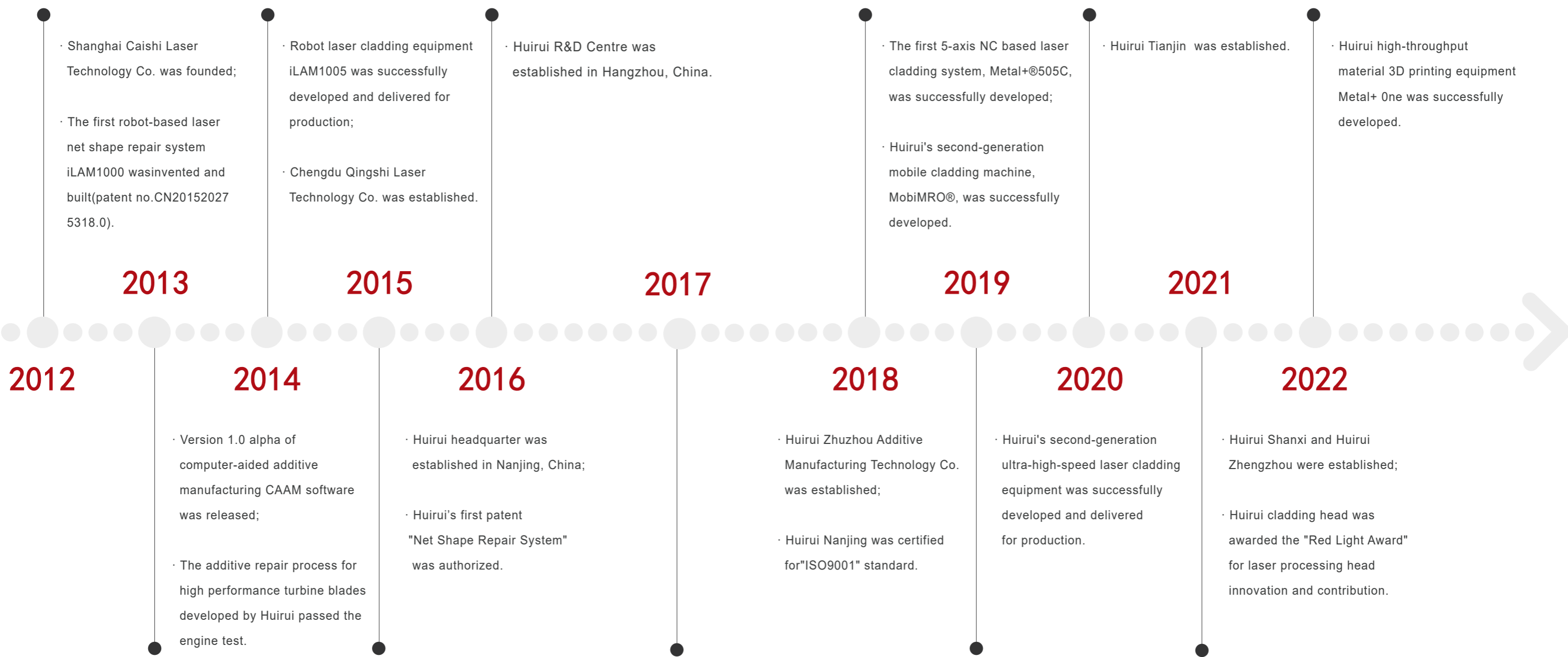


Intellectual Property

Huirui and its subsidiaries have accumulated and applied for more than 200 independent intellectual proprietary rights including 50+ invention patents, 100+ utility model patents and appearance patents, and is the owner of 20+ software registration copyrights.



Company Milestones



◎ Business Affiliations



Huirui has mature overseas market channels and after-sales support system. Our professional maintenance engineers who can provide oversea customers with after-sales support services in a timely and effective manner. Up to now, Huirui has served more than 500 customers all over the world.



Huirui Nanjing(HQ)



Huirui Chengdu Qingshi



Huirui Tianjing



Huirui Zhuzhou



Huirui Zhengzhou



Huirui Hangzhou



Huirui Shanxi



Huirui Shanghai

LASER INTELLIGENT MANUFACTURING SYSTEM

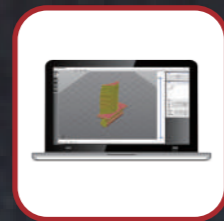
INTEGRATING FIVE KEY TECHNOLOGIES



Laser Technology



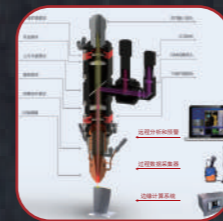
Robot and CNC



Computer-aided Design & Manufacturing



Material Processing Technology



Optical Sensing & Feedback Control Technology

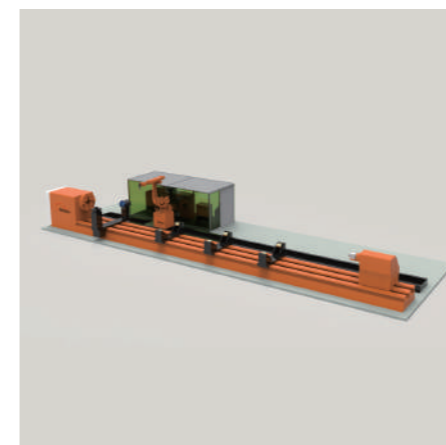
iLAM[®] Series

Intelligent Laser Additive Manufacturing System



Inert Chamber iLAM

8-axis robotic intelligent laser additive manufacturing system for net-shape additive repair of high performance part and 3D printing new products with controlled oxygen and moisture environment. Capble processing Titanium, Aluminium, Nickel-based superalloys.



Translation Robot iLAM

Laser cladding for long axle/shaft surface coating and repair with robot translation up to 10m, ultra-high speed coating to replace Chrome plating, environment friendly and high efficiency.



Robot Workstation iLAM

8-axis robots laser cladding system for non-standard parts can be adapted to complex structures and non-standard parts. For complex geometry cladding processing and surface treatment of different types of workpieces.

Metal+[®] Series

For Metal 3D Printing Directed Energy Deposition(DED) System



High-throughput Metal 3D Printing DED

Atmosphere protected 3-axis laser additive system can realize the preparation and printing of continuously-changing metal composition materials. It is mainly used in 3D printing, additive repair, cladding strengthening, material design research, etc.



Standard 5-axis NC DED

This system is professionally customized according to the actual needs of customers, taking into account both repair and 3D printing purposes; It can be used for batch production, and lean production manufacturing needs.



Metal+One[®]

3D printing high-throughput material equipment that is compact in size, refined and accurate powder feed, especially for use in material design research and laboratory environments.

UHS-iCoating[®] Series

Ultra-high-speed Laser Cladding System



- ⊙ High processing efficiency
- ⊙ Stable coating process
- ⊙ Multi-speed adjustable
- ⊙ Hydraulic tailstock jack

| Device model | C634 | C636 | C636A |
|-------------------------------|--------------------------------|----------|-------|
| Laser | Fiber/Diode laser source Laser | | |
| Laser power | ≤12kW | | |
| Spindle speed | 1-200rpm | 1-150rpm | |
| Motion mechanism | 3+1Axis | | |
| Deposition efficiency | ≤500cm ² /min | | |
| Repeat position accuracy | ±0.05mm | | |
| layer thickness | 50–1500μm | | |
| Processing length | 3m | | |
| Weight capacity | 2t | 3t | |
| Chuck diameter | 320mm | 500mm | |
| Maximum rotation diameter | 400mm | 600mm | |
| Substrate dilution rate | < 1% | | |
| Maximum diameter of workpiece | 400mm | 600mm | |
| Maximum length of work piece | 3000mm | | |

MobiMRO® Series

Mobile Laser Cladding Additive Repair System



Mobile Laser Cladding And Grinding System

To reduce the MRO response time for customer needs, the components required for laser cladding are integrated into modules, with a special transport vehicle. The equipment can be quickly delivered to the repair site, it can be quickly assembled for the cladding operation. Saving customers time and costs while improving integrity of repaired parts.

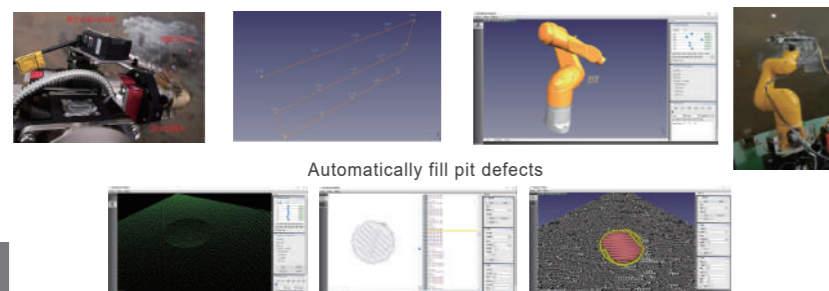


Mobile Laser Additive Repair Workstation

- 1.Humane friendly overall space layout;
- 2.Compartment design to facilitate the operation, maintenance and inspection compartment;
- 3.Equipped with process monitoring devices.

Robot Adaptive Teaching And Toolpath Generation

Scan measurement → Teaching point generation → Robot path generation → Perform cladding

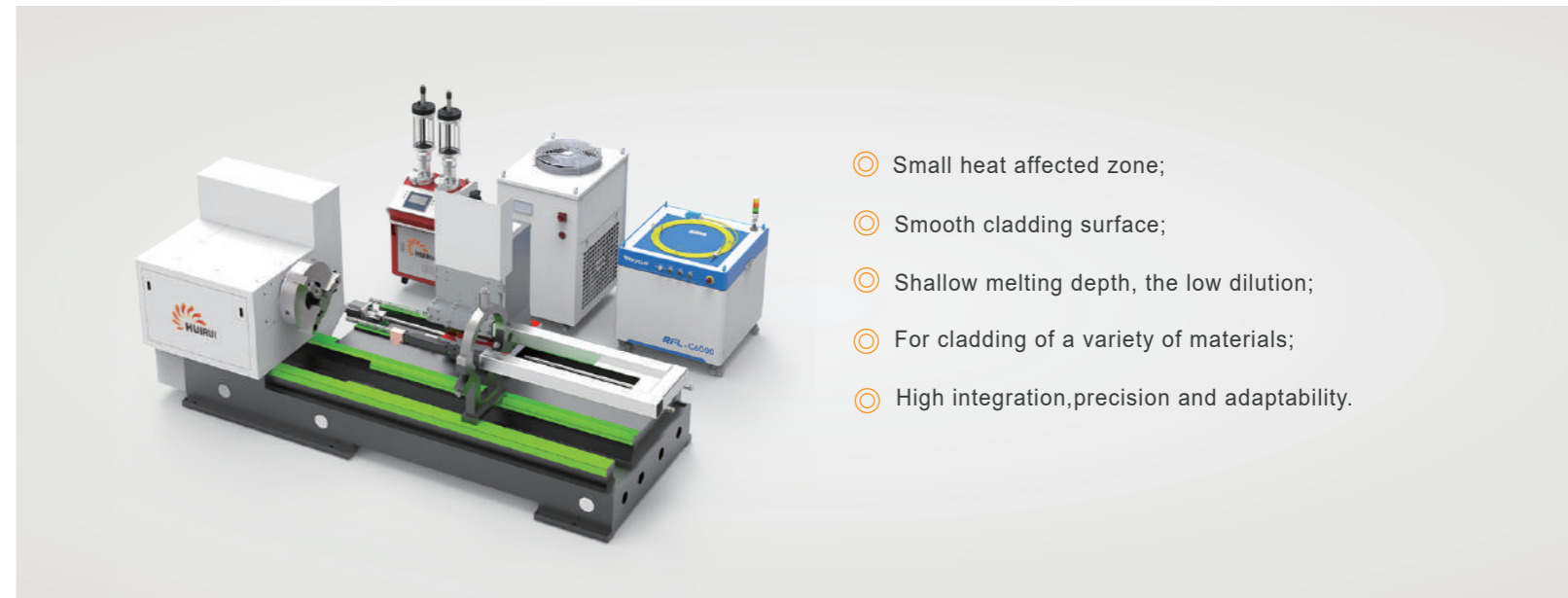


Automatically fill pit defects

- 1.Laser displacement sensor measures and automatically teaches and generates processing paths;
- 2.Saving most of the manual teaching time;
- 3.Establish workpiece coordinate system, compensate original processing path, and three-dimensional modeling.

ID Cladding Series

Inner Diameter Laser Cladding System

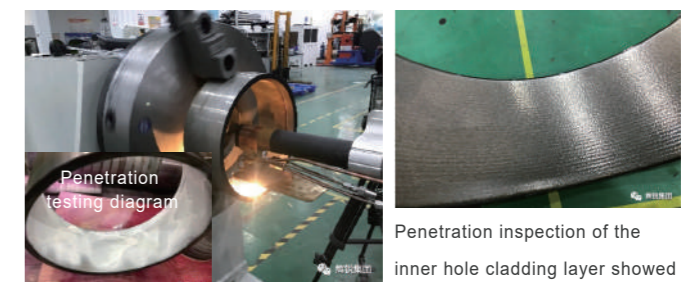


- Small heat affected zone;
- Smooth cladding surface;
- Shallow melting depth, the low dilution;
- For cladding of a variety of materials;
- High integration, precision and adaptability.

| | | | |
|---------------|------------|-----------------------|----------------------|
| Laser power | up to 10kW | Cladding efficiency | 1.0m ² /h |
| Powder size | 25-150μm | Powder feeding amount | 0.1-200g/min |
| Spindle speed | 0.5-50rpm | Cladding thickness | 0.3-1mm |

Cladding Thickness

The thickness of the cladding layer is 0.3-0.6mm. The surface of the cladding layer is continuous and uniform, no pore defects are found.



Cylinder liner cladding repair

Penetration inspection of the inner hole cladding layer showed no crack defect

Metallographic Inspection

The cladding layer and the base material are metallurgically bonded. No crack, pore and delamination defects.



Metallographic diagram



Salt spray test 1000h

Salt Spray Corrosion Test

After 1000 hours of continuous neutral salt spraying, the surface corrosion of the cladding examined. There are no rust spots on the surface of the cladding layer is found.

Laser DED Component

Laser Head



Huirui's laser cladding head can be used for various application scenarios. Diversified modules configurations and interface settings are compatible to various lasers and cladding needs achieving efficient and stable long-term operations.

- ☉ Laser-grade optical modular design;
- ☉ Precise adjustable focal point and spot sizes;
- ☉ ID 65 and shock-proof seal design for robust operation.

Laser Processing Head Innovation
Redlight Award



| Model | LH-ZSR-1020 | LH-ZVR-1020 | LH-WSR-1020 | LH-WVR-1020 |
|---------------------------------|--|-------------|-------------|-------------|
| Optical path structure | Straight | | Bent | |
| Beam splitter module | None | Yes | None | Yes |
| Applicable wavelength | 900-1100nm | | | |
| Maximum applicable power | 8kW | | | |
| Laser energy pass rate | >99.5%@900-1100nm wavelength | | | |
| Optical fiber interface | QBH, LLK-B/D, QD | | | |
| Optical path coaxial adjustment | X-Y direction adjustable precisely | | | |
| Collimation distance | 100mm/150mm | | | |
| Focus distance | 200mm/300mm/400mm | | | |
| Circular spot output size | 0.5-5.0mm | | | |
| Focal position adjustable | Yes (manual) | | | |
| Focus adjustable range | ±5mm | | | |
| Coaxial Imaging module | None | Yes | None | Yes |
| Camera | None | CCD/CMOS | None | CCD/CMOS |
| Linear spot | Available | | | |
| Lighting module | Available | | | |
| Linear spot size | 8X2mm/10X2mm/12X2mm/16X2.5mm/20X2mm/30X2mm | | | |
| Overall size(mm) | 122X102X364 | 200X102X364 | 309X102X258 | 309X102X258 |
| Overall weight | 4.5kg | 5kg | 6kg | 6.5kg |

Laser DED Component

Laser Head



Coaxial Linear Spot Cladding Head

Model:D5WL
Applicable wavelength:
900-1100nm
Power:≤8kW
Collimation distance:
100/150mm
Focus distance:300/400mm
Rectangular spot size:
10X2/16X2.5/20X2mm



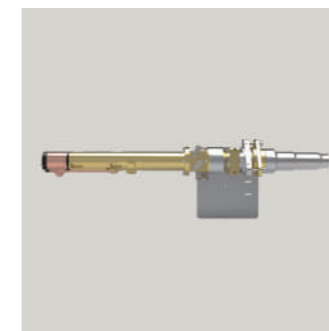
Off-axis Linear Spot Cladding Head

Model:D52WL
Applicable wavelength:
900-1100nm
Power:≤8kW
Collimation distance:
100/150mm
Focus distance:300/400mm
Rectangular spot size:
10X2m/16X2.5/20X2mm



Off-axis Linear Spot Cladding Head

Model:D52ZL
Applicable wavelength:
900-1100nm
Power:≤12kW
Collimation distance:
100/150mm
Focus distance:300/400mm
Rectangular spot size:
20X2/30X2mm



Internal Hole Cladding Head

Model:D80
Collimation distance:50mm
Focus distance:100mm
Beam spot:2-3mm
Power:≤2kW
Depth:≤300mm
ID:≥80mm



Internal Hole Cladding Head

Model:D100
Collimation distance:50mm
Focus distance:100mm
Working distance:10-12mm
Beam spot:2-3mm
Power:≤3.5kW
Depth:≤500mm
ID:≥100mm



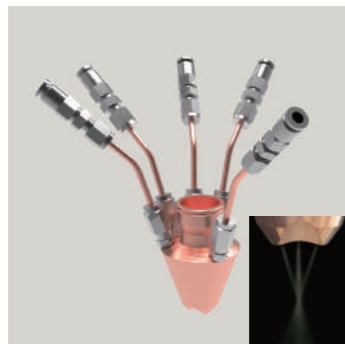
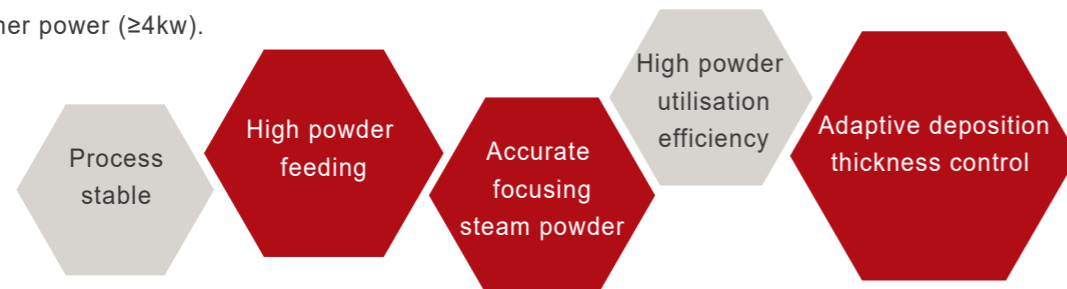
Internal Hole Cladding Head

Model:D180
Collimation distance:50mm
Focus distance:150mm
Beam spot:2-3mm
Power:≤3.5kW
Depth:≤2m
ID:≥180mm

Laser DED Component

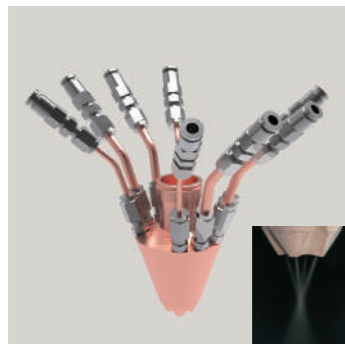
Cladding Nozzle

Huirui has developed a variety of laser cladding nozzles. The nozzles are interchangeable and can be fitted with Huirui's laser heads by the same nozzle interface module. The linear nozzles can be used in combination with the shaping module to produce a linear-shaped spot, which meets the need for efficient and long-lasting cladding at higher power ($\geq 4\text{kW}$).



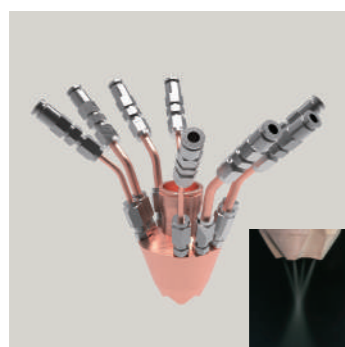
3-point Nozzle

Specification:CT-1317-01 Aperture: $\phi 6.5\text{mm}$
 Laser power: $\leq 4\text{kW}$ Powder particle size:50-200um
 Working distance:16-18mm Powder flow:3-25g/min
 Powder spot size:2-3.5mm



4-point Nozzle

Specification:CT-1317-01 Aperture: $\phi 7.5\text{mm}$
 Laser power: $\leq 6\text{kW}$ Powder particle size:50-200um
 Working distance:16-18mm Powder flow:10-100g/min
 Powder spot size:2.5-4mm

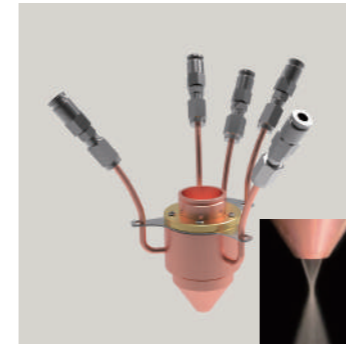


Long Focal 4-point Nozzle

Specification:CT-1330-01 aperture: $\phi 7.5\text{mm}$
 Laser power: $\leq 6\text{kW}$ Powder particle size:50-200um
 Working distance:30-32mm Powder flow:10-100g/min
 Powder spot size:3.5-5.5mm

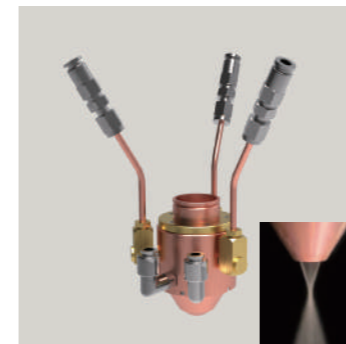
Laser DED Component

Cladding Nozzle



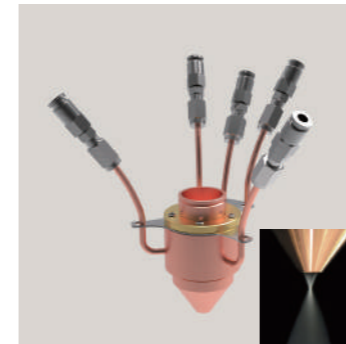
Long Focal Ultra-high Speed Cladding Coaxial Nozzle

Specification:CT-0610-01 Aperture: $\phi 6\text{mm}$
 Laser power: $\leq 5\text{kW}$ Powder particle size:25-150um
 Working distance:9-13mm Powder flow:1-45g/min
 Powder spot size:0.8-1.5mm



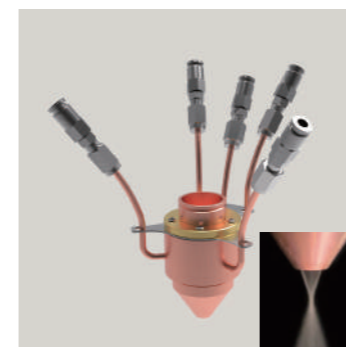
Strong Chilling Coaxial Nozzle

Specification:CT-0715-01 Aperture: $\phi 7\text{mm}$
 Laser power: $\leq 6\text{kW}$ Powder particle size:50-150um
 Working distance:15-17mm Powder flow:1-45g/min
 Powder spot size:2-3.5mm



Reinforced Focal Ultra-high Speed Cladding Coaxial Nozzle

Specification:CC-0406-01 Aperture: $\phi 4.3\text{mm}$
 Laser power: $\leq 3\text{kW}$ Powder particle size:50-150um
 Working distance:6-7mm Powder flow:1-45g/min
 Powder spot size:0.6-1mm

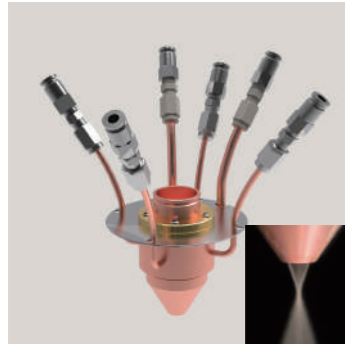


Ultra-high-speed Cladding Coaxial Nozzle

Specification:CC-0408-01 Aperture: $\phi 4.2\text{mm}$
 Laser power: $\leq 3\text{kW}$ Powder particle size:25-150um
 Working distance:7-9mm Powder flow:1-45g/min
 Powder spot size:0.8-1.5mm

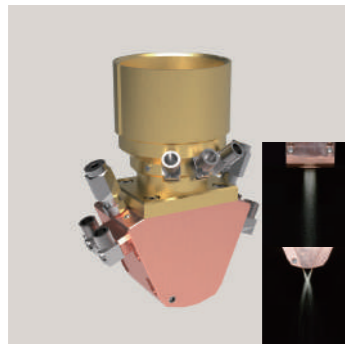
Laser DED Component

Cladding Nozzle



Long Focal Coaxial Annular Nozzle

Specification:CC-7520-02 Powder flow:1-45g/min
 Laser power:≤8kW Working distance:19-23mm
 Powder spot size:1.5-2.5mm Powder flow shape:annular-shaped
 Powder particle size:53-150um



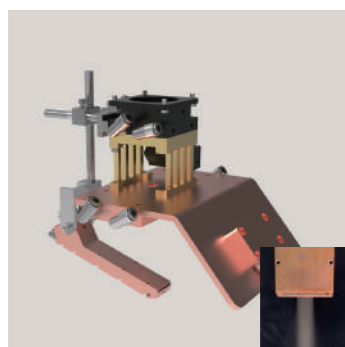
Coaxial Linear Nozzle

Specification:CC-1012(10-15)-01 Powder particle size:50-200um
 Laser power:3-10kW Powder flow:30-200g/min
 Linear Powder Flow Length:6-24mm Working distance:12.2mm
 Linear powder flow width:2-4mm



Off-axis Single-point Nozzle (Round Spot)

Specification:SO Series Powder particle size:50-200um
 Laser power:≤6kW Working distance:10-15mm
 Minimum powder feeding diameter:1.5-2mm



Off-axis Linear Nozzle (Linear Spot)

Specification:SL Series Powder particle size:50-200um
 Laser power:≤6kW Working distance:10-15mm
 Minimum powder feeding diameter:1.5-2mm

Laser DED Component

Powder Feeder



Huirui's full range of powder feeder,can achieve long-distance powder conveying, its stable and high precision powder feeding, help customers to achieve stable and lean.

- ⦿ High-precision powder feeding;
- ⦿ Synchronized to laser process;
- ⦿ Various powder hollor configurations;
- ⦿ Stable powder feeding over long distances, up to 20 metres;
- ⦿ Both pneumatic and gravity feeds are available.

| Product name | Single Hopper Powder Feeder | Double Hoppers Powder Feeder | Multi Hoppers Powder Feeder | Gravity Powder Feeder |
|------------------------------|-----------------------------|--|--|--|
| Powder hoppers | Single hopper | Double hoppers | 4/5/6 hoppers | Number of hoppers optional (gas can be loaded) |
| Powder feeding rate capacity | 0.4-300g/min | 0.4-300g/min | 0.4-300g/min | 20-50g/min 20-400g/min 20-300g/min 0.1-100g/min |
| Powder feeding accuracy | ≤±1% | ≤±1% | ≤±1% | ≤±2% |
| Gas pressure | 0.2-0.6mpa | 0-0.6mpa | 0-0.6mpa | 0-0.6mpa |
| Gas flow | 1-15L/min | 1-15L/min | 1-15L/min | \ |
| Heating temperature | N/A、 0-65℃ | 0-65℃ | 0-65℃ | \ |
| Single hopper volume | 1.5/5L | 1.5/5L | 1.5/5L | 1.5/5L |
| Applicable particle size | 20-300µm | 20-300µm | 20-300µm | 20-300µm |
| Drive motor | Stepping motor | Servo Motors | Servo Motors | DC Motor |
| Optional Functions | Stirring and heating | Stirring and heating dynamic weighing | Stirring and heating dynamic weighing | Roller type Electromagnetic type Screw type Linear type |
| Remote protocols | I/O | I/O/AI/Profinet/ Modbus | Ai/Profinet/Modbus | \ |

Laser Welding System

Huirui Laser-arc hybrid welding equipment combine laser and MIG technology his hybrid technique is faster than MIG welding alone, and the parts are subject to less distortion.

- Energy utilization is much higher than the simple addition of two heat sources, with high welding speeds;
- Compared to conventional welding, hybrid welding has a greater depth of fusion and higher weld quality;
- The combination with laser helps to improve the stability of the arc and improves for the welding gap, thus increase efficiency.



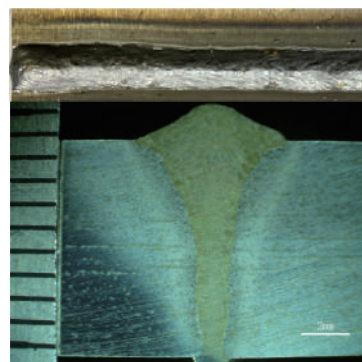
Main Configurations

| | |
|------------------------|------------|
| Laser source max power | 20kW |
| Fibre diameter | 200um |
| Motion accuracy | KUKA KR210 |
| Depth of fusion | 9mm |

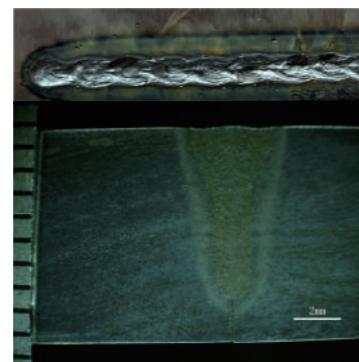
Equipment parameters

| | |
|-----------------|-----------|
| Welding method | Laser MIG |
| Laser power | 5kW |
| Current | 144A |
| Welding Voltage | 16.7V |
| Scan velocity | 10mm/s |
| Melt width | 6.7mm |

Process Testing



Section view of laser-arc hybrid

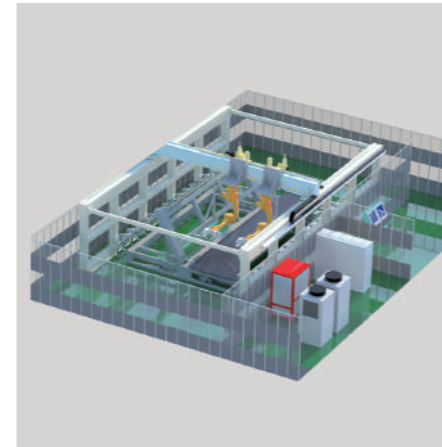


Section view of laser welding



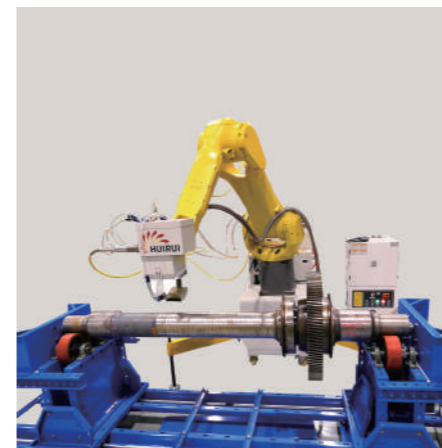
Top view of workpiece

Laser Cleaning System



Laser Cleaning Production Line

Green, efficient, flexible, easy-to-maintain and low-cost laser cleaning operations. For the removal of paint for masive-volume shaft parts, and at the same time, take into account the surface treatment of multiple types and workpieces.



Mobile Laser Cleaning System

The mobile kilowatt laser cleaning system is a high-power cleaning system, which can be used to remove metal surface oil, metal corrosion layer, all kinds of paint coatings, metal surface oxidation film and other metal coatings.



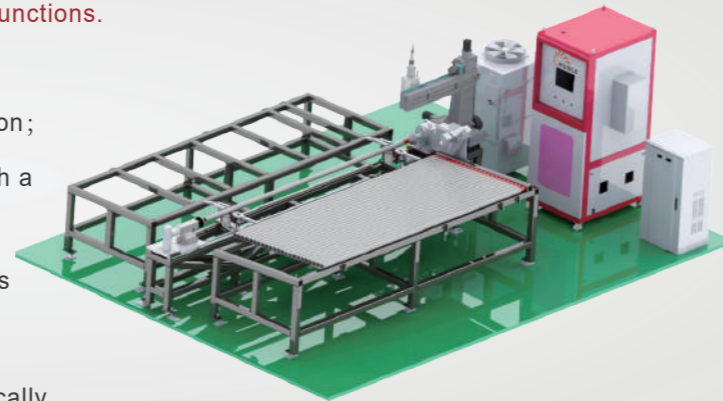
Portable Laser Cleaning Equipment

Hand held laser cleaning equipment based on low to medium power pulsed fibre lasers and high-speed scanning mirrors can be flexibly applied to a variety of cleaning-type surface treatment operations for industrial products.

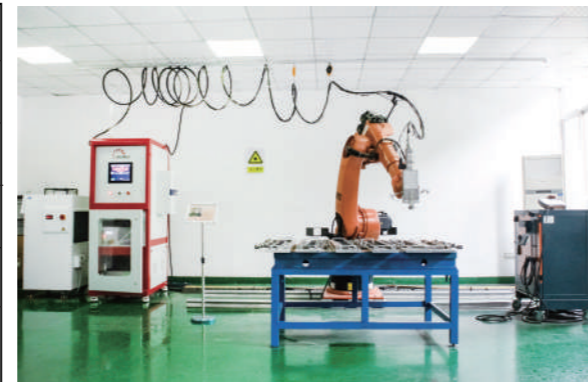
Laser Heat Treatment System

The production line can perform laser quenching process on the surface of steel tubes. Automatically load steel tubes to the workstation. With visual positioning and automatic clamping functions.

- ⊙ Automatic loading and unloading rotary station;
- ⊙ Locate the position to be laser quenched with a high-speed camera;
- ⊙ Automatically locate the start point of threads and perform the laser processing;
- ⊙ When finished, the ejector cylinder automatically relocates the workpiece.



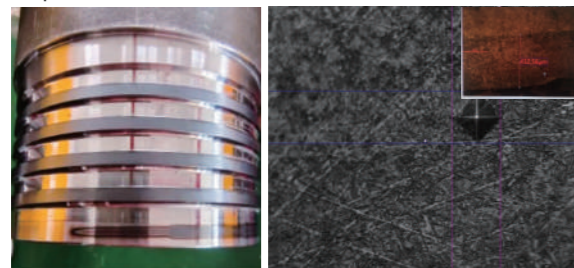
| | |
|-----------------------|--|
| Robots | 6-axis robot |
| Laser device | Diode laser source Laser |
| Laser power | 3kW |
| Adjustable Spot Range | 5X5-32X32mm (customizable) |
| System configuration | Dual colour infrared thermometer |
| | Closed-loop temperature control system |



Laser Quenching System

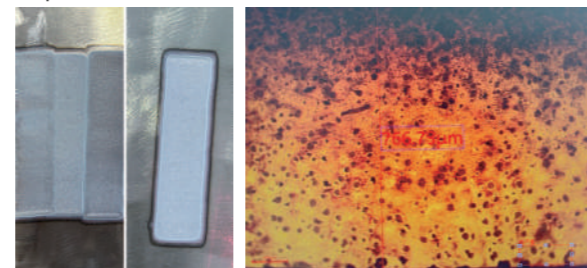
⊙ Process Testing

Experimental material: Threaded 40Cr



The depth of hardened layer is 0.3-0.5mm, and the hardness improvement. Hardness improves from 30 to 58 HRC. The local quenching thread area without any deformation, to ensure the accuracy of hardness.

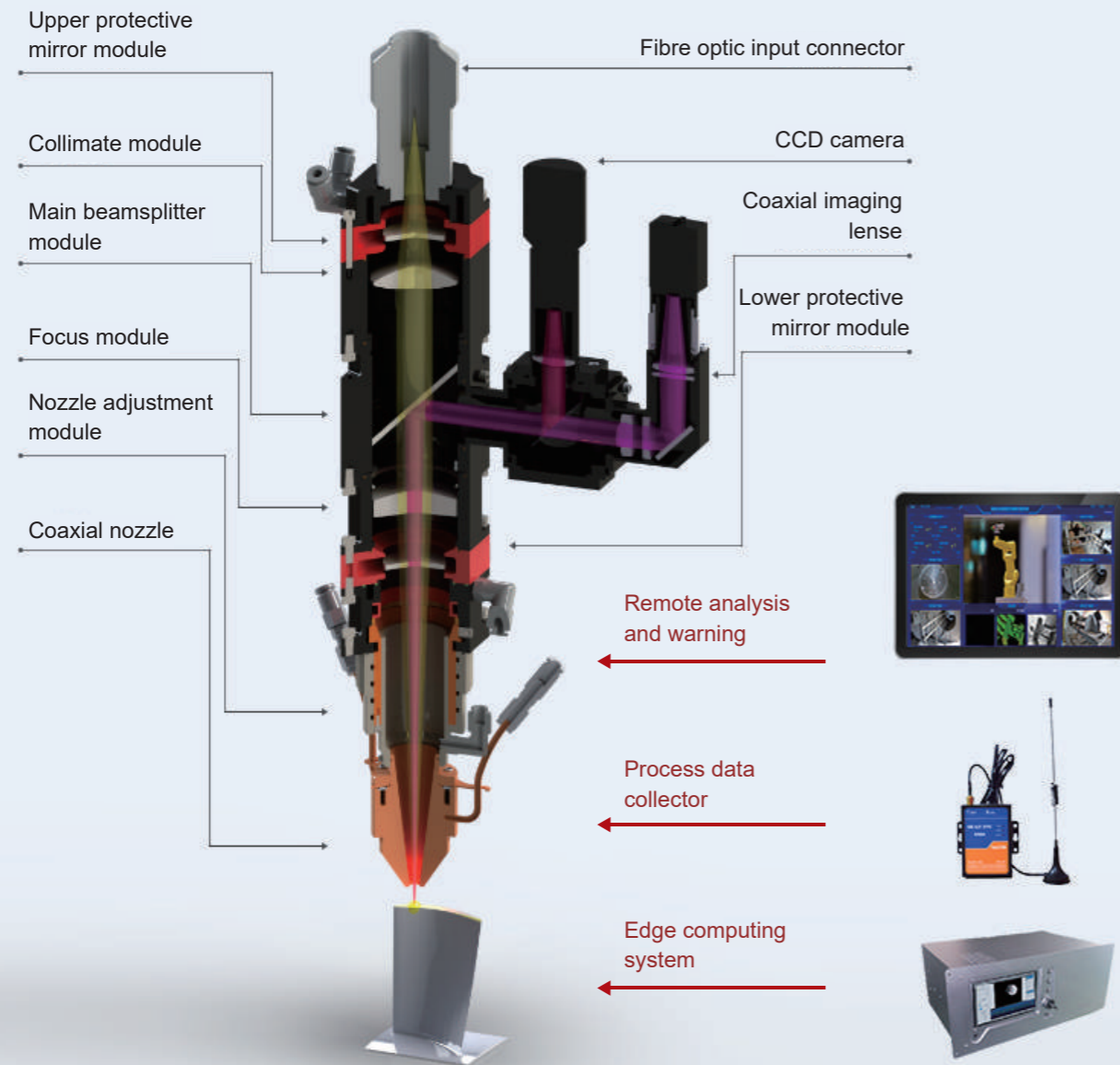
Experimental material: QT700



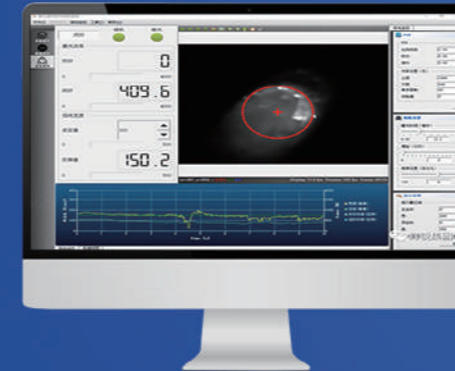
The surface of the workpiece after quenching is flat and smooth, the internal organization is well-proportioned, and the effective depth of the hardened area is 0.65mm. Hardness improves from 25 to 55 HRC.

A large database of laser powder deposition process with various high-performance alloys has been established based on a vast of application needs from many different industrial fields.

Intelligent Monitoring System



Huirui computer-aided additive manufacturing (CAMM) software package includes: system status monitoring, ImageSense, SmartVtion, DynamicHeat, ScanPath and other functional modules, enables the operability and reliability of metal 3D printing and repair a more intelligent process.



Melt Pool Monitoring And Temperature Closed Loop Control System

Closed-loop feedback control of the main parameters of the laser cladding process through optical and other monitoring means, real-time monitoring of size, shape and temperature of the molten pool and related data recording and analysis, real-time feedback adjustment or PID control of process parameters.



Portable Cobot Laser DED System PortiLAM®

Huirui has developed an adaptive shape-tracking laser cladding system, which uses 2D or 3D sensors to automatically identify defects, locate targets, and generate machining paths, replacing traditional programming with manual instructions and greatly reducing processing time.



Multi-source Data Acquisition And Analysis System

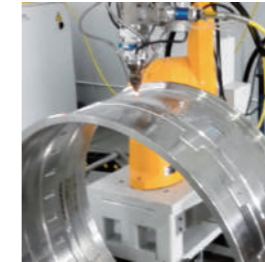
The system consists of an edge calculator, a 4G remote data collector, and a cloud computing platform. It can acquire many kinds of data such as temperature, flow rate and image at the same time, and process and analyse data.

INDUSTRIAL APPLICATION CASES

© Aerospace



Z-notch repair of low pressure turbine blade



Casing repair



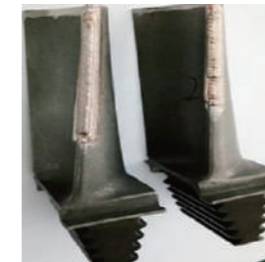
Compressor blade repair



Repair of external spline shaft parts



Blink repair



High pressure turbine blade repair

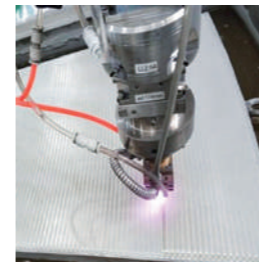


Seal tile repair



Blade notch repair

© Energy Power



Bearing tile babbatt alloy repair



Gas turbine blade tip filling



Hydro power guidevane repair



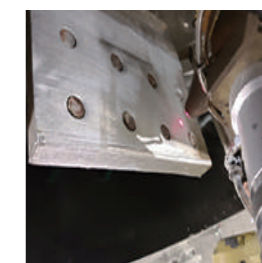
Anti-cavitation coating on hydro power station



Hydro-power turbine coating



Bottom ring on-site repair

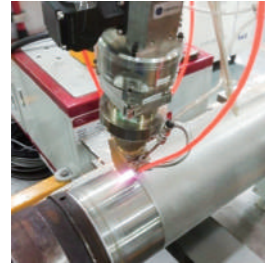


On-site repair of aluminum enclosed busbar

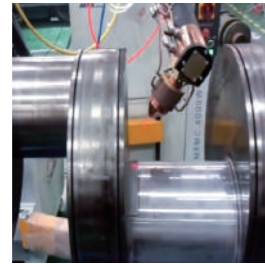


Steam turbine blade repair

◎ Machinery



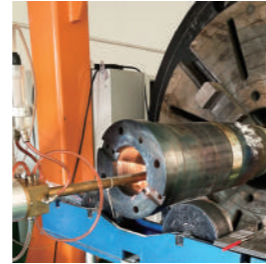
Ultra-high-speed cladding of hydraulic cylinder surface



Drive shaft (crankshaft) cladding



Reducer gear (tooth surface) repair



CNC milling machine spindle repair

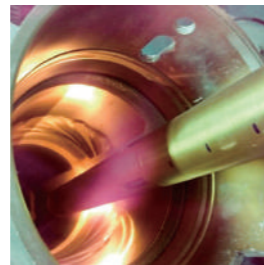
◎ Petrochemical



Axle wear repair



Centralizer wear repair



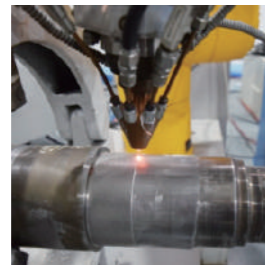
Repair of internal holes in petroleum drilling tools



Hastelloy impeller repair



Pressure compensator wear repair



Spindle wear repair



IPTA drilling tool transfer end face repair



Connection accessories repair



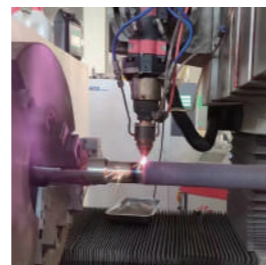
Chemical fiber tube laser cladding



Chemical plant vacuum pump blade fan repair



Ball valve cladding

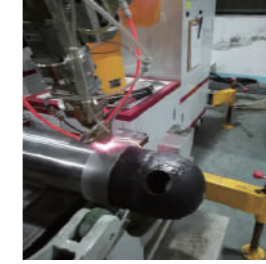


Valve stem cladding

◎ Coal Mining Machinery



Hydraulic support column repair



Living column cladding



Sprocket repair



Laser cladding of picks



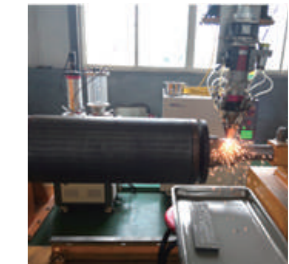
Internal hole cladding cylinder



Bearing position and key position cladding



Scraper groove plate repair



Shaft parts repair

◎ Steel miller equipment



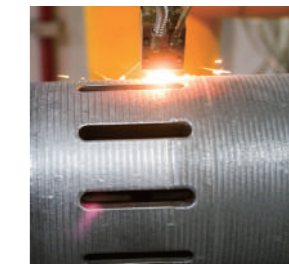
Copper plate mold cladding



Repair of the inner ring bearing surface of the crane drum



Laminar roller repair



Valve stem repair

◎ Agricultural Machinery Tools



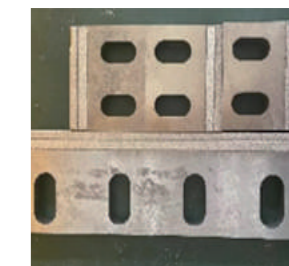
Wheat harvesting knife cladding



Corn harvester knife cladding

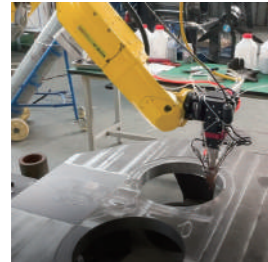


Crushing machine knife cladding

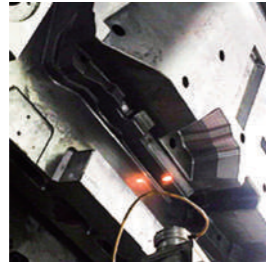


Lawn mower cladding

◎ Mould



Cast iron arm repair



Various mold strengthening



Bumper stamping die repair



Glass mold repair

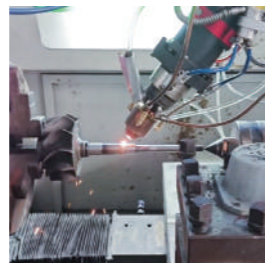
◎ Shipyard



Piston head repair



Pump shaft repair



Booster rotor shaft repair

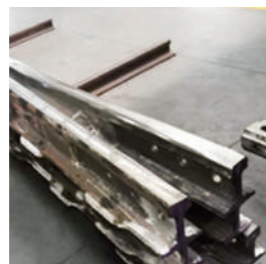


Rudder repair

◎ Other Equipment



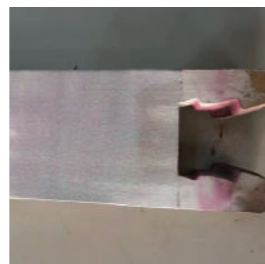
Cylinder liner repair



Repair of rail switch



Laser repair of subway motor end cover



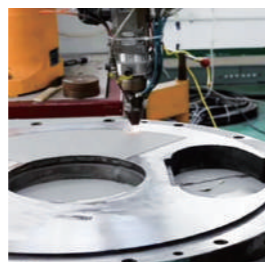
Laser surface treatment of high-speed sliding bed platen



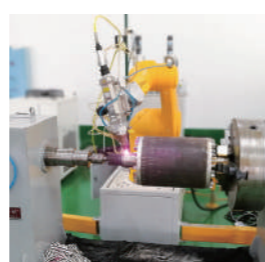
Laser repair of vehicle axle parts



Wheel tread and rim laser repair



Site remediation



Intelligent rail motor rotor shaft repair

MATERIALS

| | Metal Material | Application |
|---|--|---|
| Steel | 316L,17-4PH,SS410,420,400 | Stainless steel repair and forming |
| | H13(SKD61),P20,P21,CPM | Die casting ,oulds, Injection moulds |
| | 40Cr,45#,Cl60,42CrMo,40CrMnMo,30CrMnSiA,39CrMoAl | Repair of shaft/tooth/disc parts |
| | INVAR | Low expansion coefficient materials |
| Cobalt Based | Stellite6,21,31,Co50,42,Deloro50,60 | Abrasion and corrosion resistant materials |
| Nickel Based | INCONEL718(GH4169),625 | Turbine engine parts, oil drilling |
| | Waspalloy(GH738),GH4648, GH3030 | Turbine engine parts |
| | CMSX-4,REene N5,DD6 | Monocrystalline turbine blades |
| | Rene80,Rene142 | Aero-engine magazines, blades |
| | Ni60,Deloro50,60 | Aero-engine |
| Titanium Based | Ti-6Al-4V | Biomedical scaffolds, aircraft engines, petroleum |
| | TiAl | Turbine blade |
| | TiNi | Medical equipment |
| | TA15,TC17,TC2,TC4 | Aerospace |
| Aluminium | AlSi,AlCu,AlMg,AlZn | Rail vehicles, aerospace |
| Metal-based Wear-resistant Ceramics | WC,SiC | Abrasion resistant material |

