HUAYUE

Committed to providing customized R&D and toll processing services

for new materials to the semiconductor industry.

Jiangsu Huayue
Semiconductor Technology Co., Ltd.

About Us

With a complete equipment line from lab to production,
we deliver targeted R&D and toll processing solutions for advanced semiconductor materials.

2023
Huayue was established

10+
Sets of experimental equipment

5000+ heats
Annual production capacity
5,000+ heats

Huayue Semiconductor is deeply involved in the pan-semiconductor field, focusing on material process development, pilot verification and mass production and processing full-chain services, and is committed to providing, the global semiconductor industry chain provides advanced sintering and special bonding integrated process solutions. The business covers laboratory formula research and development, process parameters. The complete cycle from digital finalization to large-scale mass production can accurately match the technology and production needs of customers at different stages of development.

The team is led by Ma Tengfei, a professor and Ph.D. in engineering from Harbin Institute of Technology. The core members have a deep material research background and rich product experience. Industry implementation experience. The leader presided over and participated in the National Natural Science Foundation, major aviation engine and gas turbine projects, and materials from the National Defense Science and Technology Bureau. He has conducted more than 20 key scientific research projects including special projects, published more than 100 SCI papers, authorized more than 10 invention patents, and was selected as one of Quzhou City's "New 115 Talents" Engineering, Nankong elite scientific and technological innovation talents; have solid technology accumulation and achievement transformation capabilities in the fields of advanced sintering and special bonding processes. It can provide customers with full-chain technical support from process formula development to mass production.

The company's core capabilities cover two major process systems, and all categories support customized research and development and batch processing:

- **Advanced Sintering:** Covering Spark Plasma Sintering (SPS), vacuum hot press sintering, vacuum/atmosphere/debinding sintering, hot isostatic pressing sintering, and gas pressure sintering It combines five major types of processes to meet the high-performance and dense requirements of many types of core materials such as semiconductor heat dissipation substrates, functional structural ceramics, and advanced packaging materials, chemical preparation needs.
- **Special Bonding:** Covering two special bonding processes: vacuum brazing and vacuum diffusion bonding, which can realize dissimilar metals, ceramic-metal and other heterogeneous materials. High-precision, high-airtight and reliable connections, suitable for high-end core components such as semiconductor device vacuum packaging, thermal management components, and power modules' bonding needs.

The company is currently equipped with more than ten full-spectrum professional process equipment ranging from lab-scale to industrial-scale. The annual processing capacity exceeds 5,000+ heats, and can quickly respond to customers' small batch process trial production and large batch stable mass production meet the diverse delivery needs, and ensure process consistency and product yield throughout the entire process.

The company adheres to the business philosophy of "quality-oriented, innovation-driven, and service-oriented" and continues to promote the upgrading of domestic semiconductor process technology and the integration of domestic industrialization substitution process. In the future, Jiangsu Huayue will continue to develop advanced sintering and special bonding tracks, with technological innovation as the core driving force and customer-oriented Taking user value as the fundamental orientation, we are committed to becoming an industry-leading integrated process solution service provider, providing independent controllable and high-quality services for China's semiconductor industry. Quality development continues to empower.

Core Strengths

Large-scale Research & Innovation Platform

With a 3,000 m² advanced materials R&D center laboratory, we have built an integrated platform for materials development, process validation, and pilot-scale production tailored to the pan-semiconductor industry. This enables us to support the full R&D lifecycle–from initial formulation exploration to small-batch trial production.

Full Range Of Process Configurations

Equipped with more than ten professional process systems at both laboratory and production scales, we offer comprehensive coverage of advanced sintering and specialty bonding technologies. With an annual processing capacity exceeding 5,000 furnace runs, we deliver a complete service loop–from R&D prototyping and pilot trials to full-scale production–meeting diverse material processing needs under one roof.

Expert R&D Team

Led by Ph.D. and professor-level technical experts from Harbin Institute of Technology, our team is deeply engaged in the R&D and industrialization of advanced materials. We have led or participated in more than twenty national and provincial key research projects, authored over 100 academic papers, and been granted more than ten core patents. This enables us to provide full-cycle technical support – from initial process development to large-scale manufacturing–ensuring reliable solutions for complex material challenges.

Full Cycle Technical Services

We provide comprehensive technical support throughout the project cycle, including sample performance testing, process parameter optimization, and technology upgrades. By staying closely engaged at every stage, we ensure process consistency and high product yields – helping our customers achieve efficient, reliable mass production.

Service Process

Consultation & Communication → Sample Sending → Sign a Contract → Issue Report → Full-cycle Technical Services

Services

Committed to new material R&D and toll processing for the semiconductor industry.

In today's rapidly evolving semiconductor landscape, advanced process technologies and next-generation specialty materials are the twin engines driving innovation and industry progress.

We are proud to be your most trusted innovation partner, delivering a complete range of services – from custom process development and manufacturing solutions to toll processing of advanced specialty materials – all designed to accelerate your path from concept to production.

Partners

100+

The Trusted Choice of Partners

清华大学

中南大学 CENTRAL SOUTH UNIVERSITY

大连理工大学 Dalian University Of Technology

太原理工大学 TAIYUAN UNIVERSITY OF TECHNOLOGY

哈尔滨工业大学 HARBIN INSTITUTE OF TECHNOLOGY

上海交通大学 SHANGHAI JIAO TONG UNIVERSITY

中国科学技术大学 University of Science and Technology of China

南京航空航天大学

复旦大学 FUDAN UNIVERSITY

中国科学院力学研究所 Institute of Mechanics, Chinese Academy of Sciences

中国科学院上海高等研究院

中国科学院福建物质结构研究所 中国科学院海西研究院

中国工程物理研究院 CHINA ACADEMY OF ENGINEERING PHYSICS

中国科学院上海应用物理研究所

中国科学院电工研究所

HUAWEI

广州众山新材料股份有限公司 TRIO METAL (GZ) CO., LTD.

三环集团 SINCE 1970

三安光电 Sanan Optoelectronics

厦门钨业

Overview of Eight Furnace Types & Material Compatibility:

Process	Furnace Type	Core Process Advantages	Best-Suited Core Materials	Typical Performance Improvement
Advanced Sintering	Spark Plasma Sintering (SPS) Furnace	Pulse current field-assisted rapid heating, Short sintering cycle, effective grain growth suppression, and strong near-net-shape forming capability	High-performance structural ceramics, metal matrix composites, refractory metals, thermoelectric materials, and copper-diamond heat sink materials.	Grain refinement to sub-micron levels, density approaching theoretical values, excellent electrical & thermal conductivity, and R&D iteration efficiency improved by several times.
	Vacuum Hot Pressing Sintering Furnace	Uniaxial synchronous pressing under vacuum, integrated pressing & sintering, low sintering temperature, and uniform and controllable microstructure.	Cemented carbides, structural ceramics, functional ceramics, powder metallurgy copper / tungsten-molybdenum alloys, and semiconductor package substrate materials.	High density, minimal internal defects, uniform mechanical properties, and near-net-shape forming reduces post-machining substantially.
	Vacuum Hydrogen Furnace	Strong reducing atmosphere, high cleanliness, and deep deoxidation and decarburization.	Refractory metals, AlN/SiC ceramics, transparent ceramics, and powder metallurgy copper-nickel alloys.	Significantly reduces oxygen content, enhances material purity, refines grain structure, and delivers a bright, clean finished surface.
	Vacuum / Atmosphere / Debinding Sintering Furnace	Integrated debinding & sintering in a single step, suitable for small parts with complex geometries, and excellent batch-to-batch stability.	MIM stainless steel / titanium alloys, CIM structural ceramics, and carbon-based materials.	No binder residue, high dimensional precision, dense & uniform microstructure, and excellent batch-to-batch consistency.
	Gas Pressure Sintering (GPS) Furnace	High pressure suppresses component decomposition, enabling high-density sintering, and strong compositional stability.	Si_3N_4 / Sialon / AlN nitride ceramics, B_4C / SiC superhard ceramics, and high-grade cemented carbides.	Density $\geq$ 99%, no high-temperature element volatilization, significantly improved material toughness, and high structural reliability.
	Hot Isostatic Press (HIP) Furnace	Isostatic uniform high pressure, full densification, and complete elimination of internal defects.	Aerospace titanium alloys / superalloys, 3D-printed components, superhard cutting tools, and transparent ceramics.	Porosity $\leq$ 0.01%, double the fatigue life, effective microcrack elimination, and isotropic performance uniformity.
Specialty Bonding	Vacuum Diffusion Bonding Furnace	Solid-state metallurgical bonding, no liquid phase formation, and preserves base material properties.	Dissimilar metals, precision heat exchangers, ceramic-metal heterogeneous bonding, and diamond-metal composite materials.	No thermal deformation of workpieces, bonding strength equal to that of the base material, high airtightness at the joint, and excellent dimensional accuracy retention.
	Vacuum Brazing Furnace	Precision liquid-phase capillary filling, minimal workpiece deformation, and suitability for high-volume bonding of complex structures.	Flow channel plates, cemented carbide cutting tools, ceramic-to-metal seals, and refractory metal assemblies.	Smooth, oxidation-free bonding, excellent sealing performance, simultaneous multi-joint bonding, and outstanding batch-to-batch consistency.

Spark Plasma Sintering (SPS) System

Good temperature uniformity / Fast heating speed / Short sintering time / High experimental efficiency / Controllable microstructure / Energy-efficient / Environmentally friendly

PROCESS OVERVIEW

Utilizing the synergistic effect of pulse current and axial pressure, the instantaneous high temperatures generated by pulse discharge enable rapid sintering densification between powder particles. The process features rapid heating, short holding time, and low sintering temperatures, effectively suppressing grain growth and preserving ultra-fine and nanocrystalline structures. This yields superior mechanical properties in the final material. The process is suitable for a wide range of systems, including high-performance ceramics, metal matrix composites, refractory metals, and thermoelectric materials. It supports rapid formula verification and small-batch trial production, and is widely used in the R&D and mass production of semiconductor ceramic substrates, copper-based diamond heat sinks, functional ceramics, and other advanced devices.

Model	S2	S4
Sample Dia.	Φ30~50mm	Φ120mm
Mechanical Pressure	10T	50T
Ram Stroke	100mm	100mm
Heater	Pulsed DC Power Supply	Pulsed DC Power Supply
Ultimate Vacuum	6.7×10^{-3}Pa	5Pa
Max. Temp.	2400°C	2200°C

MATERIAL CLASSIFICATIONS FOR SPARK PLASMA SINTERING (SPS) SYSTEM

Ceramic Matrix / Metal Matrix Diamond Composite Materials

Leveraging the low-temperature, rapid sintering and strong interfacial bonding advantages of SPS, the process enables precise preparation of composite systems with high density and excellent thermal conductivity / wear resistance:

1. Ceramic-matrix Diamond Composites Materials

- **Ti_3SiC_2-Bonded Diamond Composites:** Through in-situ reaction synthesis during SPS, the Ti_3SiC_2 phase forms strong chemical bonds with diamond, combining the high hardness of ceramics with the excellent thermal conductivity and machinability of metals. Ideal for high-end grinding tools such as grinding wheels.
- **Copper-Diamond Composites:** SPS enables uniform dispersion of diamond particles (up to 60 vol.%) within the copper matrix, achieving a relative density exceeding 97% and thermal conductivity exceeding 500 W/(m·K). This makes it a core material for high-performance electronic packaging.
- **SiC-Diamond Composites:** By combining the high thermal conductivity of SiC with the ultra-high thermal conductivity of diamond, SPS-processed composites achieve thermal conductivity up to 392 W/(m·K), making them ideal for extreme heat dissipation applications.

2. Metal-matrix Diamond Composite Materials

- **High-Thermal-Conductivity Metal-Matrix Composites:** In addition to copper-based systems, SPS enables the preparation of Al/diamond, Mg/diamond, and other composites. The rapid sintering process effectively suppresses diamond graphitization, achieving both high thermal conductivity and low thermal expansion – making it ideal for semiconductor thermal management modules.

High-performance Tool Materials

Leveraging its capabilities in ultra-fine grain suppression and high-density regulation, SPS serves as the enabling technology for advanced tool fabrication, meeting the performance demands of tools used in a wide range of applications:

1. Cemented Carbide Tools (WC-based)

- **Ultra-Fine WC-Based Cemented Carbides:** Using nanoscale WC powder (50–100 nm) with Co/Ni/Fe binders, SPS achieves grain refinement down to the sub-micron level. The resulting material reaches a hardness of HV 2124.3 and a transverse rupture strength of 1281 MPa, making it suitable for machining difficult-to-cut materials such as superalloys and hardened steels.
- **Modified WC-Based Tools:** Additives such as Cr_3C_2 and La_2O_3 are introduced as grain inhibitors to prevent abnormal grain growth, enhancing wear resistance and impact toughness. This enables the production of complex-shaped tools, including those with intricate chip breakers and positive rake geometries.

2. Superhard Composite Cutting Tools

- **WC/cBN Composite Tools:** Through an SPS-based secondary pre-pressing process, a cBN layer is in-situ synthesized on the surface of the WC substrate. This combines the high strength of WC with the extreme hardness of cBN, making it ideal for finish machining of hardened steels and cast irons.
- **Binderless WC Ceramic Tools:** SPS enables densification of pure WC without the need for a metallic binder phase, achieving a hardness of 27.1 GPa. This overcomes the conventional limitation of requiring binder additions, making it suitable for high-precision finishing applications.

Magnetic Materials

Leveraging the low-temperature and short-cycle sintering characteristics of SPS, the grain size and phase composition of magnetic materials can be precisely controlled, effectively preventing magnetic performance degradation typically caused by high-temperature processing.

1. Rare-earth Permanent Magnetic Materials

- **Nd-Fe-B Magnets:** SPS enables densification of the $Nd_2Fe_{14}B$ phase at temperatures as low as 650°C, effectively suppressing the formation of α-Fe impurities and grain growth, while maintaining high coercivity and maximum energy product. It also supports the fabrication of $Nd_2Fe_{14}B$/α-Fe nanocomposite dual-phase magnets, achieving both high remanence and high coercivity.
- **Sm-Co Magnets:** Suitable for high-temperature-stable $SmCo_5$ and Sm_2Co_{17} permanent magnets. The rapid sintering capability of SPS minimizes oxidation of rare-earth elements, enhancing magnet purity and overall magnetic performance.

2. Soft Magnetic Materials

- **Fe-Based Nanocrystalline Alloys:** Preparation of amorphous/nanocrystalline soft magnetic materials such as Fe-Si-B and Fe-Cu-Nb-Si-B. SPS sintering preserves ultra-fine grains (20-30 nm), significantly enhancing magnetic permeability. Ideal for high-frequency electronic devices such as transformers and inductors.
- **Ferrites:** Suitable for sintering Mn-Zn and Ni-Zn spinel ferrites, as well as $Y_3Fe_5O_{12}$ (YIG) garnet ferrites. The low-temperature SPS process minimizes lattice defects in ferrites, improving low-loss characteristics at high frequencies.

3. Composite Magnetic Materials

- **Metal-Ceramic Composites:** For example, the $865Fe6Si4Al35Ni/MgFe_2O_4$ composite combines high saturation magnetization (Bs = 1.2 T) with high electrical resistivity, making it suitable for high-power power electronic devices.
- **Multiferroic Materials:** SPS enables precise control over the distribution of ferroelectric and ferromagnetic phases in $BiFeO_3$-based multiferroic ceramics, achieving robust magnetoelectric coupling. This makes them ideal for smart sensors and memory devices.

Sputtering Targets

Leveraging its capabilities in achieving high purity, near-theoretical density, and tailored grain size, SPS is the enabling technology for premium sputtering targets, widely applied in semiconductor manufacturing, functional coatings, and other key thin-film applications:

1. Metal Targets

- **Refractory Metal Targets:** For Ta, Nb, Zr, Cr, and other refractory metals, SPS achieves full densification (>99% relative density) at temperatures below 1500°C, with grain sizes refined to <10 μm. This avoids the grain coarsening and oxidation issues associated with conventional high-temperature sintering, making them ideal for semiconductor capacitors and corrosion-resistant coatings.
- **High-Purity Metal Targets:** For high-purity Al, Cu, Ni and other target materials (4N-5N purity), SPS-processed nanocrystalline Cu targets (grain size <50 nm) significantly improve electromigration reliability, making them suitable for chip interconnect layers. Alloy targets such as TiAl and NiCrAl exhibit superior compositional uniformity compared to conventional casting methods.

2. Ceramic Targets

- **Oxide Ceramic Targets:** For Al_2O_3, ZrO_2, Y_2O_3, $MgFe_2O_4$, and other oxide ceramics, SPS achieves a relative density exceeding 98% with extremely low porosity, making them ideal for functional thin-film deposition via magnetron sputtering, such as wear-resistant coatings and dielectric films.
- **Magnetic Ceramic Targets:** For YBCO (high-temperature superconducting targets), PZT (piezoelectric targets), Mn_3O_4 (magnetodielectric targets), and other magnetic ceramics, the low-temperature SPS process preserves the target phase structure, enhancing sputtering stability and film performance.

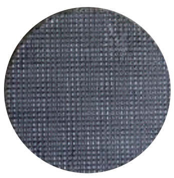
Additional Types of Ceramic Targets

Beyond the four main material families, SPS technology is also highly effective in producing the following critical materials, opening up new possibilities across diverse applications:

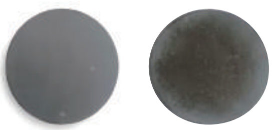
- **Functionally Graded Materials:** Stainless steel/ZrO_2, Ni/ZrO_2, and Al/polymer systems are fabricated via SPS with precisely controlled gradient temperature fields, achieving continuous compositional and performance gradation. This effectively resolves thermal expansion mismatch issues, making them suitable for aerospace thermal protection systems and electronic packaging heat dissipation modules.
- **Advanced Ceramic Materials:** Oxide ceramics (Al_2O_3, ZrO_2, Y_2O_3), nitride ceramics (Si_3N_4, AlN – high thermal conductivity and high strength), carbide ceramics (SiC, B_4C, WC–superhard and wear-resistant), and multiphase ceramics (Al_2O_3+Y_2O_3 multi-phase reinforced ceramics). Suitable for structural components, wear-resistant parts, and electronic insulation materials.
- **Metals and Alloy Materials:** High-purity metal bulks (Al, Mg, Cu, Fe, Ti) and pre-alloyed powders (e.g., Al-Si alloys). Rapid SPS sintering effectively suppresses impurity segregation, enabling the production of high-purity, ultra-fine-grained metal bulks suitable for high-end structural components and electronic materials.
- **Amorphous/Nanocrystalline Materials:** Amorphous alloys (e.g., Mg-based amorphous alloys, Fe-based magnetic amorphous alloys) and nanocrystalline ceramics/metals (e.g., 65 nm dense TiN). SPS effectively suppresses crystallization and grain growth, preserving the amorphous phase and nanocrystalline structure. These materials are suitable for high-hardness wear-resistant components and high-performance magnetic materials.

TYPICAL SINTERED SAMPLES DISPLAY

- **Al-Si Alloy Disc:** Rapid densification via SPS, achieving a density of 2.48 g/cm³. Dimensions: ϕ50 mm.



- **Alumina Ceramic Disc:** High-density Al_2O_3 ceramic with excellent electrical insulation, high-temperature resistance, and strong corrosion resistance.



- **Cemented Carbide Cutting Tip:** WC-based cemented carbide with high hardness and excellent wear resistance, ideal for precision machining applications.

- **Magnetic Materials:** Rare-earth permanent magnets, ferrites, metallic soft magnetic and nanocrystalline alloys, composite and multiferroic materials.

- **Metal Sputtering Targets (Tungsten, Molybdenum, Alloys).**

- **Metal-Matrix Diamond Composites / Ceramic-Matrix Diamond Composites.**

Vacuum Hot Pressing Sintering Furnace

Optimized Design / Excellent Temperature Uniformity / Rapid Heating /
High Pressure Precision / Safety Performance

PROCESS OVERVIEW

In a high-vacuum environment, uniaxial mechanical pressure and high-temperature heating are simultaneously applied to the green body, enabling integrated forming and sintering in a single step. The process significantly reduces sintering temperature and enhances material density, yielding products with minimal internal defects and a uniform microstructure. Near-net-shape forming is achieved, substantially reducing post-sintering machining. Widely used in the preparation of cemented carbides, structural ceramics, and functional composites, it is especially suitable for batch processing of semiconductor power device packaging substrates, high-temperature heat sink materials, insulating structural components, and other products requiring high density and consistent performance.

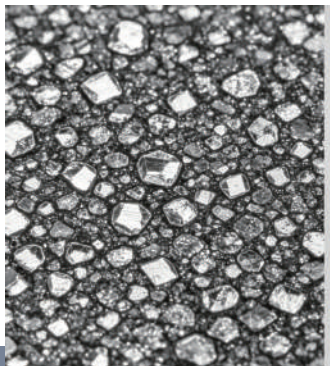
Model	P2GR24	P3VGR22
Sample Dia.	Φ20~80mm	Φ160mm
Mechanical Pressure	30T	100T
Ram Open Height / Stroke	160/100mm	370 mm / Upper 100 mm + Lower 100 mm
Heater	Isostatic Graphite	Isostatic Graphite
Ultimate Vacuum	6.7×10^{-3} Pa	6.7×10^{-3} Pa
Max. Temp.	2400°C	2200°C

MATERIAL CLASSIFICATIONS FOR VACUUM HOT PRESSING SINTERING FURNACE

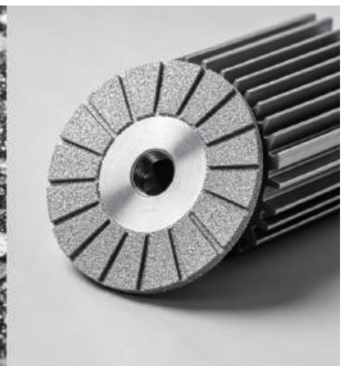
Ceramic-Matrix / Metal-Matrix Diamond Composites

Vacuum hot pressing sintering is a classic process for preparing high-density diamond composites, particularly well-suited for large-size and thick-section components:

- **Ceramic-Matrix Diamond Composites:** Using Si_3N_4, Al_2O_3, SiC, Ti_3SiC_2, and other ceramic binders, vacuum hot pressing achieves strong interfacial bonding between diamond and the ceramic matrix. This enables the production of high-thermal-conductivity electronic packaging materials and high-end grinding wheels.
- **Metal-Matrix Diamond Composites:** Using Cu, Al, Fe-Ni-Co, and other metal matrices, hot pressing under vacuum or protective atmosphere suppresses diamond graphitization. This allows for the production of high-thermal-conductivity heat sinks, geological drilling bits, and precision cutting tool inserts.



▲ Microstructure of Diamond Composite Materials



▲ Finished Grinding Wheels and Heat Sinks

Left: Uniform diamond particle dispersion with tight interfacial bonding and no visible defects.
Right: Finished ceramic-bonded diamond grinding wheels and metal-matrix diamond heat sinks – showcasing the superior integrity and densification achieved by vacuum hot pressing.

High-Performance Tool Materials

Vacuum hot pressing sintering is a classic process for preparing high-density diamond composites, particularly well-suited for large-size and thick-section components:

- **Cemented Carbide Tools (WC-Based):** WC-Co, WC-Ni, and other systems. Through precise pressure and temperature control in vacuum hot pressing, high-density (>99%) and ultra-fine-grained cemented carbides are produced, suitable for metal cutting and mining tools.
- **Superhard Tools:** PCD (polycrystalline diamond) and PCBN (polycrystalline cubic boron nitride) tools. Vacuum hot pressing serves as the core fabrication process, enabling strong bonding between diamond/cBN particles and metal/ceramic binders. These tools are ideal for finish machining of difficult-to-cut materials such as hardened steels and superalloys.
- **Ceramic Tools:** Si_3N_4, SiC, Al_2O_3-based ceramic tools. Vacuum hot pressing eliminates porosity, enhancing flexural strength and fracture toughness, offering a viable alternative to cemented carbides in high-speed cutting applications.

Display of industrial cutting tools in diverse materials and specifications. Dense, porosity-free cutting tips with smooth, clean edges – demonstrating how vacuum hot pressing refines grain structure and enhances strength-toughness balance. Designed for versatile machining applications across multiple sectors.

Complete Range of High-Performance Cutting Tools – Including Cemented Carbide Inserts, PCBN Tools, and Ceramic Cutting Blades.

Magnetic Materials

Vacuum hot pressing sintering enables the production of large-size, high-performance magnetic bulks, and is particularly suitable for permanent magnet and soft magnetic materials that demand high density and phase purity:

- **Rare-earth Permanent Magnets:** Nd-Fe-B, Sm-Co; vacuum hot pressing prevents rare-earth oxidation; high energy product and coercivity; for motors and sensors.
- **Soft Magnetic Materials:** Mn-Zn, Ni-Zn ferrites, Sendust, Permalloy; high density and low loss; for high-frequency inductors and transformer cores.
- **Metal-ceramic Composite Soft Magnets:** e.g., 865Fe6Si4Al35Ni/$MgFe_2O_4$; uniform phase dispersion; high saturation magnetization and high resistivity; reduced eddy current losses.

High density, high orientation degree, excellent corrosion resistance, high coercivity, and fine, uniform grain structure.

Hot-Pressed Sintered Nd-Fe-B Magnets

Magnetic Materials

Vacuum hot pressing sintering is a key technology for producing large-size, high-purity sputtering targets, meeting the stringent requirements of the semiconductor, display, and coating industries:

- **Metal Targets:** Refractory metals (Ta, Nb, Mo, W), high-purity metals (Al, Cu, Ti), and alloy targets (TiAl, NiCrAl). Vacuum hot pressing achieves high density and uniform grain structure, enhancing sputtering stability and film quality.
- **Ceramic Targets:** Oxides (Al_2O_3, ZrO_2, Y_2O_3), nitrides (Si_3N_4, AlN), and magnetic ceramics (PZT). Vacuum hot pressing prevents impurity introduction, producing high-purity, low-porosity targets for demanding applications.

The target surface is flat, dense, and free of bubbles or cracks, demonstrating the capability of vacuum hot pressing to achieve integrated sintering of ultra-high-purity raw materials. This ensures uniform composition and purity compliance, meeting the high-end coating requirements of the semiconductor and optoelectronics industries.

High-Purity Boron Targets: Purity ranging from 99.95% (3N5) to 99.999% (5N). Precisely controlled chemical composition with stable and consistent performance.

High-Purity Molybdenum Target Fabrication: Used in electronic components and products, including integrated circuits, information storage, liquid crystal displays, laser memory, and electronic control devices.

In addition to the four major application areas, the vacuum hot pressing sintering furnace offers versatile temperature and pressure control combined with vacuum forming advantages. It enables efficient, integrated densification of various high-performance specialty materials, addressing the needs of emerging industrial fields.

- **Advanced Ceramic Materials:** Structural ceramics (Si_3N_4, SiC, B_4C) and functional ceramics (piezoelectric, dielectric, and transparent ceramics), suitable for aerospace, electronics, optics, and other high-technology fields.

  Metals and Alloy Materials: Superalloys (Inconel, GH series), titanium alloys, refractory alloys, and others. Vacuum hot pressing enables densification forming of difficult-to-process metals for high-end structural components.

  Functionally Graded Materials: Metal-ceramic gradient components (e.g., stainless steel/ZrO_2). Through gradient hot pressing processes, continuous compositional and performance gradation is achieved, effectively resolving thermal expansion mismatch issues.

  Multiphase Ceramics / Cermets: Al_2O_3-ZrO_2, WC-Co, TiC-Ni, and other multiphase systems. Vacuum hot pressing enables synergistic multi-phase strengthening, significantly enhancing overall mechanical properties.

Special-shaped industrial components with complete structure, high density, and defect-free quality. Vacuum hot pressing enables versatile, customized production across diverse materials and applications – supporting the evolving demands of advanced materials and premium equipment sectors.

Physical images of advanced ceramic structural components, precision superalloy parts, and metal-ceramic composite components.

ADVANCED SINTERING TECHNOLOGY CENTER

Hydrogen Furnace

Safety Performance / Excellent Temperature Uniformity / Rapid Heating / High Temperature Control Precision

PROCESS OVERVIEW

Using high-purity hydrogen as a reducing atmosphere, the process deeply removes oxides and impurities from the surface of metal powders and green compacts at elevated temperatures, achieving reduction purification and surface activation of the materials. It effectively reduces oxygen content, enhances powder sintering activity, and improves the electrical and thermal conductivity of finished products–all without carbon contamination. This makes it ideal for pre-treatment of high-purity metal materials. Commonly used for pre-treatment of refractory metal powders such as tungsten and molybdenum, purification of copper- and silver-based metal powders, and reduction debinding of semiconductor packaging metal preforms, this process can be integrated with subsequent sintering and bonding steps to form a complete manufacturing chain.

HYDROGEN FURNACE (REDUCTION SINTERING FURNACE, HYDROGEN ANNEALING FURNACE)

Core Process and Equipment Features

- **Process Atmosphere:** High-purity hydrogen or hydrogen-nitrogen mixed reducing atmosphere, Operating temperature: 800–2000°C, and atmospheric to slight positive pressure operation, featuring strong reducing properties, high thermal conductivity, oxidation-free processing, and deoxidation/decarburization capability.
- **Core Functions:** Reduction of metal oxides, densification sintering in powder metallurgy, high-temperature purification of materials, stress-relief annealing, grain refinement, and removal of surface scale and impurities.

Full-Range Material Preparation and Processing

1. High-Purity Refractory Metals and Alloy Materials

- **Applicable Materials:** W, Mo, Ta, Nb, Zr, Hf and their alloys; W-Cu, Mo-Cu, W-Ni composites.
- **Process Value:** Oxide reduction, elimination of inclusions, low oxygen content, high purity and density, high-temperature strength, superior conductivity.
- **Applications:** Crucibles, electrodes, sputtering targets, vacuum components, semiconductor packaging substrates.

2. Iron / Copper / Nickel-Based Powder Metallurgy Metals

- **Applicable Materials:** Pure copper, oxygen-free copper, and tough-pitch copper; pure nickel and sintered nickel powder components; low-carbon iron-based and medium-to-high-strength iron-based powder metallurgy parts; as well as sintered brass and bronze alloys.
- **Process Value:** Reduces surface oxide layers on powders, enhances sintering densification, eliminates porosity, and improves electrical conductivity, wear resistance, and mechanical uniformity.
- **Application Products:** Precision hardware components, conductive terminals, powder metallurgy gears, and filters.

3. Cemented Carbides and Cermets

- **Applicable Materials:** WC-Co cemented carbides (full range), WC-Ni non-magnetic cemented carbides, and TiC-/TiN-based cermets.
- **Process Value:** Hydrogen atmosphere enables precise carbon control, preventing decarburization or carburization defects, refining grain structure, and enhancing both hardness and toughness of the alloys.
- **Application Products:** Cutting tools, dies, wear-resistant components, and non-magnetic precision parts.

4. Advanced Non-Oxide Structural Ceramics

- **Applicable Materials:** Aluminum nitride (AlN), silicon carbide (SiC), silicon nitride (Si_3N_4), and hexagonal boron nitride (h-BN) ceramics.
- **Process Value:** At elevated temperatures, the hydrogen atmosphere inhibits oxidation of ceramics, removes residual oxygen impurities from powders, and enhances ceramic density, thermal conductivity, and insulation stability.
- **Application Products:** High-thermal-conductivity ceramic substrates, high-temperature structural components, and insulating ceramic parts.

Model	H2MO14	H2W20
Chamber Size	200×200×300mm	200×200×300mm
Heater	MO	W
Ultimate Vacuum	6.7×10^{-4}Pa	6.7×10^{-4}Pa
Max. Temp.	1400°C	2000°C
Process Atmosphere	Nitrogen / Argon / Hydrogen	Nitrogen / Argon / Hydrogen

5. High-Purity Refractory Metals and Alloy Materials

- **Applicable Materials:** W, Mo, Ta, Nb, Zr, Hf and their alloys; W-Cu, Mo-Cu, W-Ni composites.
- **Process Value:** Oxide reduction, elimination of inclusions, low oxygen content, high purity and density, high-temperature strength, superior conductivity.
- **Applications:** Crucibles, electrodes, sputtering targets, vacuum components, semiconductor packaging substrates.

6. Semiconductor and Electronic Packaging Materials

- **Applicable Materials:** Silicon wafers, SiC wafers for hydrogen annealing, HTCC (high-temperature co-fired ceramics), ceramic metallization layers, thick-film circuit electrodes, and molybdenum-manganese metallization layers.
- **Process Value:** Passivates wafer surface defects, removes interfacial impurities, enhances bonding strength between metal layers and ceramics, and ensures packaging hermeticity.

7. Transparent Ceramics and Optical Functional Ceramics

- **Applicable Materials:** Activation and purification of magnesium-based and La-Ni-based hydrogen storage alloys; high-temperature impurity removal for lithium-ion battery graphite anodes and Si-C anodes; sintering and purification of ferrite soft magnetic and permanent magnetic materials.
- **Process Value:** Removes internal moisture, residual carbon, and impurities, enhancing material cycling stability and magnetic performance.

▲ **Hydrogen-Assisted Processing for Nd-Fe-B Magnets:** Promotes Nd diffusion at grain boundaries, inhibits grain growth, and delivers refined grain structure with enhanced magnetic properties.

▲ Clean treatment of metals, eliminating surface oxides and preventing further oxidation.

ADVANCED SINTERING TECHNOLOGY CENTER

Vacuum / Atmosphere / Debinding Sintering Furnace

Good Stability / Temperature Uniformity / Rapid Heating / Safety Performance / Strong Expandability

PROCESS OVERVIEW

In a high-vacuum environment, the high-temperature sintering process integrates multiple functions – debinding, degassing, oxidation prevention, and purification– into a single operation. Through stepped temperature control, organic components such as binders and plasticizers are first removed from the green body, followed by high-temperature densification of the material. Simultaneously, adsorbed gases and low-boiling-point impurities are eliminated, while oxidation and contamination are prevented throughout the entire process, ensuring high purity and superior performance. This process is widely used in refractory metal components, post-treatment of 3D-printed metal parts, high-purity alumina/aluminum nitride ceramics, magnetic materials, and other fields. It supports integrated batch processing from debinding to sintering, delivering excellent batch-to-batch consistency.

Model	V2GR20	V2MS17
Chamber Size	200×200×300mm	200×200×300mm
Heater	Isostatic Graphite	$MoSi_2$ Heating Elements
Ultimate Vacuum	6.7×10^{-3}Pa	6.7×10^{-3}Pa
Insulation Layer	Graphite Felt	Alumina Fiber Ceramics
Max. Temp.	2000°C	1700°C
Process Atmosphere	Nitrogen / Argon	Nitrogen / Argon / Oxygen

VACUUM / ATMOSPHERE / DEBINDING SINTERING FURNACE (INTEGRATED FURNACE FOR MIM/CIM)

Core Process and Equipment Features

- **Process Environment:** High vacuum, nitrogen, or argon inert atmosphere. Integrated low-temperature debinding and high-temperature sintering in a single process. Temperature range: 400–2000°C.
- **Core Functions:** Thoroughly removes binders from injection-molded parts; prevents oxidation and alloy element loss in vacuum or inert atmospheres; enables densification sintering of complex-shaped precision components. This is the core equipment for Metal Injection Molding (MIM) and Ceramic Injection Molding (CIM).

Full-Range Material Preparation and Processing

1. Full Range of MIM Alloys

- **Applicable Materials:** 316L and 304 stainless steels; 17-4PH and 15-5PH precipitation-hardening stainless steels; 430 and 420 ferritic stainless steels; Fe-Ni and Fe-Co soft magnetic alloys; Ti-6Al-4V and CP titanium medical titanium alloys; Inconel718 and Inconel625 nickel-based superalloys; tungsten alloys, copper alloys, and iron-based high-strength alloys.
- **Process Value:** Integrated debinding and sintering with no binder residue, high dimensional precision, high density, and smooth surface finish – ideal for mass production of miniature complex-shaped components.
- **Application Products:** Mobile phone structural parts, medical device components, precision hardware parts, and aerospace micro-components.

2. CIM Materials (Ceramic Injection Molding)

- **Applicable Materials:** Alumina (Al_2O_3) and zirconia (ZrO_2)-toughened ceramics; silicon carbide (SiC) and silicon nitride (Si_3N_4) high-performance structural ceramics; piezoelectric, dielectric, and thermistor ceramics; porous ceramics and ceramic filter elements.
- **Process Value:** Low-temperature slow debinding prevents cracking of green bodies; high-temperature sintering ensures uniform densification, enabling the forming of complex ceramic shapes.
- **Application Products:** Ceramic valve cores, sensor ceramics, electronic ceramic components, and wear-resistant ceramic structural parts.

3. Cemented Carbides and Dense Powder Metallurgy Materials

- **Applicable Materials:** Ultra-fine-grained WC-Co cemented carbides, gradient cemented carbides, cermets, and powder metallurgy high-speed steels.
- **Process Value:** Vacuum sintering eliminates porosity, precisely controls carbon content, and enhances wear resistance and impact toughness of the alloys.
- **Application Products:** Precision cutting tools, micro-molds, and mining wear parts.

4. Carbon-Based and New Energy Materials

- **Applicable Materials:** High-purity graphite, carbon nanotube composites, graphene-modified materials; lithium-ion battery cathode and anode materials, supercapacitor electrode materials; phosphors and luminescent ceramic materials.
- **Process Value:** Inert atmosphere protects carbon-based materials from oxidation; high-temperature purification enhances electrochemical performance and stability.

5. Precious Metals and Precision Annealing Materials

- **Applicable Materials:** Precision parts made of gold, silver, platinum, and palladium precious metals; annealed components of precision spring steel and bearing steel.
- **Process Value:** Vacuum annealing ensures oxidation-free processing, relieves internal stress, preserves a bright surface finish, and eliminates oxidation discoloration and impurity contamination.

▲ **Structural Ceramics:** Nuclear reactor neutron absorbers, photocatalyst supports; battery anode materials, high-temperature power semiconductors, and nuclear radiation detectors.

▲ **Powder Metallurgy:** Preparation of metal materials, composite materials, and other material systems. Applications include ceramic materials such as turbine blades and engine components, wear-resistant parts like brake pads and clutch plates, as well as biocompatible materials for implants and other medical devices.

Gas Pressure Sintering Furnace (GPS)

Temperature Uniformity / Rapid Heating / Safety Performance / Controllable Microstructure

PROCESS OVERVIEW

High-pressure inert or reactive gas is introduced into the sealed furnace chamber, enabling high-temperature sintering under controlled gas pressure. The high-pressure environment effectively suppresses volatilization of low-melting-point components at elevated temperatures, ensuring compositional uniformity while promoting densification and enhancing mechanical properties and structural reliability of the products. This process is primarily applied in the fabrication of high-performance structural ceramics such as silicon nitride (Si_3N_4) and silicon carbide (SiC). It is particularly suitable for mass production of semiconductor wafer handling components, high-temperature insulating structural parts, and premium cutting tools that demand exceptional strength and thermal stability.

Model	G2VGR20
Chamber Size	Φ200×250mm
Gas Pressure	9.8MPa
Heater	Isostatic Graphite
Ultimate Vacuum	10Pa
Max. Load	50Kg
Max. Temp.	2000°C

GAS PRESSURE SINTERING FURNACE (GPS)

Core Process and Equipment Features

- **Process Environment:** High-purity nitrogen or argon high-pressure atmosphere, pressure range 1–10 MPa, maximum temperature 2000°C.
- **Core Functions:** The high-pressure atmosphere suppresses material decomposition and volatilization at elevated temperatures, significantly enhances sintering densification, and refines grain structure. It effectively addresses the limitations of conventional atmospheric sintering – such as high porosity and insufficient performance – making it a core production equipment for high-performance structural ceramics and premium cemented carbides.

Full-Range Material Preparation and Processing

1. FHigh-Performance Nitride Structural Ceramics (Core Focus)

- **Applicable Materials:** Silicon nitride (Si_3N_4), aluminum nitride (AlN), boron nitride (BN) composite ceramics, and Sialon ceramics – materials that are difficult to densify under conventional atmospheric sintering.
- **Process Value:** High-pressure nitrogen effectively suppresses decomposition of nitrides at elevated temperatures, promotes dense grain growth, and achieves relative density exceeding 99%. This significantly enhances ceramic toughness, high-temperature resistance, wear resistance, and thermal conductivity.
- **Application Products:** Ceramic bearings, high-speed cutting tools, engine turbine components, high-thermal-conductivity heat dissipation substrates, and military protective ceramics.

2. Carbide-Based Superhard Ceramic Materials

- **Applicable Materials:** Silicon carbide (SiC), boron carbide (B_4C), titanium carbide (TiC), zirconium carbide (ZrC) ceramics, and their composite systems.
- **Process Value:** High-pressure argon atmosphere prevents oxidation and decomposition of carbides, enabling the production of superhard ceramics with high hardness, excellent wear resistance, and superior impact toughness.
- **Application Products:** Ballistic ceramics, armor plates, wear-resistant nozzles, high-temperature kiln furniture, and precision abrasive tools.

3. High-End Cemented Carbides and Cermets

- **Applicable Materials:** Ultra-fine-grained WC-Co cemented carbides, low-cobalt high-hardness cemented carbides, TiC-Ni and TiN-TiC composite cermets.
- **Process Value:** High-pressure sintering closes internal pores, homogenizes the alloy microstructure, and enhances hardness, transverse rupture strength, and wear resistance–while eliminating decarburization defects.
- **Application Products:** High-end CNC cutting tools, precision dies, and wear-resistant components for oil and mining applications.

4. Refractory Metals and Dense Superalloy Materials

- **Applicable Materials:** Sintered components of refractory metals such as tungsten (W), molybdenum (Mo), tantalum (Ta), and niobium (Nb); powder metallurgy components of nickel-based and cobalt-based superalloys.
- **Process Value:** High-pressure atmosphere promotes dense bonding between powder particles, reduces porosity, and enhances high-temperature mechanical stability.

5. Metal-Matrix and Ceramic-Matrix Composite Materials

- **Applicable Materials:** SiC particle-reinforced aluminum-matrix and copper-matrix composites; ceramic-ceramic multiphase materials; fiber-reinforced ceramic composites.
- **Process Value:** Under high pressure, tight bonding between matrix and reinforcement is achieved with no delamination or porosity, significantly improving the overall mechanical properties of the composite materials.

▲ Tungsten-Copper Composite Materials: Combining the high melting point, low thermal expansion, and wear resistance of tungsten with the high electrical/thermal conductivity and machinability of copper. Applications include electrical contact alloys for high-voltage switches, EDM electrodes, military high-temperature materials, and microelectronic materials.

▲ Porous Silicon Nitride Ceramics: Suitable for gas / liquid fluid filters, catalyst supports, separation membranes, broadband wave-transparent materials, composite reinforcement structures, heat exchangers, bioreactors, and tissue engineering scaffolds – specifically for applications in high-temperature and corrosive environments.

Hot Isostatic Pressing (HIP) Furnace

Optimized Design / Temperature Uniformity / Rapid Heating / High Pressure Precision / Safety Performance

PROCESS OVERVIEW

Using high-pressure argon or other inert gases as the pressure transmission medium, the process applies uniform, isotropic high pressure to workpieces at elevated temperatures. The pressure is applied uniformly without directionality, effectively eliminating internal defects such as porosity and shrinkage, achieving near-theoretical full densification. This significantly enhances strength, toughness, fatigue resistance, and performance uniformity – even for components with complex geometries. It is widely used in semiconductor precision ceramic components, aerospace superalloy parts, post-densification of 3D-printed products, and high-end thermal management materials. This process can serve both as a standalone sintering method and as a post-treatment step for performance enhancement of finished parts.

Model	I2CC20
Chamber Size	Φ200×250mm
Gas Pressure	200MPa
Heater	C/C
Ultimate Vacuum	10Pa
Max. Load	50Kg
Max. Temp.	2000°C

HOT ISOSTATIC PRESSING (HIP)

Core Process and Equipment Features

- **Process Environment:** High-purity argon atmosphere, temperature range 800–2000°C, pressure 100–200 MPa, with uniform isostatic pressure application.
- **Core Functions:** Completely eliminates internal defects such as closed pores, microcracks,and porosity – achieving near-100% full densification without altering the external dimensions of the workpiece. This significantly enhances fatigue strength, toughness, and service life. It is the premier process equipment for densification and defect remediation of high-end components.

Full-Range Material Preparation and Processing

1. Aerospace-Grade Titanium Alloys and Superalloys

- **Applicable Materials:** TC4 (Ti-6Al-4V), TC11, and TA15 titanium alloys; Inconel718, Inconel625, GH4169, and GH3536 nickel-based superalloys; duplex stainless steels and super austenitic stainless steels.
- **Process Value:** Eliminates internal porosity and microcracks in forged, cast, and 3D-printed components; increases fatigue life by 3–5 times; and homogenizes internal stress distribution.
- **Application Products:** Aircraft turbine discs, blades, engine combustion chambers, aerospace structural components, and high-end pressure vessels.

2. Advanced Structural and Transparent Ceramics

- **Applicable Materials:** Alumina, zirconia, silicon nitride, and silicon carbide structural ceramics; YAG, alumina, and sapphire transparent ceramics; multiphase toughened ceramics.
- **Process Value:** Closes internal micropores in ceramics, enhancing optical transmittance, density, and fracture toughness – effectively addressing issues of brittleness and defects commonly found in conventionally sintered ceramics.
- **Application Products:** Optical windows, precision ceramic components, and military transparent protective parts.

3. Superhard Cutting Tools and Cemented Carbide Materials

- **Applicable Materials:** Ultra-fine-grained WC-Co cemented carbides; PCD (polycrystalline diamond) composite blanks; and CBN (cubic boron nitride) superhard composite materials.
- **Process Value:** Completely eliminates internal micropores in cutting tools, significantly enhancing wear resistance and impact toughness – effectively preventing edge chipping and fracture during application.
- **Application Products:** High-end CNC cutting tools, mining and drilling tools, and precision abrasive tools.

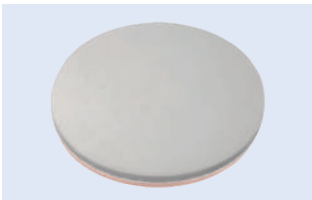
4. Materials for Additive Manufacturing Post-Processing

- **Applicable Materials:** 3D-printed components made of titanium alloys, superalloys, stainless steels, and aluminum alloys.
- **Process Value:** Addresses the critical industry challenges of interlayer porosity and high void content in as-printed parts. Densification is enhanced to above 99.9%, with mechanical properties reaching forged-component standards.

5. Fully Dense High-End Powder Metallurgy Components

- **Applicable Materials:** Powder metallurgy nickel-based alloys, tungsten-based alloys, copper-based high-strength conductive alloys, and magnetic alloys.
- **Process Value:** Eliminates the need for high-pressure uniaxial pressing. Isostatic pressure achieves uniform densification throughout the entire component, balancing high dimensional precision with superior mechanical performance.

▲ **High-Strength Metallic Structural Components:** Turbine blades, aircraft landing gear, combustion chamber materials, and other critical structural parts.



▲ **High-Performance Ceramic Materials:** Aluminum nitride (AlN) ceramic sputtering targets, power device substrates, and optical communication components.

Vacuum Diffusion Bonding Furnace

Temperature Uniformity / Rapid Heating / High Pressure Precision / Safety Performance

PROCESS OVERVIEW

In a high-vacuum environment, without the use of solder or filler materials, the process relies on the combined action of elevated temperature and pressure to promote interdiffusion and metallurgical bonding of atoms at the contact surfaces of workpieces –forming permanent, homogeneous or heterogeneous joints. The joint microstructure is consistent with that of the base material, with no interfacial defects or residue, and offers excellent hermeticity and mechanical properties. The overall heating of the workpiece results in minimal thermal deformation, enabling precise dimensional control. This process is particularly suitable for the reliable joining of dissimilar materials, such as dissimilar metals and ceramic-to-metal assemblies. It is widely used in the custom development and batch processing of precision components including power module thermal management assemblies, vacuum-sealed enclosures, water-cooled heat spreaders, and microwave devices.

Model	D2MO14	D2GR20
Chamber Size	200×200×300mm	200×200×300mm
Mechanical Pressure	5T	5T
Ram Stroke	100mm	100mm
Platen Dimensions	120×120mm	120×120mm
Heater	MO	Isostatic Graphite
Ultimate Vacuum	6.7×10^{-4}Pa	6.7×10^{-3}Pa
Max. Temp.	1400°C	2000°C

VACUUM DIFFUSION BONDING FURNACE (SOLID-STATE VACUUM DIFFUSION BONDING)

Core Process and Equipment Features

- **Process Environment:** High-vacuum environment, with elevated temperature and low-to-medium solid-state pressure – no brazing filler, no liquid phase melting.
- **Core Functions:** Relies on atomic diffusion at elevated temperatures to achieve solid-state metallurgical bonding – no thermal deformation, no heat-affected zone, and no alteration of the base material's microstructure or properties. Enables seamless joining of both similar and dissimilar materials, making it ideal for the fabrication of composite components requiring high precision, high hermeticity, and high reliability.

Full-Range Material Preparation and Processing

1. General Structural Metal Bonding (Similar Materials)

- **Applicable Materials:** 304 and 316L stainless steels; 6061, 6063, and 7075 aluminum alloys; pure copper and brass copper alloys; TC4 and CP titanium alloys; 20# and 45# carbon steels; spring steel and bearing steel.
- **Process Value:** Weld microstructure is consistent with the base material, delivering high strength, excellent hermeticity, and freedom from porosity or cracks – making it ideal for precision cavities and sealed components.

2. Dissimilar Metal Joining (Core Strength)

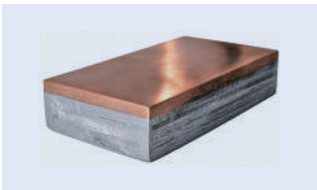
- **Applicable Materials:** Titanium alloy to stainless steel, titanium alloy to aluminum alloy, copper to aluminum, copper to steel, nickel-based alloy to stainless steel, tungsten-copper dissimilar composites, molybdenum-copper dissimilar composites, and high-entropy alloy to titanium alloy.
- **Process Value:** Overcomes the challenges of fusion bonding for dissimilar metals with significant differences in melting point and thermal expansion coefficient – enabling high-strength, seamless composite joining.
- **Application Products:** Composite heat spreader plates, conductive composite components, and aerospace dissimilar-material structural parts.

3. Ceramic-to-Metal Sealing and Composite Joining

- **Applicable Materials:** Alumina (Al_2O_3), zirconia (ZrO_2), and silicon carbide (SiC) ceramics joined to Kovar, titanium, copper, nickel, and stainless steel.
- **Process Value:** The vacuum environment prevents interfacial oxidation, ensuring high bond strength, excellent hermeticity, reliable high-temperature resistance, and stable electrical insulation performance.
- **Application Products:** Vacuum devices, semiconductor packages, sensor bases, and high-voltage ceramic electrodes.

4. Functional Composite Materials and Hard Composite Structures

- **Applicable Materials:** Diamond-copper and diamond-aluminum high-thermal-conductivity composites; cemented carbide-steel mold composite structures; graphite-metal composite components; and carbon-fiber-composite-to-metal joints.
- **Process Value:** Preserves the individual superior properties of each material, achieving complementary functionality – combining wear resistance, thermal conductivity, and high strength in a single integrated component.
- **Application Products:** High-end heat dissipation devices, precision molds, tool substrates, and lightweight aerospace structural components.



· Copper-diamond composites, copper-molybdenum / copper-tungsten alloys, copper-aluminum dissimilar joints, and metal-ceramic composite substrates.
· High-end heat dissipation substrates for AI chips, core components for high-power immersion liquid cooling systems, and ultra-high-thermal-conductivity heat spreaders using dissimilar materials.
Features: Solder-free, atomic-level bonding, low thermal resistance – specifically designed for premium AI thermal management applications.

KEY LABORATORY OF SPECIALTY BONDING

Vacuum Brazing Furnace

High Stability / Temperature Uniformity / High Chamber Cleanliness / Rapid Heating / Safety Performance

PROCESS OVERVIEW

In a high-vacuum, contamination-free environment, a filler metal with a melting point lower than that of the base material is used. Through heating, the filler metal melts and is drawn into the joint gap by capillary action, forming a strong metallurgical bond upon cooling. The process ensures uniform heating, minimal workpiece deformation, and clean, dense, hermetic seams – with the ability to simultaneously weld multiple joints and multiple components in a single cycle, making it ideal for complex structural assemblies. This process is widely used for vacuum chambers in semiconductor equipment, heat exchangers, thermal management modules, cemented carbide cutting tools, precision sensor assemblies, and vacuum-sealed connectors. It supports customized, high-volume batch processing across a wide range of materials and product types, offering flexible and reliable contract manufacturing services.

Model	V2MO13
Chamber Size	200×200×300mm
Heater	MO
Ultimate Vacuum	6.7×10^{-4}Pa
Max. Temp.	1300°C
Temp. Uniformity	±3°C

VACUUM BRAZING FURNACE (LIQUID-PHASE VACUUM BRAZING)

Core Process and Equipment Features

- **Process Environment:** High vacuum (10^{-4}~10^{-6} Pa), with brazing filler metal melting and wetting the base material at elevated temperatures, then filling the joint gap via liquid-phase capillary action to achieve a robust metallurgical bond.
- **Core Functions:** Precision joining is achieved through wetting and diffusion of the brazing filler metal, resulting in minimal bonding distortion, smooth and clean seam surfaces, and excellent hermeticity. The process is ideally suited for thin-walled, precision, complex-cavity, and porous structural components, while also enabling simultaneous annealing, degassing, and purification of the workpieces.

Brazable Materials and Component Systems

1. Precision Brazing of Various Structural Metals

- **Applicable Materials:** 304/316L stainless steels, duplex stainless steels, titanium alloys, aluminum alloys, copper alloys, nickel-based alloys, carbon steels, mold steels, and high-speed steels.
- **Process Value:** Vacuum environment ensures oxidation-free processing; Bonding seams are free from scale and inclusions, with excellent corrosion resistance and high strength.
- **Application Products:** Vacuum heat exchangers, cooling chambers, precision tubing, aerospace thin-wall structures, and heat sinks.

2. Specialized Brazing for Cemented Carbides and Cutting Tools

- **Applicable Materials:** WC-Co cemented carbide tips + steel shanks; PCD diamond cutting bodies + substrates; CBN tool composite brazing; Mining rock drilling tools; Wear-resistant alloy components.
- **Process Value:** Uniform wetting of the brazing filler; Full, defect-free seams; High bonding strength; Cutting tools exhibit excellent high-temperature resistance and impact toughness.

3. Ceramic-to-Metal Vacuum Hermetic Sealing

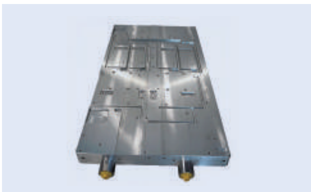
- **Applicable Materials:** Alumina (Al_2O_3), zirconia (ZrO_2), and aluminum nitride (AlN) ceramics brazed/sealed to copper, nickel, Kovar, and stainless steel.
- **Process Value:** Achieves high-hermeticity insulating seals with no leakage and no interfacial defects – suitable for high-voltage, vacuum, and high-temperature operating conditions.
- **Application Products:** Ceramic vacuum feedthroughs, sensor packages, microwave devices, and aerospace sealing components.

4. Brazing of Refractory Metals and Specialty Materials

- **Applicable Materials:** Easily oxidized refractory metals such as tantalum (Ta), niobium (Nb), zirconium (Zr), beryllium (Be), tungsten (W), and molybdenum (Mo); precious metal precision parts made of gold, silver, and platinum.
- **Process Value:** The high-vacuum environment completely prevents oxidation, overcoming the difficulty of conventional bonding for refractory metals – ensuring stable performance of components.
- **Application Products:** Specialty vacuum devices, military precision components, and tantalum capacitor elements.

5. Brazing of Porous, Honeycomb, and Complex-Structure Components

- **Applicable Materials:** Aluminum honeycomb panels, stainless steel porous filter elements, multi-layer composite heat dissipation structures, and custom-shaped precision cavities.
- **Process Value:** Low-temperature brazing ensures minimal deformation, uniform gap filling, and excellent batch-to-batch consistency – making it ideal for mass production of precision lightweight components.



· Oxygen-free copper, tough-pitch copper, 6061 aluminum alloy, and standard stainless steel.
· Conventional copper micro-channel cold plates, aluminum liquid-cooled plates, CDU heat exchangers, water-cooled backplanes, and IGBT liquid-cooling thermal modules.
Features: Brazed with filler metal, standard liquid-cooling components, high-volume production, and general-purpose design.

Spark Plasma Sintering (SPS) System

Temperature Uniformity / Rapid Heating / Short Sintering Cycle / High Production Efficiency / Controllable Microstructure / Energy-Efficient & Environmentally Friendly

Applicable Materials:

Semiconductor ceramic substrates, high-thermal-conductivity ceramics (silicon nitride, alumina, aluminum nitride), silicon carbide ceramics; electronic functional ceramics, piezoelectric ceramics, high-purity sputtering targets (copper, aluminum, titanium, precious metals), ceramic packaging substrates, cemented carbides, metal-ceramic composites, and powder metallurgy alloys.

Model	S-300
Effective Working Zone	Φ400×800mm
Sample Dia.	Φ300mm
Mechanical Pressure	300T
Ram Stroke	200mm
Heater	SPS
Ultimate Vacuum	5Pa
Max. Temp.	2200°C

Vacuum Hot Pressing Sintering Furnace

Optimized Design / Temperature Uniformity / Rapid Heating / High Pressure Precision / Safety Performance

Model	P5VGR22
Effective Working Zone	Φ500×700mm
Sample Dia.	Φ300mm
Mechanical Pressure	300T
Ram Stroke	Upper 200 mm + Lower 200 mm
Heater	Isostatic Graphite
Ultimate Vacuum	6.7×10^{-3}Pa
Max. Temp.	2200°C

Applicable Materials:

Semiconductor heat-dissipation ceramic components, insulating structural parts, high-density ceramics (silicon nitride, silicon carbide, boron carbide), cermet components, precision powder metallurgy alloys, semiconductor sputtering targets, electronic functional ceramics, ceramic-metal composite substrates, copper-diamond heat dissipation materials, and alumina / aluminum nitride electrostatic chucks.

Vacuum Diffusion Bonding Furnace

Temperature Uniformity / Rapid Heating / High Pressure Precision / Safety Performance / Fast Cooling

Model	D4MO14
Platen Size	400×400mm
Mechanical Pressure	150T
Ram Stroke	100mm
Gas Cooling Pressure	2Bar
Heater	MO
Ultimate Vacuum	6.7×10^{-4}Pa
Max. Temp.	1400°C

Applicable Bonding Materials / Components:

Ceramic-metal composite assemblies, aerospace-grade semiconductor interconnects, high-precision hermetic seals, molybdenum-copper / tungsten-copper heat spreaders, vacuum electronic components, integrated circuit thermal management assemblies, new energy power devices, and precision brazed cemented carbide components.

Vacuum Brazing Furnace

High Stability / Temperature Uniformity / High Chamber Cleanliness /
Rapid Heating / Safety Performance / Strong Expandability

Model	V4MO13
Effective Working Zone	400×400×600mm
Heater	MO
Ultimate Vacuum	6.7×10^{-4}Pa
Max. Load	100kg
Max. Temp.	1300°C
Temp. Uniformity	±3°C

Applicable Bonding Materials / Components:

AMB brazing, IGBT power modules, water-cooled heat dissipation cavities, copper-aluminum dissimilar metal bonding, Mo-Cu, W-Cu heat spreaders, precision semiconductor sealing components, integrated circuit thermal management assemblies, new energy power devices, and precision brazed cemented carbide components.

HUAYUE

Jiangsu Huayue Semiconductor Technology Co., Ltd

Address: Building 4, Jufeng Science and Technology Innovation Industrial Park, Tongzhou District, Nantong City

Phone: 86-189 1747 2276 **Email:** sales@huayuesemi.com

Official Website: www.huayuesemi.com

HUAYUE
Official WeChat Account

Scan to Add WeChat