OPTIC-WELL

Diamond Materials Lead Future Technology

.CVD Diamond Wafer

.High Thermal Conductivity Heat Spreader

.CVD Diamond Optical Window

.Monocrystalline & Polycrystalline CVD Diamond

Chengdu Optic-Well Co,.Ltd
www.opticwell.com

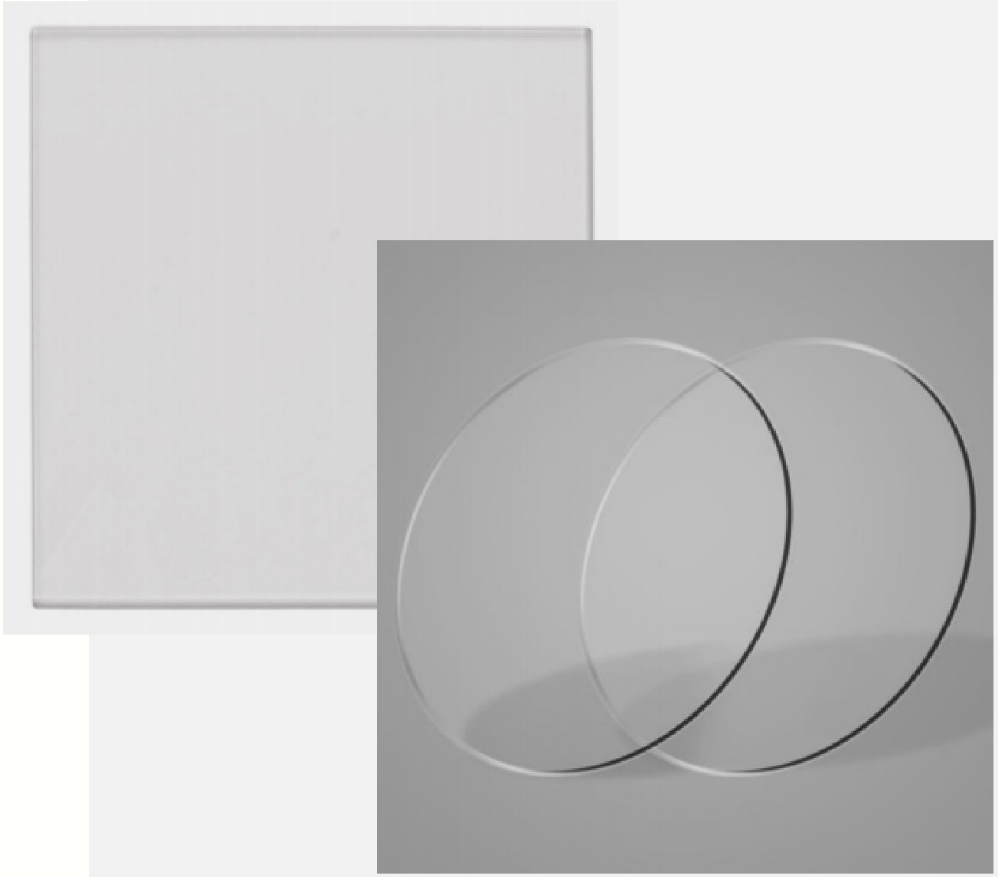
Ili Company Overview

CVD (chemical vapor deposition) diamond is an advanced material for future high-tech fields. With its ultra-high thermal conductivity, excellent mechanical strength, outstanding optical transparency and insulation properties, CVD diamond performs well in electronic devices, quantum computing, optical systems and high-power heat dissipation.

Chengdu Opticwell Co., Ltd. is a high-tech enterprise focusing on the research and development of afull set of diamond wafer technologies. The company is committed to promoting the innovative application of diamond materials through CVD technology. Starting from the basic science and technology of diamond growth, the company provides customers with highly consistent and high-quality solutions, promotes the miniaturization and efficiency of electronic devices, and becomes an important support in the fields of lasers, communications, AI chips, new energy vehicles, energy storage, etc., enabling the infinite possibilities of future technology.。

III Ultra-high thermal conductivity optical grade monocrystal diamond wafer

- Size: 3~25mm;
- Thermal conductivity: >2100 W/(m·K), excellent heat dissipation performance;
- Optical transparency: >95% transmittance, suitable for high-precision optical applications;
- Monocrystal structure: excellent crystal integrity, ensuring high performance;
- Thickness: 0.5mm~3mm, customizable;
- Low thermal expansion coefficient: <1.0×10^{-6}/K, greatly reducing thermal stress;
- Mechanical strength: >90 GPa, excellent durability and stability;
- Application areas: high-power lasers, optoelectronic devices and quantum computing, etc.



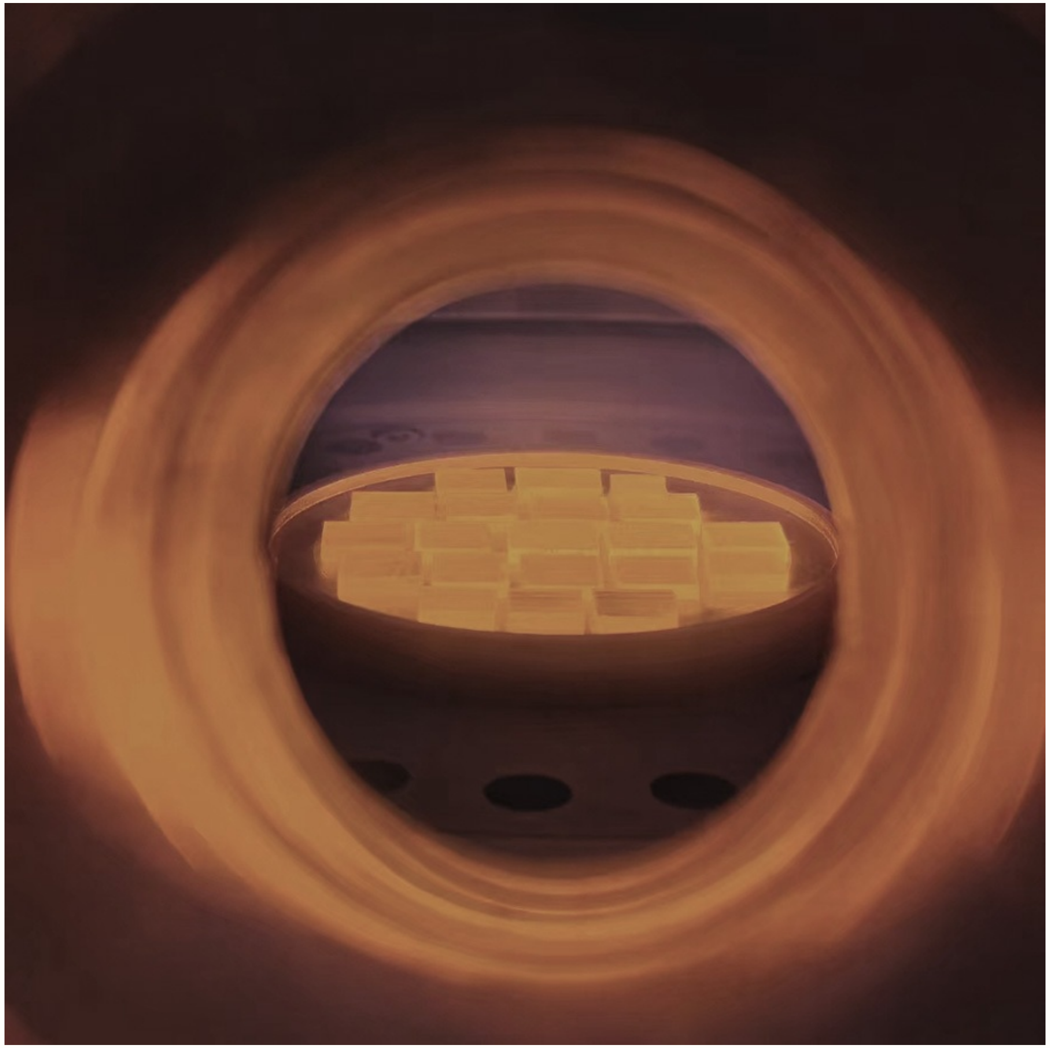
Ⅲ Ultra-high thermal conductivity optical grade polycrystalline diamond wafer

- Thermal conductivity: up to 1600 W/(m·K), excellent heat dissipation performance;
- Polycrystalline structure: optimize crystal arrangement and improve material consistency;
- Size range: up to 100mm diameter, meeting large-scale application needs;
- Thickness selection: 0.5mm~2mm, can be customized.

- Optical transparency: ≥90% transmittance, suitable for high-end optical applications;
- Low thermal expansion coefficient: <1.0×10-6/K, reducing the risk of thermal stress;
- Mechanical strength: >80 GPa, providing superior durability and stability;

High thermal conductivity monocrystal diamond wafer

- Size: 3~25mm;
- Thermal conductivity: >1500 W/(m·K);
- Monocrystal structure: excellent crystal integrity, ensuring high performance;
- Thickness range: 0.5mm~5mm, flexible to meet different needs;
- Low thermal expansion coefficient: <1.0×10–6/K, greatly reducing thermal stress;
- Mechanical strength: >90 GPa, excellent durability and stability;
- Application areas: high–power electronic equipment, laser systems, heat dissipation management, etc.;
- Metalization: customizable.



lli High thermal conductivity polycrystalline diamond wafer

- Thermal conductivity: ~1300 W/(m·K), providing good heat dissipation performance;
- Polycrystalline structure: standard crystal structure arrangement, high material consistency;
- Size range: ~100mm diameter, meeting large-scale application needs;
- Thickness selection: 0.5mm~3mm, can be customized;
- Low thermal expansion coefficient: <1.0×10−6/K, reducing the impact of thermal stress;
- Mechanical strength: >70 GPa, providing good durability and stability;
- Application areas: high-power electronics, laser cooling, heat dissipation management, etc.;
- Metalization: can be customized.

lli Customized Diamond Wafer Parameters 1

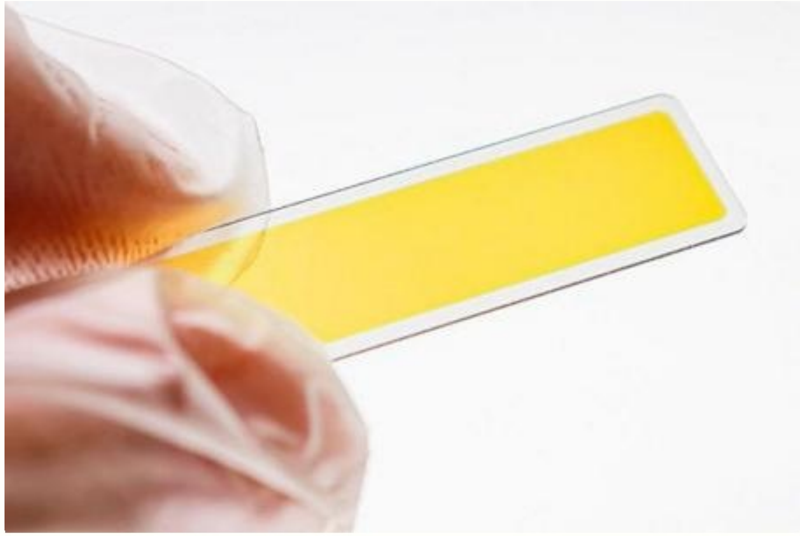
Properties	Optical Grade		Heat sink Grade	
	Polycrystal	Monocrystal	Polycrystal	Monocrystal
Growth method	MPCVD	MPCVD	MPCVD	MPCVD
Size (mm)	Φ50~Φ100	3~25	Φ50~Φ100	3~25
Spectral transmittance (1mm thickness)	>65%@ λ>500nm	>72%@ λ>500nm	/	/
Absorption coefficient (cm^{-1})	<0.12@ λ=1.06μm <0.07@ λ=10.6μm	<0.10@ λ=1.06μm <0.05@ λ=10.6μm	/	/
Thermal conductivity (W/mk@300K)	>1600	>2100	>1200	>1500
Coefficient of thermal expansion (10^{-6}/K@300K)	1.02	0.9	1.1	0.95
Young's hardness (GPa)	1050	1060~1200	1010	1060~1200
Vickers hardness (GPa)	80	75~120	80	75~120
Grain size (μm)	⩽10	/	⩽20	/

Customized Diamond Wafer Parameters 2

Properties	Optical Grade		Heat sink Grade	
	Polycrystal	Monocrystal	Polycrystal	Monocrystal
Thickness (mm)	⩾1	⩾0.3	⩾0.2	⩾0.1
Thickness tolerance (mm)	±0.03	±0.02	±0.03	±0.02
Parallelism (μm/cm)	⩽5	⩽4	⩽8	⩽4
Flatness PV value (interference fringes/cm@633nm)	⩽1	⩽1/3	⩽2	⩽2/3
Roughness (nm)	⩽10	⩽1	⩽30	⩽5
Warp (μm/cm)	⩽4	/	/	/
TTV (μm)	<15	<5	<15	<5
Dielectric constant	5.5±0.2@140GHz	5.5±0.2@140GHz	5.5±0.2@140GHz	5.5±0.2@140GHz
Dielectric loss	$<8*10^{-5}$@GHz	$<4*10^{-5}$@GHz	$<5*10^{-4}$@GHz	$<2*10^{-4}$@GHz

Ⅲ Applications – Diamond Laser Optical Output Window

The diamond window not only has excellent light transmittance at the pump wavelength, but also has thermal conductivity that is unmatched by other materials. The ultra–high thermal conductivity of CVD diamond enables it to quickly disperse the heat generated by the laser medium to the surrounding environment. Through the precise polishing process, the close contact between the diamond window and the laser crystal further enhances the heat conduction and improves the efficiency and accuracy of the laser output.

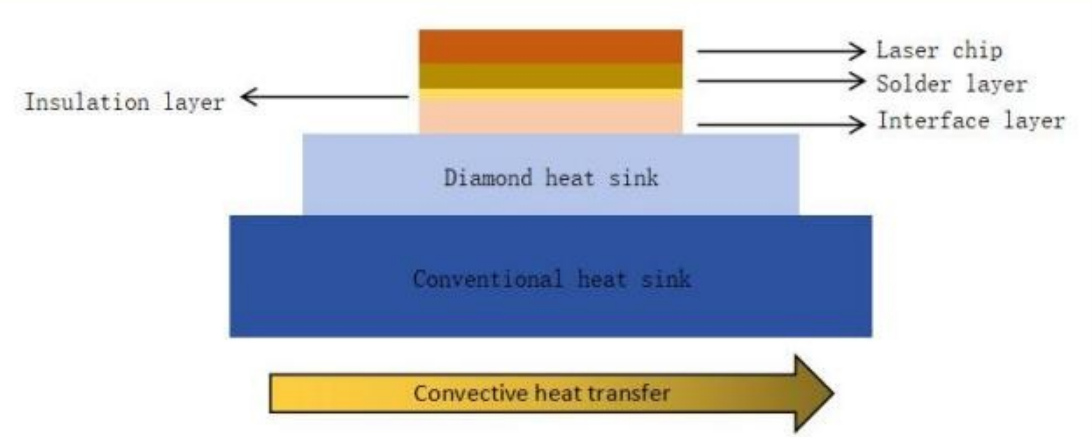


When the temperature of the optical material reaches a certain high level, the thermal lens effect will destroy the ability to control the beam profile. When the laser is working, the effective conversion r ate of the pump energy is usually no more than 30%, which means that a large amount of energy is converted into heat and needs to be processed quickly to avoid the impact of temperature increase on laser efficiency. The application of CVD diamond in the laser window can effectively reduce the thermal lens effect.

Ⅲ Application – High power laser chip

In the packaging of high-power semiconductor lasers, the higher the thermal conductivity of the transition heat sink, the more conducive it is to reducing the thermal resistance of the laser.

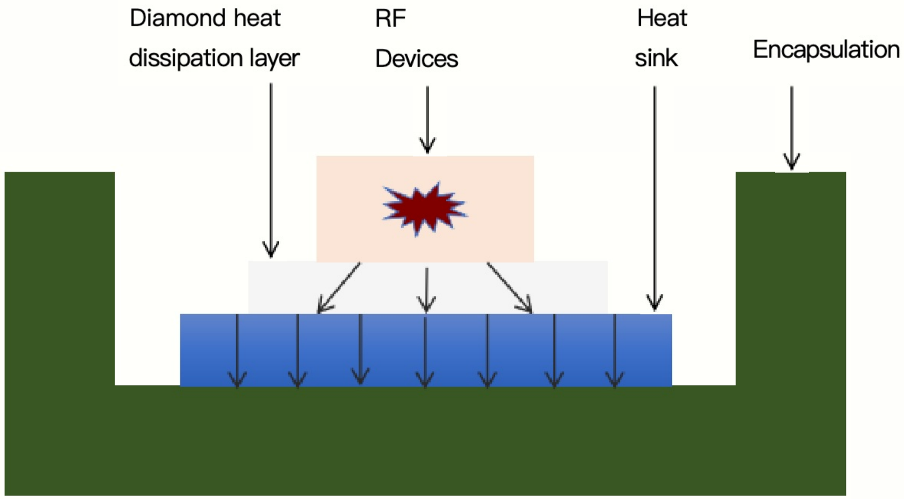
Diamond exhibits excellent heat dissipation characteristics: on the one hand, the heat concentrated in the PN junction of the device can be evenly and quickly diffused along the surface of the heat sink; on the other hand, the heat is quickly discharged along the vertical direction of the heat sink.

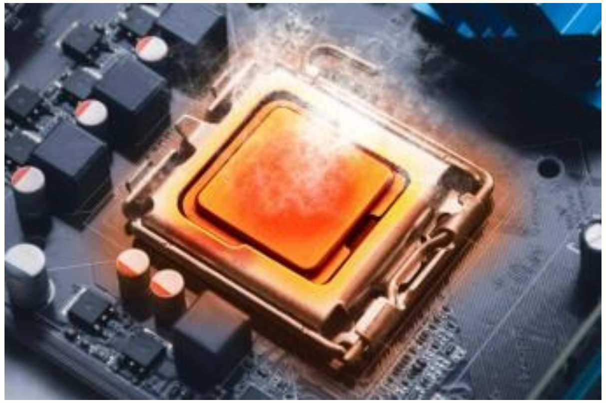


lli Application – RF device thermal management

1. Diamond heat sinks reduce peak temperature by rapidly reducing heat flux density on active devices (such as GaN chips);
2. Low dielectric constant can effectively reduce parasitic capacitance;
3. Low thermal expansion coefficient can ensure the linear performance of stable device operation;
4. Especially suitable for high-power amplifiers.

GaN has become the core of modern wireless communication systems due to its excellent electrical properties and high power density. By combining GaN with a diamond substrate, overheating and voltage problems can be effectively solved. Diamond's ultra-high thermal conductivity allows heat to be conducted quickly, thereby reducing the thermal stress of GaN devices and ensuring that they can operate stably under high loads. In addition, the power density of GaN-on-Diamond MOSFET can be three times that of when diamond is not used, greatly improving the overall efficiency of the system. This feature not only improves the performance of wireless communication equipment, but also reduces its size, adapting to the needs of modern miniaturization and high integration.



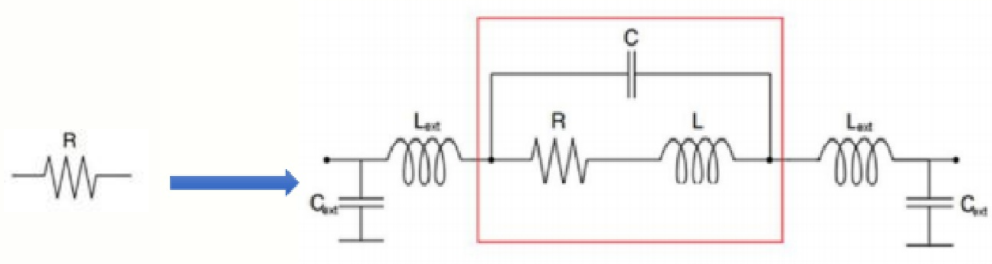


lli Applications – RF Thin Film Resistors

In RF working mode, the parasitic capacitance and inductance of the resistor are very obvious, and its nonlinearity can easily cause component signal distortion. Among them, the capacitive reactance has the greatest impact. The contradiction is:

In order to reduce the capacitive reactance, the surface area of the resistor needs to be reduced.

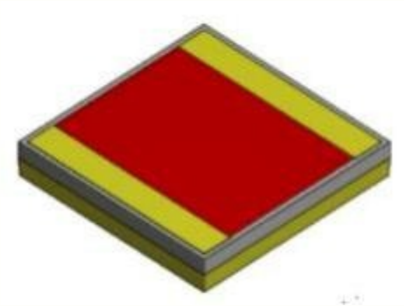
In order to accelerate heat dissipation, the surface area of the resistor needs to be increased.



Practical Equivalent Model of RF Resistors

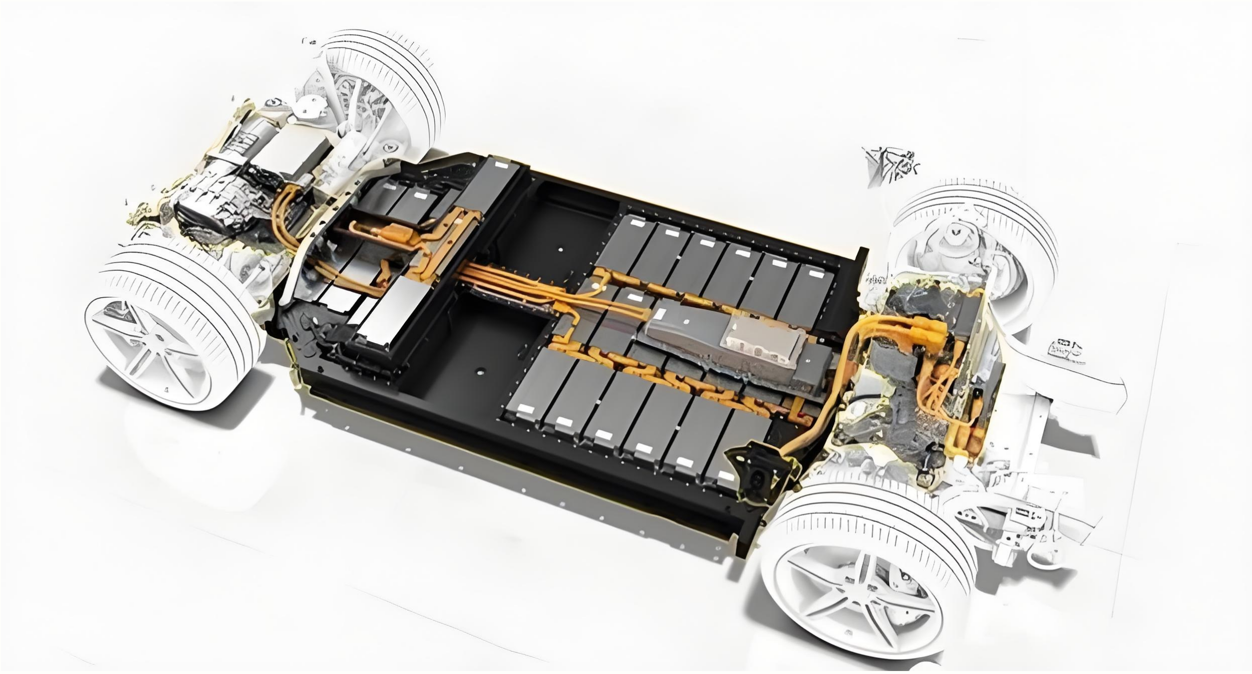
Solution: Composite thin film resistors – using CVD diamond as the substrate (to enhance thermal conductivity) and reducing the surface area of the resistor itself.

CVD diamond high power resistors are thin film passive devices that use CVD diamond as the resistor substrate. This resistor can carry extremely high rated power in the smallest area and with lower parasitic behavior, making it very suitable for 5G communications and military millimeter wave applications up to 30GHz, phased array radars, high-power Wilkinson power dividers/combiners, and feedback networks for RF power amplifiers (PAs).



RF High Power Resistors

Ili Application – New Energy Vehicle Power Devices



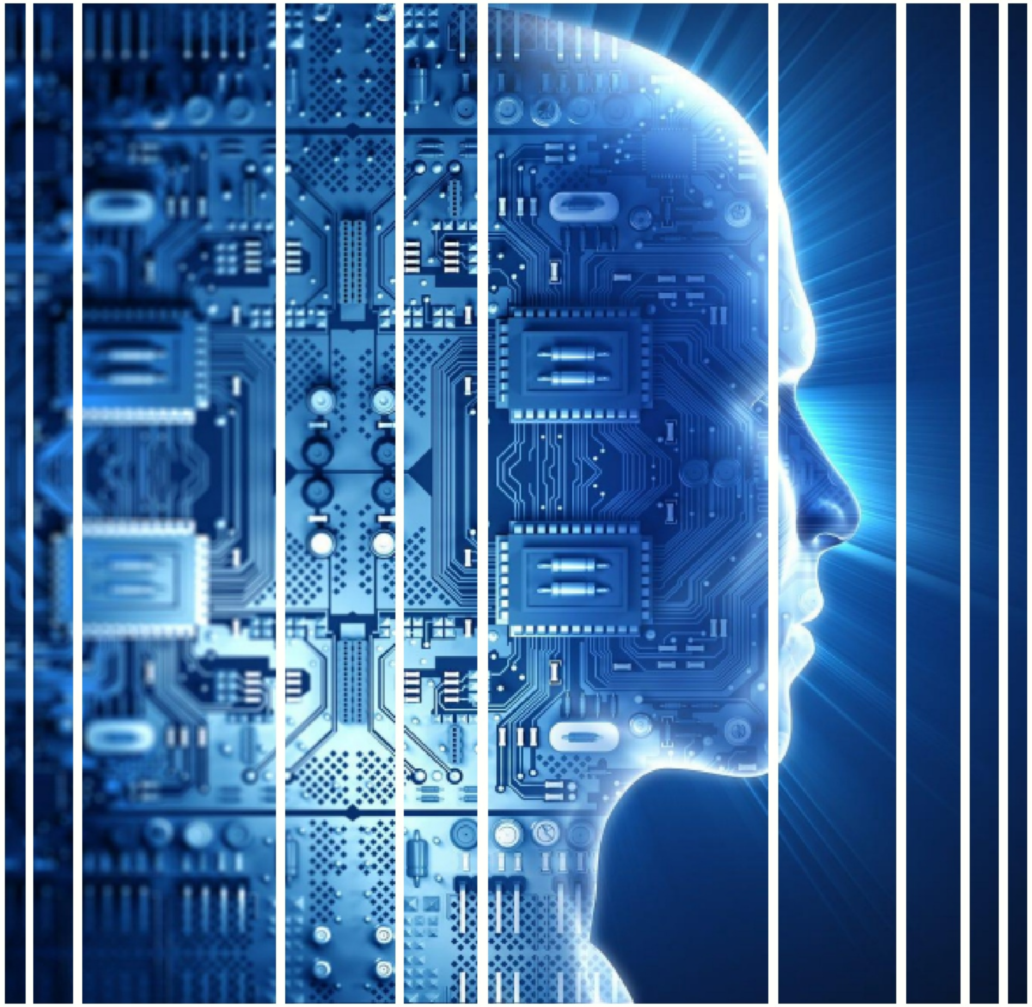
The superior mechanical strength and chemical stability of diamond materials enable it to maintain high performance in harsh environments, extending the service life of the module. In motor drive and inverter systems, the use of diamond film can improve the efficiency of power conversion, reduce energy loss, and provide support for the endurance of electric vehicles. Therefore, the application of CVD diamond has brought innovation to the power electronics technology of new energy vehicles and promoted the development of more efficient and reliable electric drive systems.

CVD diamond plays a key role in the IGBT modules of new energy vehicles, especially in improving heat dissipation performance. IGBT chips generate a lot of heat in high–power applications. If the heat cannot be effectively dissipated, the stability and life of the system will be affected. Due to its ultra–high thermal conductivity, CVD diamond film can quickly transfer heat from the IGBT device to the heat sink, significantly reducing the device temperature. This not only improves the thermal management efficiency of the IGBT module, but also reduces the failure rate and improves the reliability of the entire vehicle.

Ⅲ Application – AI computing chip

The development of AI is based on the demand for powerful computing power, but the high performance of computing chips is difficult to optimize and improve from the perspective of upper-level design. In this context, the application of CVD diamond as an emerging material is bringing revolutionary changes to AI computing chips. The ultra-high thermal conductivity of diamond can effectively manage the heat generated by AI chips when working under high load, ensuring their stable operation under extreme conditions.

In addition, the superior electrical properties of diamond enable AI computing to perform efficient calculations at high frequencies, greatly improving data processing speed. Combined with diamond materials, AI chips not only respond quickly when executing complex algorithms, but also reduce energy consumption and significantly extend the life of the equipment. It can be said that the application of CVD diamond has become an inevitable choice for further improving computing systems.



Ⅲ Applications – Cloud Computing & Big Data Storage

The application of CVD diamond in the field of data storage has shown significant performance advantages, especially in data conversion efficiency and thermal management. Compared with traditional memory chips, diamond substrates can increase data processing speed by 2 to 3 times, significantly improving the responsiveness of the system. In addition, the chip temperature can be reduced by 50% while reducing cooling costs by 20%.

This property is crucial for high–performance computing and big data analysis, and can extend the life of equipment and improve stability. For example, in supercomputers and ultra–high–speed storage devices, the chemical stability and high temperature resistance of diamond materials make them an ideal choice. The introduction of CVD diamond is driving data storage technology towards higher efficiency and lower energy consumption.

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Product Line: Sapphire Parts, CVD Diamond

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