

## 培育钻石（CVD 单晶金刚石）

### CVD diamond

公司生产并销售 CVD 单晶金刚石，产品涵盖工具级至宝石级金刚石，被广泛应用于机械、制造、军事、航空航天、科技、医疗器械以及奢侈品等行业。

金刚石类型:目前产品主要为 II a 型金刚石，作为珠宝属于稀有级钻石品种，同时也是非常好的光学窗口材料。

金刚石类型	I a	I b	II a	II b
氮含量	>0.1%	<0.25%	<0.001%	<0.001%
杂质含量	无	HPHT含Fe,Ni等	无	含B,Al
颜色	无-黄、棕	无-黄、棕	无-棕、粉红	蓝

金刚石红外透光率理论高达 71%，公司金刚石红外透光率>69%。

The products range from tool-grade to gem-grade diamonds, which can be widely used in fields such as machinery, manufacturing, military, aerospace, science and technology, medical equipment, and luxury goods industries.

#### Diamond Type

Diamond Type	I a	I b	II a	II b
Nitrogen content	>0.1%	<0.25%	<0.001%	<0.001%
Impurity content	None	HPHT contains Fe, Ni, etc	None	Contains B, Al
Color	None-yellow Brown	None-yellow Brown	None-Brown pink	Blue

At present, our products are mainly type IIa diamond, which is a very good optical window material. The theoretical infrared transmittance of diamond is as high as 71%, and the infrared transmittance of ZZSM diamond is more than 69%.

#### 半导体特性

金刚石与其他常用半导体材料性能对比

性能	常见金刚石	征世金刚石	Si	4H-SiC	GaN	SiC
室温下热导率 (W/(cm · K))	20	20	1.5	3.8	1.3	4.9
禁带宽度 (eV)	5.47	5.47	1.12	3.26	3.44	3.26
介质击穿场强 (MV/cm)	5~10	10	0.23	3	5	2.8
电荷迁移率 (cm <sup>2</sup> /(V · s))	4500	4500	1400	900	1500	1000
空穴迁移率 (cm <sup>2</sup> /(V · s))	3800	3800	/	120	<10	/
电子的饱和速率 (cm/s)	(1.5~2.7)×10 <sup>7</sup>	2×10 <sup>7</sup>	0.86×10 <sup>7</sup>	3×10 <sup>7</sup>	2.4×10 <sup>7</sup>	与金刚石相似 (2.2×10 <sup>7</sup> )
空穴的饱和速率 (cm/s)	(0.85~1.2)×10 <sup>7</sup>	0.8×10 <sup>7</sup>	/	/	/	与金刚石相似

由于金刚石具有极高的电荷迁移率，以及现有物质中最高的热导率，使得金刚石基半导体器件能够在高频、高功率、高电压以及十分恶劣的环境中运行，因此金刚石是一种极具优势的半导体材料。

### Semiconductor Property

#### Properties Comparison of diamond with other common semiconductor materials

Property	Common diamond	ZS	Si	4H-SiC	GaN	SiC
Thermal conductivity at room temperatur (W/(cm · K))	20	20	1.5	3.8	1.3	4.9
Band gap (eV)	5.47	5.47	1.12	3.26	3.44	3.26
Breakdown field (MV/cm)	5~10	10	0.23	3	5	2.8
Electron mobility (cm <sup>2</sup> /(V · s))	4500	4500	1400	900	1500	1000
Hole mobility (cm <sup>2</sup> /(V · s))	3800	3800	/	120	<10	/
Electron saturation velocity (cm/s)	(1.5~2.7)×10 <sup>7</sup>	2×10 <sup>7</sup>	0.86×10 <sup>7</sup>	3×10 <sup>7</sup>	2.4×10 <sup>7</sup>	Similar to diamond (2.2×10 <sup>7</sup> )
Hole saturation velocity (cm/s)	(0.85~1.2)×10 <sup>7</sup>	0.8×10 <sup>7</sup>	/	/	/	Similar to diamond

Diamond has extremely high Electron mobility and highest Thermal conductivity in the existing materials, which makes diamond based semiconductor devices operate in high frequency, high power, high voltage and very harsh environment. So diamond is an extremely advantageous semiconductor material.

### 光学特性

金刚石与其他常用红外材料性能对比

性能	常见金刚石	征世金刚石	ZnS	Ge	Si	GaAs	ZnSe
禁带宽度/eV	5.47	5.47	3.9	0.664	1.11	1.42	2.7
截止波长/ $\mu\text{m}$	0.225	0.225	14	23	/	/	20
吸收系数	0.1~0.3	0.1~0.3	0.2	0.02	0.35	0.01	0.005
吸收系数(10.6 $\mu\text{m}$ )	0.1~0.6	0.1~0.6	0.2	0.02	/	/	0.0005
显微硬度/( $\text{kg}/\text{mm}^2$ )	>8000	~10000	230	780	1150	721	137
折射率	2.417	2.417	2.19	4	3.42	3.28	2.4
$dn/dT(10^{-3}/\text{K})$	1	1	4.1	40	13	15	6.4
热导率/【 $\text{W}/(\text{cm}\cdot\text{K})$ 】	20	20	0.27	0.59	1.63	0.55	0.19
热膨胀系数/ $10^{-6}\text{K}^{-1}$	2.3	2.3	7.9	5.9	2.56	5.9	7.6

金刚石红外透光率理论高达 71%，公司金刚石红外透光率 >65%。

金刚石禁带宽度 5.47eV，除在 3~5 $\mu\text{m}$  处由声子振动引起的吸收峰外，从真空紫外（227nm）到远红外和微波（毫米波段）具有很好的透过特性。兼具化学惰性、耐磨性、极低的热膨胀系数和高热导率，使金刚石具有优良的抗热震性能。而金刚石低吸收系数、高激光损伤阈值以及高热导率使金刚石作为激光输出窗口热透镜效应比 ZnSe 窗口低 200 倍，低原子序数使金刚石对 X 射线几乎透明。因此金刚石是理想的红外光学窗口材料。

### Optical Property

#### Properties Comparison of diamond with other common infrared materials

Property	Common diamond	ZS	ZnS	Ge	Si	GaAs	ZnSe
Band gap/eV	5.47	5.47	3.9	0.664	1.11	1.42	2.7
cutoff wavelength/ $\mu\text{m}$	0.225	0.225	14	23	/	/	20
absorption coefficient	0.1~0.3	0.1~0.3	0.2	0.02	0.35	0.01	0.005
absorption coefficient(10.6 $\mu\text{m}$ )	0.1~0.6	0.1~0.6	0.2	0.02	/	/	0.0005
Microhardness/( $\text{kg}/\text{mm}^2$ )	>8000	~10000	230	780	1150	721	137
Refractive index	2.417	2.417	2.19	4	3.42	3.28	2.4
$dn/dT(10^{-3}/\text{K})$	1	1	4.1	40	13	15	6.4
Thermal conductivity/【 $\text{W}/(\text{cm}\cdot\text{K})$ 】	20	20	0.27	0.59	1.63	0.55	0.19
Coefficient of thermal expansion/ $10^{-6}\text{K}^{-1}$	2.3	2.3	7.9	5.9	2.56	5.9	7.6

The theoretical infrared transmittance of diamond is as high as 71%, and the infrared transmittance of

ZZSM diamond is more than 69%.

The diamond Band gap width is 5.47eV, except the absorption peak caused by phonon vibration at 3~5 $\mu\text{m}$ , it has a good transmittance from vacuum ultraviolet (227nm) to far infrared and

microwave ( Millimeter wave band). Diamond has Chemical inertness, wear resistance, very low Coefficient of thermal expansion and high Thermal conductivity, which makes diamond excellent Thermal shock resistance. The low Absorption coefficient, high laser damage threshold and high Thermal conductivity of diamond make the thermal lens effect of diamond as laser output window 200 times lower than that of ZnSe window, and the low atomic number makes diamond almost transparent to X-ray. So diamond is an ideal infrared optical window material.

### 刀具特性

在一定温度下纯天然金刚石与公司金刚石主要性能比较

性能	常见金刚石	征世金刚石	CVD金刚石 (来源网络)
硬度(KG/mm <sup>2</sup> )	>8000	~10000	>8000
密度(g/cm <sup>3</sup> )	3.52	3.52	3.52
杨氏模量(GPa)	>1200	1050	>1000
断裂能(J/M)	10	10	25
断裂韧性(Mpa · m <sup>1/2</sup> )	3.4	3.4	1~8
热导率(W/cm · k)	20	20	20
磨损比	>40万	>40万	>30万

处理后表面粗糙度达 RA: < 5 纳米

CVD 金刚石刀具的性能与天然金刚石相比十分接近, 能实现超薄切削, 可以加工出极高的工件精度和极低的表面粗糙度, 是公认的、理想的和不能代替的超精密加工刀具。金刚石晶面不同, 硬度值也有差异, 公司金刚石产品可精确晶面定向。

### Tool Properties

Main Properties Comparison of pure natural diamond with ZZSM diamond at a certain temperature

Property	Common diamond	ZS	CVD diamond (source network)
Hardness (KG/mm <sup>2</sup> )	>8000	~10000	>8000
Density (g/cm <sup>3</sup> )	3.52	3.52	3.52
Young's modulus(GPa)	>1200	1050	>1000
Fracture energy(J/M)	10	10	25
Fracture toughness(Mpa · m <sup>1/2</sup> )	3.4	3.4	1~8
Thermal conductivity(W/cm · k)	20	20	20
Wear ratio	>0.4 Million	>0.4 Million	>0.3 Million

After treatment, Top surfaces as-grown one side and polished Ra < 5 nm

The property of CVD diamond tool is very close to that of natural diamond. It can achieve ultra-thin cutting, and can produce extremely high workpiece precision and extremely low surface roughness. It is recognized as an ideal and irreplaceable ultra-precision machining tool. The hardness values of diamond products are different with different crystal faces. ZZSM diamond products can be precise crystal surface orientation.

定制服务

提供 0.5 克拉到 10+克拉高净高色钻石，也提供最丰富的花样琢型，确保每一颗钻石都拥有无比璀璨的火彩，让每一个客户都满意。

作为国内首批生产光学级、电学级、宝石级 CVD 金刚石的企业，以国际领先的研发能力，远超同行业的技术水平，

稳定的质量、可靠的信誉、客户至上的服务精神赢得了全球众多客户的认可与好评。

Customization Services

Customize your favorite products and strive for the world