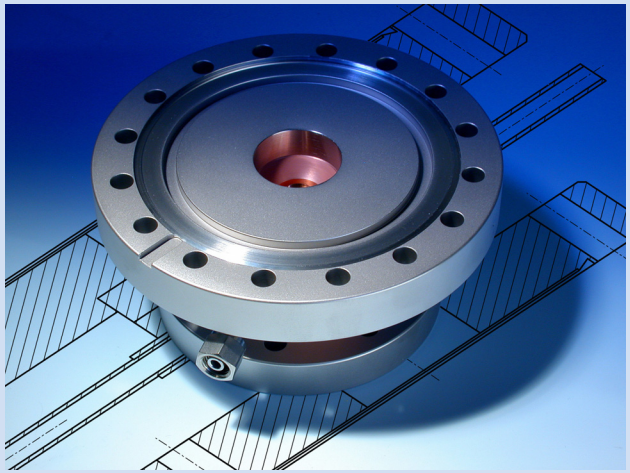
Diamond Materials

Advanced Diamond Technology



CVD Diamond for Synchrotron Beamlines

Diamond Materials manufactures CVD diamond windows and filters for high-brilliance synchrotron beamlines. Our offer includes water cooled X-ray windows as well as infrared windows with broadband transparency ranging from the visible over the infrared to microwaves. These windows separate the UHV of synchrotron storage rings from the remainder of the beamline.

We have extended expertise in the preparation of large, high-grade diamond foils and sheets and in the UHV compatible mounting in custom designed vacuum components.

X-ray windows

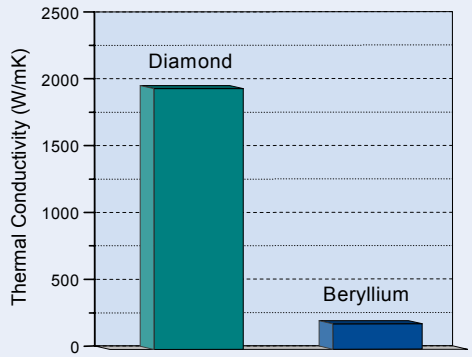
Diamond exhibits a bunch of unique properties such as extreme hardness, high thermal conductivity and chemical inertness. In terms of X-ray windows another property of diamond is of crucial importance: diamond consists of carbon i.e. diamond is a low Z material which is transparent to X-rays.

Using CVD techniques ***Diamond Materials*** is able to manufacture diamond in the shape of thin foils with thicknesses starting from a few nanometers up to more than a millimeter.

These diamond foils are employed for the production of X-ray transmitting windows for various applications including UHV windows for X-ray beamlines.

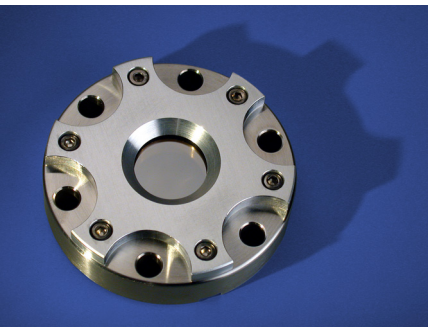
Diamond X-ray windows: Properties
Material: CVD diamond, optical grade
Surface: Polished, surface roughness < 10 nm rms
Thickness 20 – 300 µm
Efficient water cooling jacket
UHV compatible
Bakeable up to 250°C
Custom design
Circular or oval free aperture

Property	Diamond	Beryllium
Atomic number	6	4
Hardness	12 000 – 15 000 kg/mm^2	150 – 200 kg/mm^2
Strength, tensile	>1200 Mpa	310-550 Mpa
Density	3.52 g/cm^3	1.85 g/cm^3
Young's modulus	1140 GPa	290 Gpa
Poisson's ratio	0.069	0.075
Specific heat	0.52 J/gK	1.87 J/gK
Thermal expansion coefficient	1.1 ppm/K (at RT) 2.6 ppm/K (20-500°C)	11.6 ppm/K (at RT) 18.4 ppm/K (25-1000°C)
Thermal conductivity	2000 W/mK (at RT), 730 W/mK (at 500°C)	180 W/mK (at RT) 97 W/mK (at 540°C)
Optical transparency	UV to far IR	Opaque
Resistivity	Insulator 10^{13} - 10^{16} Wcm	Conductor 4.1 µWcm
Melting temperature	at 1500°C diamond transforms to graphite	1285 °C
Toxicity	None	High (even small amounts can cause chronic beryllium disease)

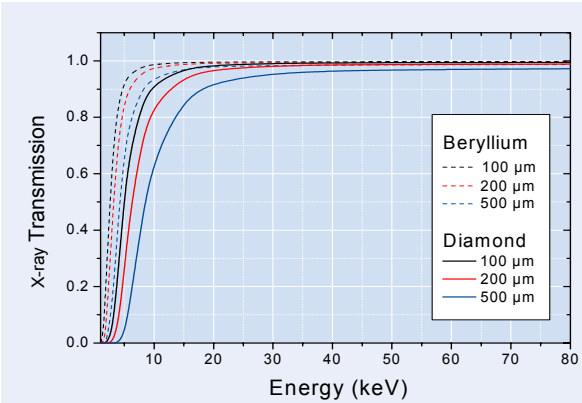


Advantages of Diamond X-ray windows:

Diamond X-ray windows: Advantages
High thermal conductivity resulting in reduced temperature gradients
No health risk !!!
Low thermal expansion resulting in low thermo-mechanical stress and superior resistance against
Exceptional stiffness. No buckling due to radial elasticity of mounting assembly.
No plastic deformation of a window in the working cycle and therefore no low cycle fatigue
Optical transparency facilitates inspection
Superior radiation hardness



Diamond Materials offers custom designed infrared windows embedded in UHV vacuum flanges.



Infrared windows

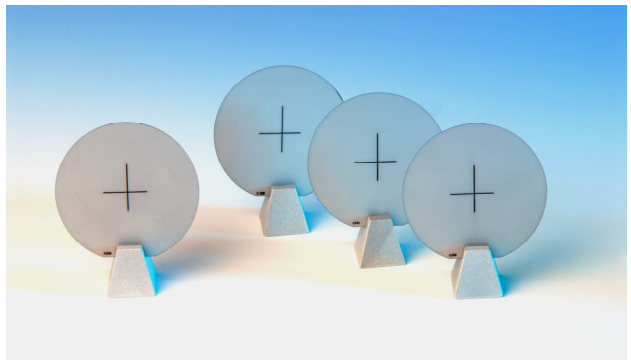
Diamond exhibits a broadband transparency ranging from the UV to the far IR. There is only one minor absorption band around 5 µm with resulting from two-phonon absorption (maximum absorption coefficient: 12 cm^{-1}).

At longer wavelengths no additional absorption arises. Diamond is transparent for microwave, radar and THz radiation. Hence it is an ideal material for multi-wavelength spectroscopy.

Diamond Infrared Windows: Specifications	
Thickness	300 – 1000 µm
Diameter	5 – 50 mm
Wedge	0-1°
Flatness	< 1 fringe/cm @633 nm
Bakeable	at up to 250°C
Vacuum tightness	He leak rate $<10^{-9}$ mbar l/sec

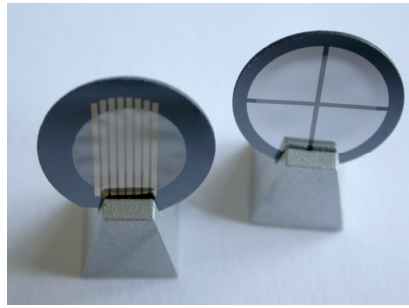
Fluorescence beam monitors

A bright luminescence in the visible combined with a low absorption and a high thermal conductivity makes diamond the ideal choice to make X-ray or particle beams visible. Screens can be either be made with polished or silky surface finish

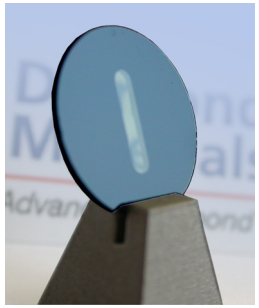


Diamond membranes and sensors

Thin membranes of detector grade CVD diamond are used as innovative transmission sensors for X-ray and heavy ion beams. In addition they are used as ultra-thin vacuum tight X-ray windows for multi-spectral applications.



Diamond strip detector (left) and 4-quadrant-sensor (right) for high resolution beam monitoring



Thin (4 µm) diamond membrane serving as a low-loss X-ray window

Contact Diamond Materials

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