OPTICS

Diafilm OP

DISCOVER LIMITLESS OPTICAL POTENTIAL

Our CVD diamond properties outperform competing optical materials many times over, benefiting engineers today designing tomorrow's high performance laser systems

element six
a De Beers Group Company

ENGINEERED TO ACHIEVE NEW LEVELS OF PERFORMANCE

For engineers working in laser development and spectroscopy, the extremely broad wavelength transmission spectrum of Diafilm OP, from 220 nm to >50 µm, opens new levels of functionality. When combined with core properties of CVD diamond, such as high thermal conductivity, chemical resistance and biocompatibility, the characteristics of Diafilm OP open the way to new horizons in product development throughout the photonics industry.

In demanding applications where the lifetime of the optic is a critical parameter in the performance of the equipment and processes, Diafilm OP sets the standard.

It enables optical engineers to design new and innovative products for their industries. Crucially, Diafilm OP opens up new applications which have not been possible with less extreme materials. This revolutionary material also offers the prospect of unparalleled performance and reduced cost of ownership in existing optical applications.

Optical components made of Element Six Diafilm OP have been proven in the field for more than 15 years, delivering unsurpassed performance and reliability.

GOING BEYOND TODAY'S TECHNICAL BOUNDARIES

With the use of Element Six Diafilm OP, new opportunities arise for the development of optical components for use in extreme situations such as high thermal loads, hazardous and aggressive environments, and combinations thereof. Due to its biocompatibility Diafilm OP is also ideal for use in the medical photonics industry.

TAILOR-MADE SOLUTIONS

The processing and mounting of components determines many of the performance characteristics of the optical elements they contain. Our specialized team of application engineers and processing technologists can design the right component for your application even up to 135 mm in diameter and 3 mm thick. This includes the windows, prisms and lenses themselves, their processing and mounting, as well as partial or anti-reflective coatings. Mounts can be of simple flange design or made to customer specifications which facilitate special features such as water or air cooling if required.

ADVANTAGES OF DIAFILM OP

- Extremely broad transmission spectrum from 220 nm up to >50 µm
- High thermal conductivity (up to 2200 W/mK)
- Biocompatible
- Standard thicknesses available up to 1.5 mm*
- Sizes available up to Ø 118 mm in diameter*
- Chemically inert and operates in corrosive environments
- Scratch resistant

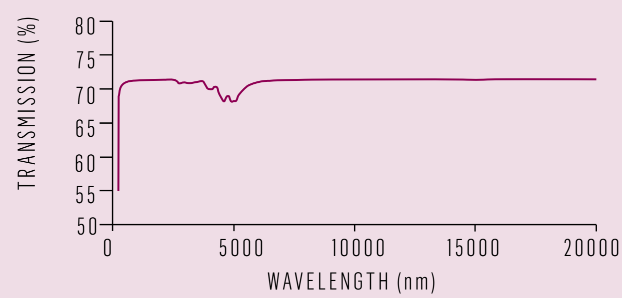
** Larger sizes available in other optical grades*

MODELING AND ANALYZING PROPOSED SOLUTIONS

Our engineers and technologists use the latest computation models to analyze every aspect of the thermal and mechanical properties of a proposed application. In this way the ultimate performance of a component can be accurately predicted before prototyping.

WIDE TRANSMISSION SPECTRUM OF DIAFILM OP

(100 µm THICK UNCOATED)



TYPICAL APPLICATIONS OF DIAFILM OP

EXAMPLE APPLICATIONS	COMPONENT
High Power CO_2 lasers	Optical windows, lenses and output couplers
High Power Density Solid State Lasers	Optical windows and lenses
Spectroscopy (both laboratory and on-line)	Optical windows, prisms and lenses
Semiconductor processing	Optical windows and beam splitters
Terahertz and Radar applications	Optical windows
(Bio)Medical Optics	Optical windows, prisms and lenses
Defense and aerospace (directed energy/imagery)	Thermal mounting & optical windows

DIAFILM OP OUTPERFORMS SAPPHIRE AND ZINC SELENIDE

PROPERTY	DIAFILM OP	SAPPHIRE	ZINC SELENIDE
Hardness (GPa)	81 ± 18[1]	16[1]	1.05[1]
Fracture toughness (MPam$^{0.5}$)	5.3 – 7.0[1]	2[1]	0.5[1]
Young's modulus (GPa)	1000 – 1100[1]	344[1]	70.3 ± 2.8[1]
Poisson's ratio	0.1[1]	0.27[1]	0.28[1]
Tensile strength (MPa) [Weibull Modulus] (0.4 mm thick)			
Nucleation surface	800 [10][4]	400[7]	50[1]
Growth surface	400 [15][4]		
Rain impact DTV (m/s) 2 mm drop size	525[2]	457–533[2]	137[2]
Sand erosion (mg/kg) at 100 m/s C300/600 sand	2.1 ± 0.6[1]	92 ± 2[1]	>30 000[1]
Thermal conductivity at 300 K (W/mK)	1900 – 2200[4]	34[1]	16[1]–18[3]
Thermal conductivity at 500 K (W/mK)	1100[4]	6[3]	–
Thermal expansion coefficient (ppm/K)	1.0 at 300 K[4]	5.3[1]	7.1 at 300 K[1]
	4.4 at 1000 K[4]		10.9 at 800 K
Thermal shock FOM (×10^3 W/m)*	~1000[4]	5.4[1]	1.1[1]
Refractive index	2.375 (at 10 µm)[1]	1.77 (633 nm)[1]	2.4 (10 µm)[1]
dn/dT (1/K)	9.6 x 10^{-6}[1]	12 x 10^{-6}[1]	57 x 10^{-6}[1]
Dielectric constant D (35 GHz)	5.68 ± 0.15[5]	9.4 – 11.6[1]	8.98[1]
% increase in D at 773 K	4.3%[5]	6.5%[5]	–
Loss tangent 145 GHz (10^{-6})	8 – 20[8]	200[8]	–
8–12 µm absorption coefficient (1/cm)	<0.07[4]	>1000[1]	0.0005[1]
3–5 µm absorption coefficient (1/cm)	min 0.8 at 3.7 µm[5]	0.01– 0.04[1]	0.015[3]
1 µm absorption coefficient (1/cm)	Typical 0.12[9]	–	0.001
Emissivity at 10 µm (1 mm thick)	0.02 at 573 K, 0.03 at 773 K[5]	N/A	–
Integrated forward scatter 8–12 µm (%)	0.1 – 0.7%[5]	N/A	–
Integrated forward scatter visible (%)	<4%[5]	0.1%[1]	–
Density (×10^3 kg/m^3)	3.52[7]	3.98[7]	5.27[7]
Specific heat capacity (J/kgK) 300 K	520[1]	750[1]	340[1]
Transmission 8–200 µm (1 mm thick)	71.4%#[4]	N/A	–
Transmission 633 nm (1 mm thick)	>64%#[4]	84.5%[6]	60.8%[6]

\# = Reflection and scattering loss limited   N/A = Not applicable
– = Not known

***THERMAL SHOCK FIGURE OF MERIT**

FOM = S(1 – υ) k / α E
α = Expansion coefficient
E = Young's modulus
υ = Poisson's ratio
S = Strength
k = Thermal conductivity

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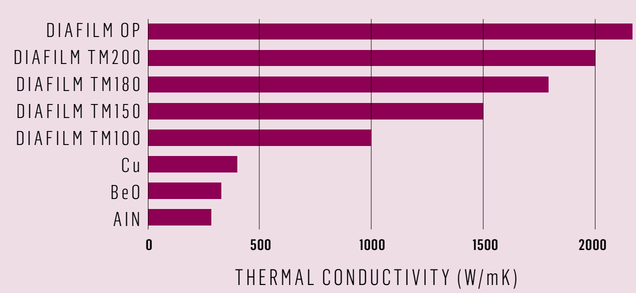
THERMAL CONDUCTIVITY



ELEMENT SIX

Element Six, part of the De Beers Group of Companies, designs, develops and produces synthetic diamond and other supermaterials, and operates worldwide with primary manufacturing facilities in China, Germany, Ireland, South Africa, the UK and US.

Element Six supermaterial solutions are used in applications such as cutting, grinding, drilling, shearing and polishing, while the extreme properties of synthetic diamond beyond hardness are opening up new applications in a wide array of industries such as optics, power transmission, water treatment, semiconductors and sensors.

If you would like to know more about Element Six please visit our website www.e6.com/optical or contact us at any of the addresses below.

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