Semiconductor Graphite

Materials and post processes

The grades of graphite manufactured by Entegris are segmented by grain size. These include one, five, and ten micron, which are then further segmented by application.

The defining characteristic of Entegris graphites is the uniform microstructure inherent in the graphite materials. These graphites have a proven cost of ownership, due to the attributes of the material's isotropic microstructure. All of which is the result of a unique manufacturing process.

Entegris grades of graphite are sold in bulk form or as custom machined components for specific applications. The properties of graphite make it an ideal material to be used as a replacement technology, regardless of the system performance requirements. Graphite has a lower cost of ownership and improved performance when compared to many other material choices.

In addition to engineering specific properties into the graphite, Entegris has a variety of post processing options to further modify the material to fit specific applications.

TYPICAL DATA ANALYSIS

Purified Entegris graphite

Element	Concentration
Na	<0.005 ppm*
Mg	<0.005 ppm*
Al	0.090 ppm
K	<0.005 ppm*
Ca	<0.005 ppm*
Ti	0.020 ppm
V	0.002 ppm
Mn	<0.001 ppm*
Fe	0.030 ppm
Ni	0.010 ppm
Cu	<0.001 ppm*
Zn	<0.005 ppm*

**Denotes value below detection limits.*

POST PROCESSES

All Entegris grades are available as bulk product, but post processing is normally done on 5 µm grain size materials. All grades can be purified to less than 5 ppm.

Densification (-3)

Graphite has tiny voids (pores), which may link to the surface (open porosity) or be isolated (closed porosity). Densification partially fills the open pores with pure carbon, which is then regraphitized. The resulting material has improved properties.

Purity (-2)

Unpurified Entegris graphite has typical impurity levels over 1000 ppm. The major constituents are metals, but Entegris' purification process reduces impurities to 5 ppm (99.9995%) or less as determined by ash analysis.

Pyrolytic Carbon Treatment (PYC)

Purified, finished parts go through a unique, proprietary Chemical Vapor Infiltration (CVI) process that provides a nonporous surface with an amorphous carbon coating. The treatment seals the surface of the graphite and reduces particle generation in demanding environments. These materials are acid resistant.

Entegris produces a number of pyrolytic carbon treated materials marketed under different trade names for semiconductor applications. Each of these different materials is targeted at specific applications.

FABMATE® (Amorphous Carbon Treatment) Graphite

FABMATE graphite crucibles offer the user cleaner handling with reduced particle content in the melt. Additional benefits are reduced wetting and longer crucible life.

DFP-1 graphite is machined and purified and then given an amorphous carbon treatment. This treatment is unique because it does more than coat the surface. It also infiltrates and locks onto the graphite. This treatment provides a harder surface with the porosity sealed to reduce wetting and eliminate particles.

FABMATE-BG is another graphite grade targeted at e-beam evaporation. This grade starts with DFP-3-2 as the precursor before the FABMATE treatment is applied.

TYPICAL MATERIAL PROPERTIES

PROPERTY	ZEE-2	SFG	DFP	TRA	HPD	CZR	SCF	PLS
Particle size	1 µm (40 µin)	1 µm (40 µin)	5 µm (200 µin)	5 µm (200 µin)	5 µm (200 µin)	5 µm (200 µin)	5 µm (200 µin)	10 µm (400 µin)
Pore size[1]	0.3 µm (12 µin)	0.3 µm (12 µin)	0.8 µm (32 µin)	0.8 µm (32 µin)	0.8 µm (32 µin)	0.8 µm (32 µin)	0.8 µm (32 µin)	1.5 µm (60 µin)
Coefficient of thermal expansion[2] **µm/m°C (µin/in°F)**	8.4 (4.65)	8.1 (4.5)	8.1 (4.5)	7.9 (4.4)	8.1 (4.5)	7.8 (4.3)	8.5 (4.7)	8.2 (4.55)
Compressive strength	193 MPa (28,000 psi)	166 MPa (24,100 psi)	140 MPa (20,000 psi)	118 MPa (17,100 psi)	156 MPa (22,600 psi)	93 MPa (13,500 psi)	163 MPa (23,600 psi)	100 MPa (14,500 psi)
Flexural strength[3]	103 MPa (15,000 psi)	96 MPa (13,900 psi)	86 MPa (12,500 psi)	75 MPa (10,900 psi)	90 MPa (13,000 psi)	61 MPa (8800 psi)	93 MPa (13,500 psi)	60 MPa (8700 psi)
Tensile strength[4]	72 MPa (10,400 psi)	67 MPa (9700 psi)	60 MPa (8700 psi)	53 MPa (7600 psi)	63 MPa (9100 psi)	43 MPa (6200 psi)	65 MPa (9400 psi)	42 MPa (6100 psi)
Shore hardness	100	84	74	72	80	70	91	68
Electrical resistivity µΩ-cm (µΩ-in)	3050 (1200)	1950 (770)	1475 (580)	1560 (615)	1815 (715)	1840 (725)	2450 (965)	1460 (575)
Apparent density g/cm³ (lb/in³)	1.77 (0.064)	1.77 (0.064)	1.77 (0.064)	1.72 (0.0621)	1.76 (0.0636)	1.65 (0.0596)	1.77 (0.064)	1.77 (0.064)
Thermal conductivity W/m-K (Btu-ft/hr/ft²°F)	44 (25)	75 (44)	95 (55)	85 (50)	85 (50)	76 (44)	50 (29)	105 (60)
Oxidation threshold[5]	470°C (880°F)	470°C (880°F)	470°C (880°F)	450°C (840°F)	455°C (850°F)	440°C (820°F)	475°C (890°F)	460°C (860°F)

[1] Measured using Hg porosimetry method.

[2] Average for temperature range of RT – 800°C.

[3] Measured using 4-point bend method.

[4] Estimated at 70% of flexural strength.

[5] Temperature that results in 1% weight loss in 24 hours; Oxidation threshold increases by approximately 100°C if graphite is purified. Test sample size equals 0.5" × 0.5" × 1.0".

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