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Extremely Pure Pyroid® Pyrolytic Graphite for Ion Implantation

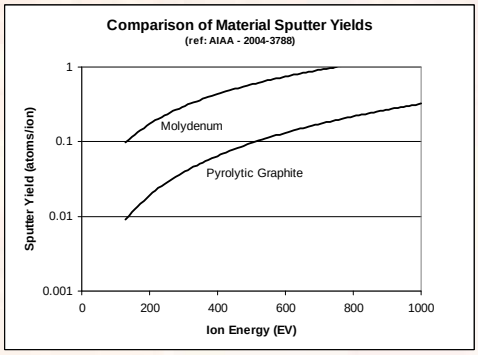
Ion implantation uses two or three closely spaced multiple-aperture electrodes to extract ions from a source and eject them in a collimated beam. The electrodes are called "grids" because they are perforated with a large number of small holes in a regular array.

Ion impact erosion of the ion optics (i.e., the grids) is the primary mechanism limiting the life of the ion grids. The erosion of the grid eventually weakens it to the point that the grid fails and breaks causing unnecessary and costly production down time.

Pyrolytic Graphite exhibits the **lowest erosion rate of any known material**, even in extreme working conditions such as in ion bombardment or in plasma applications.

Common grid material parts such as molydenum and other fine-grain,high-desity graphite used in ion implantation equipment are exposed to high erosion wear rates. Pyrolytic graphite has low erosion rate is due to its extremely high purity > 99.999% and single crystal structure.

Pyrolytic Graphite provides reduced cost of ownership due to the low erosion rates of the material. This is a key factor in all improvements is the reduction of costs for the end user and improves productivity by enabling the user to operate longer without tooling changes and the associated costs of downtime during the tooling change over.



Customer Benefit:

Since the ion grid focuses ions, minimizing erosion provides longer life and more precise beam focus, increasing productivity, lowering maintenance and saving costs from production down time.

With over 30 years of experience in the semiconductor industry, we produce components that conform precisely to the OEM standard

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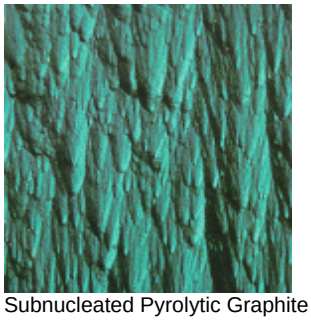

Subnucleated Pyrolytic Graphite SEM

Electrodes Made From Pyrolytic Graphite for Electron Beam Lithography

Zero porosity

Customer Benefit:

Zero porosity translates into little or no outgassing of contaminants and no structure capable of trapping contaminants that can alter the dopant effect on the implantation

Density

The theoretical density of monocrystalline graphite is 2.26 g/cm^3. The density of highly pure pyrolytic graphite is 2.23 g/cm^3 which is greater than any known graphite due to its single crystal structure. This means that there is no porosity due to ash contamination in the material that degrades the structure. This porosity is found in even purified isostatically pressed fine-grained graphite material.

In addition pyrolytic graphite offers

- High purity > 99.999%
- Stability at high temperature and vacuums
- Extreme resistance to thermal shock.
- Temperature tolerance from cryogenic to > 2000° C.

Typical Pyroid® Pyrolytic Graphite Analysis > 99.999% (75 element analysis)	
Element	*Concentration (ppm wt)*
F	< 0.05
Na	0.01
B	< 0.01
Al	< 0.01
Na	0.01
Mg	< 0.05
K	< 0.05
Ca	< 0.05
Cr	< 0.1
Si	0.37
Ti	0.04
V	< 0.005
Mn	< 0.005
Fe	< 0.01
Ni	< 0.01
Cu	< 0.05
Zn	< 0.05
P	< 0.01
all others	< 0.01 or better

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Pyrolytic graphite has a stable coefficient of thermal expansion which means temperature gradient effects on the ion grids are negligible

Customer Benefit:

Near zero thermal expansion means the grids maintain their relative spacing across of range of temperature and energy settings. This translates into more precise control for depositing dopant atoms into the substrate

High Purity Pyrolytic Graphite

Pyrolytic Graphite can be easily machined and the material can be routinely manufactured into complicated parts with close tolerances. Pyrolytic Graphite is can be supplied with a high level of surface finish, flatness or a defined surface roughness

Typical Applications

- Ion Implantation Grids
- Wafer Trays
- Electrodes for Plasma Etch
- Boats
- Crucibles
- Susceptors
- Brazing and glass-to-metal sealing jigs

Physical Properties for Substrate Nucleate (SN) Pyrolytic Graphite

Property	Direction*	Metric Units	English Units
Density	---	2.22 g/cc	137 lb/ft3
Flexural Strength			
Room Temperature	a	840 kg/cm2	12,000 psi
2750°C	a	3,500 kg/cm2	50,000 psi
Compressive Strength			
Room Temperature	a	1,050 kg/cm2	15,000 psi
	c	1,750 kg/cm2	25,000 psi
Shear Strength			
Room Temperature	a	70 kg/cm2	1,000 psi
Coefficient Thermal Expansion			
Room Temperature	a	0.057×10^{-6} cm/cm°C	0.061×10^{-6} in/in°F
2200°C	a	1.09×10^{-6} cm/cm°C	1.16×10^{-6} in/in°F
Room Temperature	c	23.9×10^{-6} cm/cm°C	25.5×10^{-6} in/in°F
2200°C	c	25.0×10^{-6} cm/cm°C	26.67×10^{-6} in/in°F
Thermal Conductivity			
Room Temperature	a	444 W/m°K	257 BTU/(hr ft2)(°F/ft)
1650°C	a	114 W/m°K	66 BTU/(hr ft2)(°F/ft)
Room Temperature	c	2.20 W/m°K	1.27 BTU/(hr ft2)(°F/ft)
1650°C	c	1.30 W/m°K	0.75 BTU/(hr ft2)(°F/ft)
Electric Resistivity			
Room Temperature	a	500 $\mu\Omega$cm	
1650°C	a	200 $\mu\Omega$cm	
Room Temperature	c	0.6 Ωcm	
1650°C	c	0.22 Ωcm	
Scleroscope Hardness	a	103	103
	c	68	68
Oxidation Threshold		650°C	1200°F
Permeability		Helium Leak Tight at 10-6 mmHg	

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