Entegris

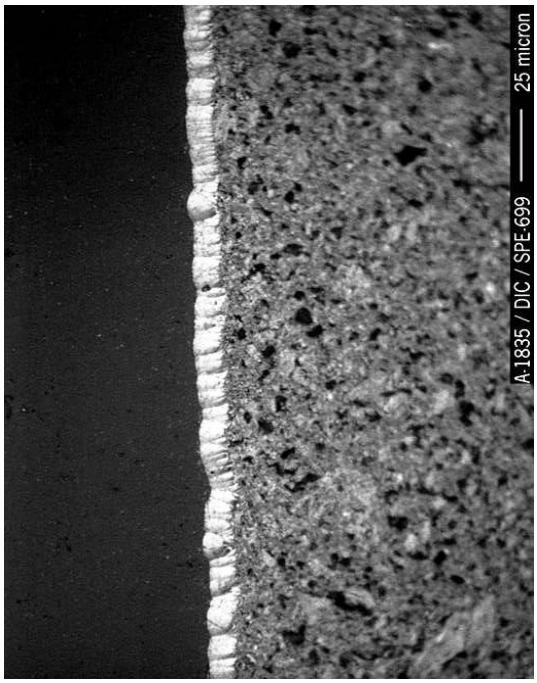
PYROLYTIC CARBON COATED GRAPHITE

Particle-free products for clean environments

Overview

Pyrolytic carbon coated graphites are a family of finished products that have been purified, machined and subjected to Entegris' proprietary carbon surface treatment. Known as FABMATE™ (using DFP-2, as a 5 micron substrate), FABMATE-BG (using DFP-3-2, as a densified 5 micron substrate) and PLS-PYC (using PLS-2 as a 10 micron substrate), these materials are designed for use in clean environments. They are ideal for both semiconductor and solar applications requiring exceptional cleanliness and a pore-free surface.

The graphite substrates used are isotropic, fine-grained, high-strength materials that have excellent machinability. Products are produced by machining the selected graphite to its final configuration, purifying and ultrasonically cleaning these parts, then placing them in a CVD furnace where they receive an amorphous carbon treatment. This treatment is unique because it does more than coat the surface, it also infiltrates the open surface pores and locks onto the graphite. The pyrolytic carbon treatment provides a harder, abrasion resistant surface that produces no particulates. The result is a surface that is particle free, harder than the substrate, but extremely thin. Due to the nonporous surface, FABMATE, FABMATE-BG and PLS-PYC resist attack by hydrofluoric (HF) and most other acids used in typical fluid cleaning processes. These materials are thermally stable and ideal for applications with temperatures up to 550°C in the presence of oxygen and up to 2500°C in vacuum or an inert atmosphere.



Photomicrograph (500X) shows the proprietary treatment effect on graphite. The surface is completely sealed as the treatment infiltrates the graphite.

Quality

Entegris' quality program assures that each person has the opportunity to perform a quality job in a safe environment. Quality is built into each Entegris product as it progresses through the plant. Entegris is an ISO:9008 and AS:9100 registered company.

Process

Machining

The uniform grain structure of these materials makes it very easy to machine the precision parts necessary to meet the demands of high-technology applications. Entegris' precision machine shop is equipped with the latest design, manufacturing and inspection technology. Entegris design engineers work with customer engineering prints or sketches when needed to provide a final design well suited to the treatment process. Once parts are machined, our inspection group can verify even the most demanding parts with accuracy.

Design Considerations

Since the amorphous carbon treatment is applied after the machining process is complete, customer provided prints may need small modifications by Entegris engineers to allow for coating of some features (such as small holes or screw threads). Sharp edges and corners should be avoided whenever possible. Surface texturing can be done prior to the carbon treatment to improve film adhesion for deposition components if desired. Surface treatment adds 0.0001" to 0.0002" of amorphous carbon to each surface.

Purification

Pyrolytic carbon coated products are composed of 99.9995% (by ash test) elemental carbon. They are virtually free of organic or metallic impurities. The following steps are taken to ensure this high level of purity. After final machining, all parts are ultrasonically cleaned with deionized water to remove machining dust. Parts are cleaned in a class 1000 cleanroom and packaged in a class 100. All parts submitted for pyrolytic carbon treatment have completed the Entegris purification process prior to acceptance into this final step of the operation.

Typical Purity as Determined by Spectrographic Analysis, Parts-per-million.

Elements	Detected	PPM Range*
Fe	Yes	Trace to 5
Si	Yes	Trace to 5
Al	Yes	Trace to 5
Mg	Yes	Trace to 5
V	Yes	Trace to 5
Ni	No	–
Cr	No	–
Ti	No	–
Cu	No	–
B	Yes	Trace to 5
Mn	No	–
Li	No	–
Cd	No	–
Mo	Yes	Trace
Pb	No	–
Ag	No	–
Zn	No	–
Ca	Yes	Trace to 5
K	No	–
Na	No	–

**Total ash range is 5 ppm or less.*

Applications

Semiconductor

FABMATE is an alternative to quartz and other troublesome materials. Particle-free FABMATE products are ideal for use in cleanroom environments. FABMATE surfaces are hard, abrasion resistant and vacuum compatible. The surface coating will not be broken down by exposure to most acids. Thermal shock will not cause spalling, crazing or flaking of the coating. After machining, the surface is textured to ensure that Chemical Vapor Deposition (CVD) films will adhere to the surface and not flake off during use. Every precaution has been taken to ensure that FABMATE products do not produce particulates.

FABMATE material is used in various semiconductor processes where the products include electron beam crucibles, Metal Organic Chemical Vapor Deposition (MOCVD) susceptors and Low Pressure Chemical Vapor Deposition (LPCVD) wafer carriers. FABMATE and pyrograph materials are ideal for use in beam focusing components in ion implantation equipment.

Solar

PLS-PYC provides a clean, metal-free solution for use in solar high-temperature processing. Providing particle free surfaces PLS-PYC is an excellent choice for evaporation source crucibles and other deposition components. Both FABMATE and PLS-PYC resist thermal shock and offer the benefits of the underlying Entegris graphite substrate, guaranteeing uniform properties throughout the material. A smooth matte finish provides excellent adhesion surfaces to obtain critical uniformity of deposition.

Custom components, from heaters and tubing to fluid containers with mating lids, can be designed to benefit from this porosity sealing surface treatment.

Typical Material Properties

Property	FABMATE	FABMATE–BG	PLS–PYC
Particle size:	5 µm (200 µin)	5 µm (200 µin)	10 µm (400 µin)
Apparent density:	1.77 g/cm³ (0.064 lb/in³)	1.82 g/cm³ (0.066 lb/in³)	1.77 g/cm³ (0.064 lb/in³)
Flex strength:	86 MPa (12,500 psi)	86 MPa (12,500 psi)	60 MPa (8500 psi)
Compressive strength:	140 MPa (20,000 psi)	140 MPa (20,000 psi)	107 MPa (15,500 psi)
Shore hardness:	74	74	68
Electrical resistivity:	1410 µΩ-cm (555 µΩ-in)	1360 µΩ-cm (535 µΩ-in)	1460 µΩ-cm (575 µΩ-in)
Coefficient of thermal expansion:	8.1 µm/m°C (4.5 µin/in°F)	8.1 µm/m°C (4.5 µin/in°F)	8.2 µm/m°C (4.55 µin/in°F)

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