Pyrolytic Graphite Comes to the Glass Plant

This leading supplier of refractories to the glass industry has introduced a new forming and shaping material. Pyrolytic graphite, a form of elemental carbon which possesses unique thermal, mechanical, and electrical properties, is finding increased use in the glass industry.

By V.N.P. Rao, Ph.D., Director, and Robert P. Pulley, Jr, Applications Specialist, Pyrogenics Group, Minteq International

With a history of applications in the manufacturing of plasma etching cathodes and ion grids for the electronics industry and in the manufacturing of rocket nozzles in the aerospace industry, pyrolytic graphite is now gaining use in the glass plant.

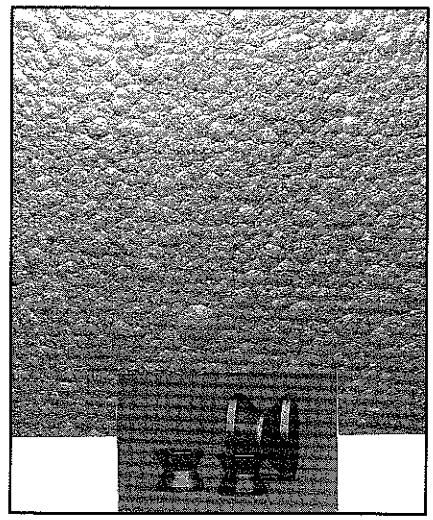
Most common uses are as dies and forming tools that shape semi-molten glass, but new applications are being researched. Stemware, container glass, and specialty glass manufacturers are discovering better results when forming with pyrolytic graphite. Drop plates, deflector shields, and other glass contact applications using traditional graphites are being substituted with pyrolytic graphite.

One of the reasons is that pyrolytic graphite is absolutely non-wetting so that glass "slides right off."

Because of its resistance to thermal shock, it can also be used for support pads to isolate annealed glass, preventing localized cooling, which minimizes checking due to thermal stress. In addition, when used in glass processing, pyrolytic graphite does not shed particles into, or mar the surface of hot glass, making it an ideal material for glass benders and temperers.

Traditional graphites are formed from resins and particles that are molded hydraulically or isostatically, then baked to bond the raw materials, and finally post-treated to enhance specific material properties. On the other hand, pyrolytic graphite is pure polycrystalline graphite that is formed by chemical vapor deposition at temperatures in excess of 2000°C. Pyrolytic graphite also contains no binders.

Typical molded graphite composition consists of very structured, repetitively-stacked layers. The layers found in pyrolytic graphite are randomly-stacked. This structure of the basal planes in pyrolytic graphite accounts for the difference in properties (anisotrophy) as a function of the direction in which measurements are made.



Pyrolytic graphite surface and samples of forming tools.

In the planar direction, the material acts as a conductor, thermally and electrically similar to copper. In the thickness direction, it acts as an insulator similar to a ceramic. This ratio of conductivity to insulation is 200 times greater in directionality.

Technical Explanations

The unique crystalline orientation seen under x-ray diffraction is a function of deposition temperature and density, and it is what causes the anisotropic properties of the material. In addition, in pyrolytic graphite, the random stacking of layers destroys the periodic repetition of lattice positions in the thickness direction, and the graphite structure can no longer be considered a repetition of unit cells. A value of planar spacing in pyrolytic graphite is about equal to that of normal graphite.

The c/2 values are about 3.40 to 3.45Å as compared to 3.35Å for a single crystal graphite. This increase in the c/2 value is the result of stacking disorder. High density pyrolytic graphite material, however, approaches the 3.35Å c/2 spacing.

A photomicrograph of the typical growth structure of pyrolytic graphite shows what is typically known as "mandrel-nucleated pyrolytic graphite" with slight regeneration of the growth cones. The amount of regeneration in the material is a function of the process conditions. The rather pronounced cones of the pyrolytic graphite are caused by depositing onto the irregular surface of the commercial graphite substrate. The regular order of the pyrolytic graphite compared to the random structure of the ordinary graphite explains why it is helium-leak-tight while traditional graphite exhibits porosity.

Pyrolytic graphite is oxidation-resistant to 650°C and chemically inert. It can also be machined with standard carbide tooling.

Pyrolytic graphite can be supplied in flat or fully-machined pieces as required by the customer's applications and drawings.

Minteq International, the largest processor of pyrolytic graphite in North Americ under the trade name Pyroid®, is a wholly owned subsidiary of Minerals Technologies Inc. (MTI). Operating in 41 countries, with 18 manufacturing sites and four R&D facilities in North America, South America, Europe, and Asia, Minteq International has been a refractory supplier to the steel industry for 75 years and a supplier to the glass industry for 35 years.

In addition to Minteq International Inc., MTI also owns Specialty Minerals Inc., the predominant player in the precipitated calcium carbonate business with nearly 50 satellite PCC plants operating at major paper mills worldwide. SMI owns 5 limestone mines across the USA which are estimated to have reserves between 40 and 70 years.