Characteristics and Structure of A New Fine-Particle Graphite Material

F. T. Frick, W. H. Brixius, L. D. Fiel

Poco Graphite, Inc.
1601 S. State Street
Decatur, Texas 76234

A new graphite (ZXF-5Q) has been developed that is characterized by an extremely fine-particle size and unusually high strength. Compared to Poco AXF-5Q, the new material's particle size is much smaller and the strength and hardness are higher. Density, electrical resistivity, and the coefficient of thermal expansion are approximately the same as AXF-5Q.

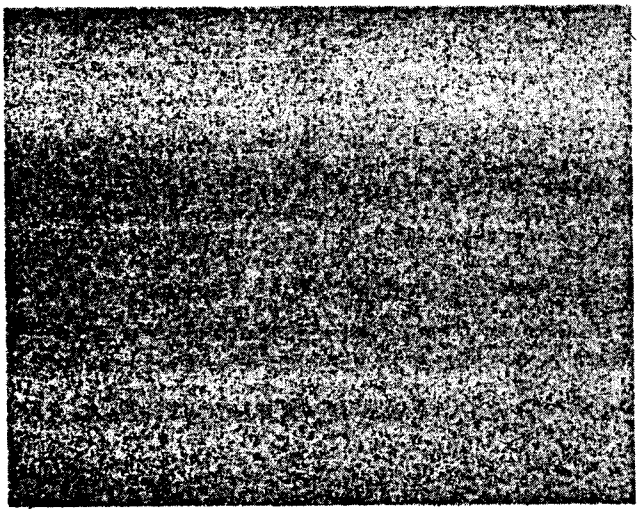
Table 1 shows the strength of the new graphite, ZXF-5Q, compared to AXF-5Q. Flexural strength was determined by the four-point loading test. Tensile strength specimens were carefully prepared and fixtured to minimize such things as bending moments and torsional stress so as to allow for true uniaxial tension. Compressive strengths were determined by standard practices. Referring to the figures shown in Table 1, the tensile strength is 44% higher, flexural strength 38% higher, and compressive strength 24% higher than AXF-5Q. Strengths in excess of 15,000 tensile and 22,000 flexural have been noted.

Table 1. Typical Strength of ZXF-5Q Compared With AXF-5Q

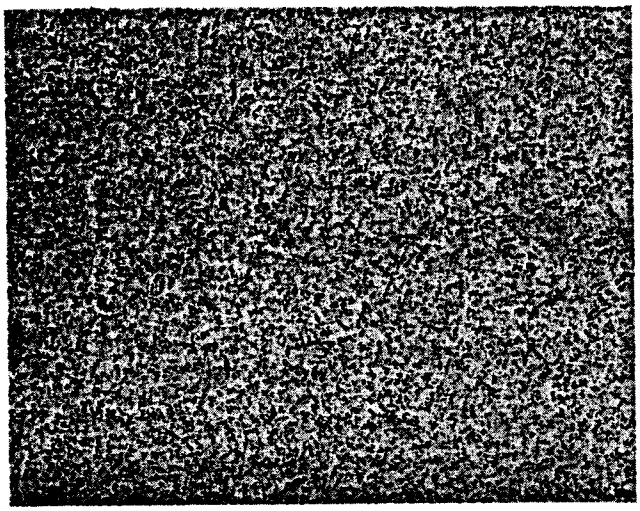
	ZXF-5Q	AXF-5Q
Tensile Strength(psi)	13,000	9,000
Flexural Strength(psi)	18,000	13,000
Compressive Strength(psi)	28,000	22,500

The 100X photomicrographs in Figure 1 illustrate the uniformity of pore size and structure of ZXF-5Q. The average particle size is less than 1.0 micron and the average pore size is 0.2 microns. Pore size was determined by mercury porosimetry. A comparison of ZXF-5Q and AXF-5Q porosity data is shown in Table 2. Even though pore volumes of ZXF-5Q and AXF-5Q are comparable, the small pore size of ZXF-5Q results in the larger internal surface area (over three times larger).

Permeability tests which were done with helium on 1/4" thick by 3/4" Ø cross-sections of ZXF-5Q showed no flow with pressures up to 40 psi. Flow data for higher pressure is shown in Figure 2, along with data for AXF-5Q. The helium permeability values on ZXF-5Q are two orders of magnitude less than for AXF-5Q at pressures up to 160 psi.



100X Photomicrograph of ZXF-5Q



100X Photomicrograph of AXF-5Q

Figure 1. Comparison of Microstructure.

Table 2. Porosimetry Data Comparison

	ZXF-5Q	AXF-5Q
Average Pore Size (μ)	0.20	0.84
Porosity (% Volume)		
Theorectical	19.00	19.00
Open	14.80	14.80
Closed	4.20	4.20
Surface Area (m^2/g)	2.20	0.64

Nondestructive testing has been evaluated as a method for determining the structural uniformity of ZXF-5Q. Specific methods evaluated were ultrasonic, radiation density gauge, and x-ray radiography. A radiation density gauge has been used to check density uniformity of billets up to 2" x 4" x 12". The uniformity was found to be within ± 1.5%. Visual observation using x-ray radiography gave general indications of uniformity but an optical densitometer was needed to quantify visual observations.

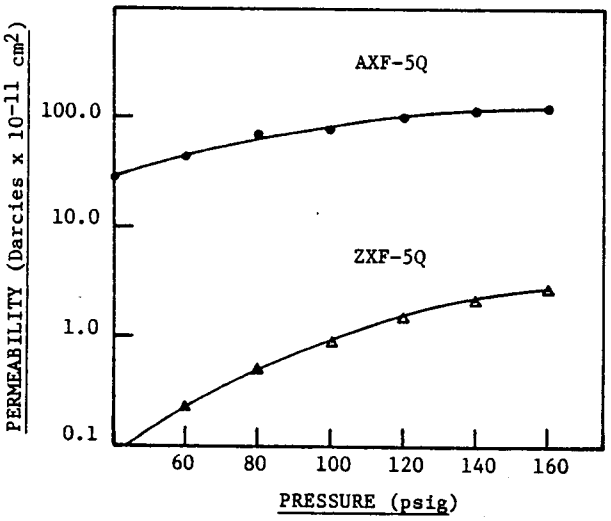


Figure 2. Comparison of Helium Permeability

This new graphite should be suitable for end-uses in fields such as optoelectronics, hot die pressing, high energy physics, and other applications where exceptional strength and structural uniformity are important.