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Thermal and Electrical Conductivity of Graphite

Graphite has a tendency to behave very much like a metal because the carbon molecules arrange themselves into a lattice structure. The crystal lattice is the same orientation that metal forms, and it allows the free-movement of electrons, making it a good electrical conductor. In graphite the carbon atoms are arranged into 2-dimensional sheets with the carbon atoms arranged into hexagons called benzene rings. The bonding in these rings has something called resonance in which the bonds are somewhere between a single and a double bond.

This causes the electrons to be free to move throughout the 2-dimensional sheet. As a result the electrons are easily moved to create and electric current.

The electrical conductivity of graphite increases with rise of temperature as contrasted with the decrease of the thermal conductivity with temperature rise. The thermal expansion of graphite is low in comparison to metals, being about 1/4 that of iron. Graphite has excellent thermal shock resistance for a brittle material due to its high thermal conductivity, low thermal expansion and low elastic modulus. Although graphite is considered an electrical conductor, the electrical resistivity of polycrystalline commercial Graphite is several hundred-fold higher than that of copper. At low and moderate temperatures, the temperature effect is negative, but becomes positive at high temperatures.

Graphite can withstand a wide range of temperature from very cold levels to > 3000°C in inert and reducing atmospheres and vacuum making it invaluable in many applications. Graphite does not melt but sublimates at 3900° K and withstands sharp temperature drops. Coefficient of thermal expansion of graphite is largely influenced by its structure. Accordingly, this property is specific to each grade and depends on the material anisotropy and temperature.

Graphite flake can be exfoliated into thinner and thinner sheets much like expanded vermiculite or popcorn when heated under controlled conditions.

Graphite is readily machined, due to its properties and structure it can be made into intricate shapes to small tolerances and high accuracy. Such combination of good properties inherent in this material has predetermined its extremely wide use.

An intimate knowledge of the material properties, permanent striving for technological progress and a long-standing experience in the graphite production provide the development of new applications thereof.