"The Effect of Short-term Neutron Irradiation on the Shear Compliance of Hot-worked Pyrolytic Graphite"

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A new direct technique is described for the measurement of the shear compliance in thin specimens of various types of graphite. It involves the determination of the torsional resonant frequency of compound aluminium/graphite specimens. Using this technique the shear modulus (C_{44}) of hot-worked pyrolytic graphite of density 2.23 gm/cc is found to be 1.3 $\pm 0.3 \times 10^9$ dynes/cm^2. The C_{44} of graphite single crystals is calculated to be $\sim 4.0 \times 10^{10}$ dynes/cm^2 from specific heat data, so that most of the observed compliance must be attributed to dislocation movement. Electron microscope studies of the graphite indicate it to be similar in structure to heavily sheared crystals of natural graphite and that probable dislocation anchorage points are micro-twins.

Neutron irradiations were carried out at 30°C up to doses of 5×10^{17} nvt (Ni) to reach saturation. The maximum value of C_{44} measured is 1.5×10^{10} dynes/cm^2 which is still much less than that anticipated. It is concluded that saturation at such low doses occurs not by the complete blocking of dislocation movement but by the interaction and combination of efficient "pinning" defects and new single interstitials to form larger less efficient defect clusters at higher doses. This combination process is also observed on annealing the irradiated specimens at temperatures up to 1,000°C. The maximum rate of decrease in modulus and also, therefore, in "pinning" defect population occurs at about 200°C.

The possible configurations of these pinning defects are discussed in the light of these results. From the calculated interaction energies it is concluded that primary bonds exist between small interstitial clusters and the

original basal planes. Conclusions are made with regard to reactor-grade graphites, it being demonstrated that in this case the prevention of dislocation movement need not be the only cause of irradiation hardening; changes in the basic lattice C_{44} may be equally effective.