9. THERMAL AND OPTICAL MEASUREMENTS ON VACANCIES IN TYPE IIa DIAMOND.

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In previous work[1], damage in diamond was produced by electron irradiation and observed as a reduction of the thermal conductivity between 320 and 450 K. This reduction was analysed in terms of a thermal resistivity depending on the vacancy concentration only, since it was assumed that displaced carbon atoms have negligible effect on the high-temperature thermal conductivity. In the present work, this assumption has been verified by measuring the thermal resistivity and the GR 1 optical absorption, which is most probably produced by vacancies [2]. The samples, of type IIa diamond, were irradiated with electrons of 1.50, 0.90, 0.60, or 0.35 MeV. The strength of the GR 1 absorption was found to be proportional to the radiation-induced thermal resistivity (based on 16 experimental points). The thermal resistivity thus correlates with the concentration of neutral vacancies.

In the present work diamonds were irradiated at temperatures below 250 K for comparison with the previous irradiations [1] at about 500 K. No detectable differences in damage rates were found. The experimental results, together with Mitchell's calculations [3], are consistent with an effective displacement energy for carbon atoms of 80 eV.

It was also assumed previously that recombination of displaced atoms and vacancies was negligible during irradiation. However, since the vacancy concentrations were high (of the order of 0.01 %) the production of damage began to saturate. This is inferred here from a small deviation from linearity in graphs of the two experimental quantities (thermal resistivity and GR 1 absorption) against dose for the 1.50 MeV irradiation. A simple model illustrates that there is competition at high doses for displaced atoms to recombine with vacancies or to become trapped near dislocations and other defects.

References:

(1) E.A. Burgemeister & C.A.J. Ammerlaan, Phys. Rev. B21 (1980) 2499.

(2) J.Walker, Rep. Prog. Phys. 42 (1979) 1605.

(3) E.W.J. Mitchell, "Physical Properties of Diamond", ed. R. Berman (Clarendon Press, Oxford, 1965) Chapter 15.