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Linewidth and Relaxation in the Conduction Electron Spin Resonance of Polycrystalline Graphite

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ABSTRACT

Electron spin resonance measurements have been made on single crystal and polycrystalline graphite at 9.3 GHz and at 335 MHz in air and in vacuum. The object of this work was to obtain the temperature dependence of the intrinsic spin-lattice relaxation time of the conduction electrons by eliminating the obscuring effects of g anisotropy and physically adsorbed oxygen on the linewidth.

For small crystallite-size material (SP-3 spectroscopic lampblack-base powder*), electron motion is sufficient to produce complete motional averaging. The completeness of averaging is established by the fact that the observed linewidth (approximately 4 gauss) is the same at both high and low frequencies, even though the single crystal g anisotropy is thirty times larger at the higher frequency.

For the larger crystallite types of graphite, SP-1 and SP-2, the linewidths at low frequencies are similar to that observed for SP-3, despite the fact that incomplete averaging causes extreme anisotropy broadening at microwave frequencies.

Different graphite particle sizes have significantly different linewidths; however, the linewidths for all the samples varied approximately as 1/T above room temperature. Between 200°K and 100°K, the linewidths tended to level off with decreasing temperature.

Although the low frequency results clearly eliminate g anisotropy contributions to the linewidth, the relative importance of various relaxation mechanisms in graphite of different crystallite and particle sizes is still not completely clear. The possible contributions of impurities, chemisorbed oxygen, and structural imperfections to the relaxation time are being investigated.

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* Grades SP-1, SP-2, and SP-3 "National" Spectroscopic Powders are manufactured by Union Carbide Corporation, Carbon Products Division.

① Crystallite size sufficiently small that the g-shift is averaged between g_c and g_{ab}.
2) line width & spin lattice relaxation.