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Magnetism and ^{13}C NMR relaxation of nanodiamond powder
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— The magnetization, ^{13}C NMR relaxation, and composition of commercial nanodiamonds with an average grain diameter of 4 nm have been studied. The magnetization contains several contributions due to (1) the diamagnetic effect of core and valence electrons of carbon, (2) ferromagnetic-like and (3) superparamagnetic contributions from Fe-bearing particles detected in nanodiamonds, and (4) a paramagnetic contribution from unpaired electrons. The spin concentration obtained from the paramagnetic susceptibility is 2.2×10^{20} spins/g. At 300 K, nanodiamond powder shows ferromagnetic magnetization of 0.01 emu/g. ^{13}C NMR spectra and relaxation times should be unaffected by the ferromagnetic particles with so small magnetization. Thus, a reduction of ^{13}C NMR T_1 relaxation times by orders of magnitude compared to microdiamond can be explained by unpaired electrons in the nanodiamond grains. The origins of unpaired electrons and ferromagnetism in nanodiamond powder and other carbon-based materials are discussed in view of our results.

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