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Mössbauer Studies of Cesium -- Graphite Compounds*

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The Mössbauer effect of the 81-KeV γ-ray from Cs^{133} is being used to examine the chemical bonding in lamellar compounds of cesium and graphite. All experiments have been carried out at liquid helium temperature using techniques and information available from earlier work.[1] All samples were prepared by reacting ultra-pure cesium with pyrolytic or spectroscopically pure polycrystalline graphite in vacuo, using the well-known "two-bulb" system.[2] The samples used in this study are described in the text.

Earlier measurements of electrical and magnetic properties of lamellar compounds of graphite demonstrate rather conclusively that most of these compounds are only incompletely ionized.[2] The measurements do not reveal whether the charge is shared equally by the intercalated atoms or is localized on one ion, with the rest of the reactant present in an atomic or molecular state. One of the objectives of the current study is to ascertain, if possible, the distribution of electric charge in the donor, cesium, of the lamellar compound.

The earliest specimen examined was the first stage compound, C_8Cs, made from pyrolytic graphite. A relatively broad line was observed; this could be evidence of either quadrupole broadening of the first excited nuclear state in Cs^{133} or of magnetic broadening due to a long relaxation time in atomic cesium, if present. The relaxation time might be expected to increase in a more dilute cesium compound, hence a test was made by measuring the Mössbauer line from $C_{24}Cs$ (this sample was made from polycrystalline graphite), but no significant increase in the line-broadening was found.

A further experiment was carried out by examining the Mössbauer emission from a specimen of cesium graphite placed in a magnetic field. To this end a sample of C_8Cs made from

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†Deceased.

polycrystalline graphite was placed in a 40 kilogauss magnetic field in a superconducting solenoid. The purpose was to make use of the paramagnetic alignment of an unpaired spin that is caused by high fields at low temperatures. If atomic cesium with a 6s valence electron were present, a spectrum of many lines due to the nuclear Zeeman effect in an internal field of about 10^6 gauss should be observed. A modest additional broadening was observed, which was more nearly characteristic of the applied field of 40 kilogauss than of the expected nuclear field of a megagauss.

Thus far, we have found no evidence for the presence of atomic cesium in these compounds; it appears that the electric charge is shared among the donor atoms of the compound. Studies are continuing with additional samples made from pyrolytic graphite in order to explore the effects of crystallite alignment and to determine the source of the observed broadening in the absence of a magnetic field.

(1) A. J. F. Boyle and G. J. Perlow, Phys. Rev. 149, 165 (1966)
Phys. Rev. 151, 211 (1966).

(2) G. R. Hennig, Prog. Inorg. Chem. 1, 125 (1959).