infinite brightness at infinite voltage. However, Eq. (1) predicts a point of inflection under certain conditions while Eq. (2) does not. Also, Eq. (1) predicts a power-law dependence at high voltages while Eq. (2) gives a linear dependence.

This equation has been tested on results reported from several published sources and we have also carried out more exhaustive comparisons with experimental results obtained in this laboratory. The results are shown in summarized form in Table I. In all cases the fit of the curve, given by Eq. (2), to the experimental results was as good as, or better than, that of the other relationships proposed. A typical example is shown in Fig. 1 for a ZnS:Cu phosphor prepared in this laboratory. It can be seen that, while the Destriau relationship gives considerable deviation at low voltages, Eq. (2) provides good agreement over the whole voltage range. The deviation at very high voltages, shown in this figure, has been observed in only a few cases and generally lies within the limits of experimental accuracy. Nevertheless, this apparent inconsistency is being investigated more fully.

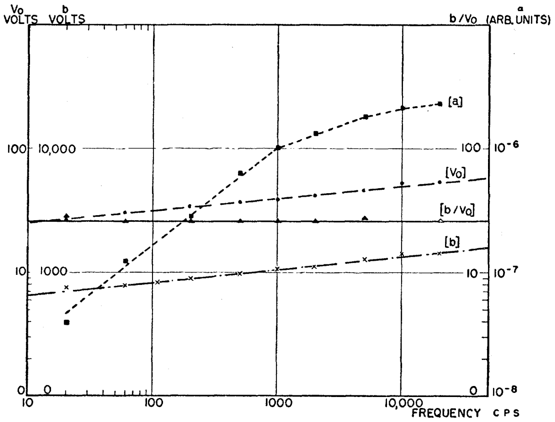

FIG. 2. Variation of the constants a, b, and V_0 of Eq. (2) with frequency of applied electric field (ZnS:Cu).

It can be seen from Table I that, although there is considerable variation in the constant a due to the different arbitrary units of brightness which have been used, the values of the constants b and V_0 are restricted to comparatively small ranges, b being of the order of 1000 volts and V_0 of the order of 50 volts. Further, the dimensionless quantity b/V_0, which is independent of cell thickness, shows even more constancy and seems to depend upon the activator used in the phosphor.

We have also studied the frequency dependence of the constants b and V_0; the results are shown in Fig. 2. It appears that both b and V_0 have a slight dependence upon frequency which can be expressed by the relationship,

$$b=b'f^n, \tag{3}$$

$$V_0=V_0'f^n, \tag{4}$$

where the exponent n is the same in both cases. This results from the fact that the ratio b/V_0 remains constant over the whole frequency range, as we have shown in the diagram. The frequency dependence of the constant a, also shown in Fig. 2, appears to be somewhat more complex; this is not too surprising since it would appear that this constant is the most sensitive to external influences.

No attempt has been made, in this Letter, to interpret the implications of Eq. (2) but a more complete account of this work will be published at a later date.

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Magnetic Anisotropy Constants of Ferromagnetic Spinels

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IN calculations involving magnetization processes, it is necessary to know the magnetic anisotropy constant of the material in question. Unfortunately, this information is lacking for most ferromagnetic spinels. Single crystals of $NiFe_2O_4$ and $CoFe_2O_4$ made by the flame-fusion method apparently always have some ferrous iron present[1] and are, therefore, in reality mixed crystals with magnetite, Fe_3O_4. Magnetite, however, has been made in single crystals of good purity[2] and K_1, the first order magnetic anisotropy constant, measured[3,4] as -1.1×10^5 ergs/cm^3.

One can calculate anisotropy constants for the ferromagnetic spinels as follows. Went and Wijn[5] have presented strong evidence that, unlike metals, the *initial permeability*, μ_0, of sintered, polycrystalline ferromagnetic spinels is predominantly due to spin rotation. We then have

$$\mu_0-1=kM_s^2/K_1,$$

where M_s is the saturation magnetization and k is a constant variously given[6–8] as π, $4\pi/3$, and $8\pi/3$. From the known data for magnetite ($\mu_0=45$ for sintered material and $M_s=480$, both at room temperature) we find $k=21$. Now taking this value for k we find K_1 for the other ferromagnetic spinels. Initial permeability of dense, polycrystalline materials was obtained by the author for carefully prepared samples. These were

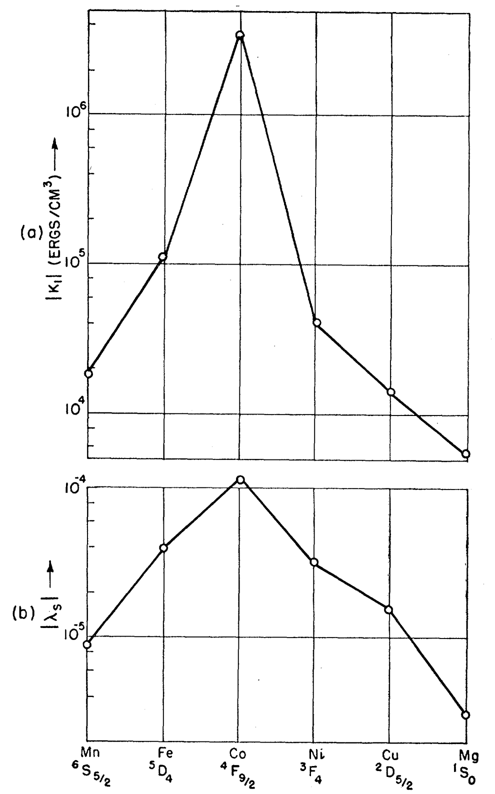

FIG. 1(a). Calculated anisotropy constant, K_1, (b) observed average magnetostriction constant, λ_s, plotted against M, for the ferromagnetic spinels, MFe_2O_4. Below each M is the ground-state term of M^{++}.

cooled slowly and are presumably nearly strain-free, with the exception of $CuFe_2O_4$ which had to be quenched. Values of M_s at room temperature were obtained in these laboratories and from other appropriate sources.[9]

The calculated values of $|K_1|$ for MFe_2O_4 are plotted in Fig. 1(a) *versus* the ground-state term of M^{++}. One will note there the direct correspondence between K_1 and J, the inner quantum number of M^{++}. Such a relationship is expected in view of the dependence of magnetic anisotropy on spin-orbit coupling. Van Vleck[10] has discussed a similar behavior in the paramagnetic bivalent salts of the iron series.

We find by our calculations, $K_1 = -4.0\times10^4$ ergs/cm^3 for $NiFe_2O_4$ and $K_1 = -3.4\times10^6$ for $CoFe_2O_4$. Experimental values are, respectively,[11,1] -5.1×10^4 and -1.7×10^6. Since these experimental values were obtained on crystals containing some magnetite in solid-solution,[1] it seems reasonable that K_1 for $NiFe_2O_4$ is higher and K_1 for $CoFe_2O_4$, lower, respectively than what we calculated for pure materials.

Figure 1(b) is a plot of $|\lambda_s|$, the average value of the saturation magnetostriction for sintered, polycrystalline ferromagnetic spinels. (We have ignored the fact that λ_s is positive for Fe_3O_4 and negative for the others). The values for λ_s were obtained here (with the exception of $CoFe_2O_4$)[12] and are believed to be accurate to ±25 percent. One will note again the same type of dependence on J.

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Infrared Spectrum of Barium Titanate*

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THE infrared absorption of barium titanate ($BaTiO_3$) has been studied between 2μ and 33μ. The spectrum obtained (Fig. 1) consists of two broad bands, one centered near 550 cm^{-1}, the other starting near 450 cm^{-1} and reaching a maximum beyond 300 cm^{-1}. The low transmission in the high-frequency end of the spectrum is due to scattering since the barium titanate was examined as a fine powder deposited on a KBr (or NaCl) plate from a suspension in isopropyl alcohol.

Several specimens of barium titanate were examined. The majority showed additional bands at 6.95, 9.45, and 11.65μ, which were proved to be due to carbonate ion impurities. Other impurity bands were noted at 7.1, 10.3, 11.05, 11.4, 11.85, and 12.85μ, but the impurities were not identified. The spectrum of a very

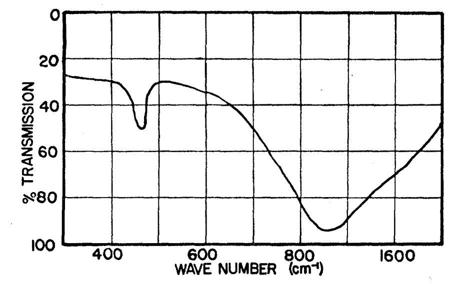

FIG. 1. The infrared absorption spectrum of $BaTiO_3$.