and Bauer.[6] They find that $F(D)$ is constant over the range 0.05–1.00 for Eastman spectroscopic VD plates and microfile film.

The deviation of $F(D)$ from constancy reported by Bartell and Brockway for low densities is of no great significance to molecular structure studies, the type of study to which the calibration procedure has been applied in our Laboratory. Since the deviation is important for the atomic structure investigation which has been reported by Bartell and Brockway,[7] an effort should be made to resolve the disagreements with the publications mentioned.

[1] L. S. Bartell and L. O. Brockway, J. Appl. Phys. 24, 656 (1953).
[2] J. Karle and I. L. Karle, J. Chem. Phys. 18, 957 (1950).
[3] A. Becker and E. Kipphan, Ann. Physik 10, 15 (1931).
[4] A. Charlesby, Proc. Phys. Soc. (London) 52, 657 (1940).
[5] Baker, Ramberg, and Hillier, J. Appl. Phys. 13, 450 (1942).
[6] J. M. Hastings and S. H. Bauer, J. Chem. Phys. 18, 17 (1950).
[7] L. S. Bartell and L. O. Brockway, Phys. Rev. 90, 833 (1953).

Reply to Comment on "The Calibration of Photographic Emulsions for Electron Diffraction Investigations"

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THERE is no disagreement between our views[1] and the conclusions presented in the publications[2–5] cited by Karle and Karle[6] regarding the initial proportionality of the variables D and E. This proportionality appears to be well supported by experimental evidence and, indeed, is probably more quantitatively established by the data of Karle and Karle and of ourselves than by the earlier articles.[2–4] Any difference of opinion, then, involves the point at which the deviation from proportionality is considered to become appreciable. It should be noted that the function, $F(D) = E/D$, introduced by us, emphasizes this deviation far more than does the conventional plot of D vs E, and that the deviation indicated by our experiments is very small in the region of D in dispute ($D < 0.25$). Since the discrepancy amounts to only about 1 percent in the comparison of, say, the densities 0.15 and 0.25 in the $F_1(D)$ curve, an accuracy of a fraction of 1 percent at small D is required to resolve the question of whether this discrepancy, denied by Karle and Karle, is real.

Furthermore, contrary to the contention of Karle and Karle, there is no disagreement between our results and the results of Becker and Kipphan,[2] Charlesby,[3] and Baker, Ramberg, and Hillier,[4] in any region of the calibration curves. In the region with $D > 0.3$, our results agree satisfactorily with those of the foregoing workers. In the disputed region an examination of the publications mentioned shows that the results fit either point of view equally well, the scattering of the experimental points being too great to distinguish between them. In reference to the work of Hastings and Bauer,[5] it should be pointed out that Bauer has published experimental curves for a number of emulsions including Eastman lantern slide plates[7] and these are in satisfactory agreement with our results. According to the data, not even the $F(D)$ curves for microfile film are completely constant to $D = 1.0$.

Unfortunately, we have not had the opportunity to examine in any detail the data of Karle and Karle, but we are confident that any disagreement with our data is not large. The consistency of our results has strongly suggested that the form $F(D) = 1 + cD$ holds at small D but, in view of the smallness of the effect which is in a region that is difficult to measure with great accuracy and in view of our high regard for the work of Karle and Karle, we certainly do not consider our evidence for this limiting form as final. In fact, our article suggests conditions under which the expected limiting form would be in accord with the results of Karle and Karle. In any event, the aforementioned uncertainties do not invalidate the general calibration procedure described in the article.[1]

Finally, it is to be emphasized that, contrary to the claim of Karle and Karle, the disputed region had absolutely no bearing on the results of the atomic structure investigation[8] cited because, in this study, densities were kept well out of the uncertain range and sectors were chosen which minimized the remaining uncertainties in the emulsion. The effect discussed in the article on calibration[1] that is important in atomic structure studies (though really of any consequence only in the region of the K shell) is an unrelated effect which is undisputed to our knowledge.

[1] L. S. Bartell and L. O. Brockway, J. Appl. Phys. 24, 656 (1953).
[2] A. Becker and E. Kipphan, Ann. Physik (Lpz.) 10, 15 (1931).
[3] A. Charlesby, Proc. Phys. Soc. (London) 52, 657 (1940).
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[5] J. M. Hastings and S. H. Bauer, J. Chem. Phys. 18, 17 (1950).
[6] I. L. Karle and J. Karle, J. Appl. Phys. 24, 1522 (1953).
[7] Bauer, Keidel, and Harvey, Technical Report on project covered by contract N6 ori-213, Task Order I NR 052-040, Cornell University (1949).
[8] L. S. Bartell and L. O. Brockway, Phys. Rev. 90, 833 (1953).

Note on the Stress Dependence of the Activation Energy of the Rupture Process

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IN the course of some investigations on the effects of hot combustion gases on stressed metals (to be described elsewhere), it was found that, in the case of a cold-worked nickel-chromium-iron alloy, relations between rupture time, temperature, and applied stress obey a rate process law, at temperatures between 900°C and 1150°C, in an atmosphere of burning propane.

However, use of the rate process equation, extrapolated to include other values of stress, is not in agreement with experimental data, because of changes in the activation energy with stress. As seen in Fig. 1, if one plots the logarithm of the reciprocal
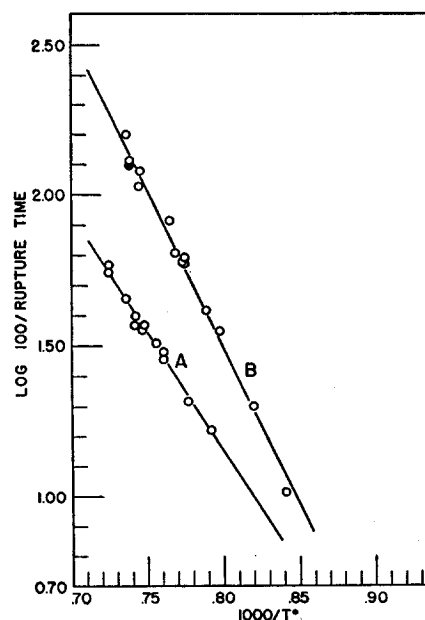

FIG. 1. Changes in slopes at different stress values for chromel wire.

of the rupture time in minutes against the reciprocal of the absolute temperature, a straight line is obtained, the slope of which is a measure of the activation energy. Line A in the diagram is a plot at a stress of 5380 psi, and B is that at 7500 psi. The

activation energy of the process at the lower stress is 36 kcal, and 48 kcal at the higher.

Further experiments are under way to determine whether the activation energy is truly stress dependent, since the difference in values is believed to be beyond the limits of the experimental error of the methods used.

Effect of Cross-Section Area and Compression upon the Relaxation in Permeability for Toroidal Samples of Ferrites

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WE have investigated the effects of cross-section area and compression upon the relaxation frequency of a sample of NiZn ferrite and of a sample of MnZn ferrite. We found that change in cross-section area had no effect upon the relaxation frequency of the NiZn ferrite but caused the relaxation frequency of the MnZn ferrite to shift in a manner predicted by theory.[1] Compression reduced μ' for both materials. The relaxation frequency altered as expected for the MnZn but not for the NiZn ferrite.

A toroidal sample of each material was used. Originally, the samples were of the same nominal dimensions—750 mils o.d., 420 mils i.d., and 200 mils thick. Each sample was wound with 10 turns, and inductance and resistance measurements were made on a Maxwell bridge from 25 kc to 2 mc. The components of complex permeability ($\mu = \mu' - j\mu''$) were calculated from these data. Both materials showed relaxation frequencies below 1 mc.

The cross-section areas of the toroids were changed by grinding. Thicknesses were reduced and inner diameters increased, thus reducing the areas. The successive dimensions are tabulated in Figs. 1 and 2. After each dimension change, the toroids were rewound and measured. After measurements for the smallest cross-section areas, the samples were put under compression by encasing them in plastic[2] and measurements were made for this condition. Figures 1 and 2 show the results.

If the low-frequency relaxation results only from domain wall motion, a change in cross-section area would not be expected to
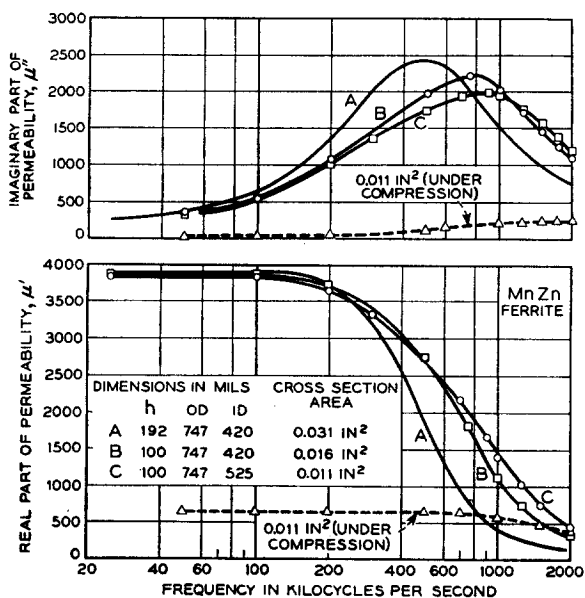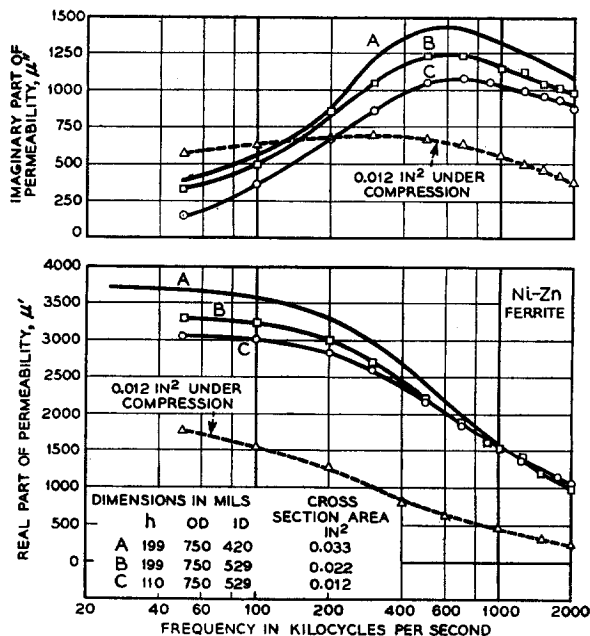

FIG. 2.

affect the relaxation frequency. On the other hand, eddy current effects, either displacement, conduction, or both, will be influenced by cross-section area. Prache and Billottet[1] have shown that in this case the relaxation frequency would be inversely proportional to diameter for a circular cross section.

Figure 1 for MnZn ferrite shows definite shifts in both μ' and μ'' as cross-section area is changed. Table I compares the ratio of

TABLE I.

Curves	(Area ratio)$^{\frac{1}{2}}$	Frequency ratio
A and B	1.4	1.5
A and C	1.7	1.7
B and C	1.2	1.2

relaxation frequencies with the square roots of cross-section areas.

The close agreement in Table I is as would be expected in the absence of domain wall relaxation. Essentially, it indicates that the true permeability of the material has not changed in this frequency range and, therefore, that the wall motion has not relaxed. Had the walls shown relaxation, there would be changes in the permeability with frequency, and the indicated correlation between relaxation frequency and dimensions would not be found. Thus the agreement between frequency ratio and square root of area ratio supports the conclusion that for this material the relaxation of permeability should be attributed to dimensional effects rather than to wall motion.

In contrast to the behavior of MnZn ferrite, the NiZn showed no change in relaxation frequency with dimensions. This behavior strongly supports the conclusion that in this material the relaxation should not be attributed to dimensional effects. As further evidence of this, the apparent dielectric constant of this sample was measured and found to be of the order of 1500, which leads to a predicted dimensional relaxation frequency of about 40 mc. Figure 2 shows a slight drop in low-frequency μ' with a decrease in cross-section area. This relatively small effect may be attributable to strains set up when the sample was ground to change its dimensions.

The two materials responded quite differently to compression. For the MnZn ferrite, μ' decreased to about $\frac{1}{6}$ the unstressed value,

FIG. 1.