depends on the 'total amount' of shear. In connexion with this, the possibility arises for aluminium of the *simultaneous occurrence of smaller recrystallisation power and greater hardening* and vice versa.

With the aid of this conception it has been possible to understand in principle the results obtained by several investigators[5], in which this non-parallelism between hardening and recrystallisation power has been demonstrated.

The experiments also permit us to understand why large aluminium crystals, grown by recrystallisation of strained polycrystalline test pieces, seem to favour a position in which a [110] direction is parallel to the direction of straining[6]. This can be related to the fact which has been shown experimentally, that the recrystallisation power is, in general, greatest for aluminium crystals which have been stretched in a direction approaching the [110] direction, the reason for which seems to be that in this direction the probability of the occurrence of *multiple* slip (along 'forbidden planes') is smallest. Therefore it seems probable that on stretching a polycrystalline aggregate, a crystal grain of such orientation will serve as nucleus for the single crystal formed on heating.

I wish to thank Mr. J. J. A. Ploos van Amstel for his valuable help with these experiments. For details I refer to the *Zeitschrift für Physik*, in which they will be published shortly.

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* The 'amount of shear' is defined by the relative displacement of two parallel planes of slip at unit distance.

[1] W. G. Burgers and P. C. Louwerse, *Z. Phys.*, **67**, 605 ; 1931. *Metallw.*, **11**, 251 ; 1932.
[2] *Trans. Far. Soc.*, **24**, 121 ; 1928. Compare also A. Müller, loc. cit., 173 ; H. J. Gough, 137.
[3] *Proc. Roy. Soc.*, A, **116**. 39 ; 1927.
[4] *Z. Phys.*, **41**, 116 ; 1927.
[5] See, for example, P. Beck and M. Polanyi, *Z. Elektrochem.*, **37**, 521 ; 1931. A. E. van Arkel and M. G. van Bruggen, *Z. Phys.*, in the press.
[6] See, for example, C. F. Elam, *Phil. Mag.*, (6), **50**, 517 ; 1925. G. Sachs and J. Weerts, *Z. Phys.*, **59**, 497 ; 1929.

Debye's Dispersion of Nitrobenzene

According to Debye, dispersion must take place in polar liquids around a frequency ν given by the expression :

$$\frac{1}{2\pi\nu} = \tau = \frac{\zeta}{2kT} \tag{1}$$

where T is the so-called time of relaxation, k is Boltzmann's constant, T is the absolute temperature and ζ is a constant corresponding to the internal friction which prevents the polar molecules from rotating freely. In the case of spherical molecules, to which Stokes's law can be applied

$$\zeta = 8\pi\eta a^3 \tag{2}$$

where η is the coefficient of viscosity and a the radius of the molecules. The time T is of the order of 3×10^{-11} seconds for water and this period corresponds to a wave-length of about 1 cm. In order to bring the dispersion in a region of wave-length more accessible to undamped oscillating circuits, one can dissolve the polar liquids in very viscous non-polar solvents, as has been shown by Williams and Johnstone[1]. This procedure has another advantage, namely, that of eliminating the spurious effects of molecular association always present with polar substances.

We have dissolved different polar molecules in Shell oil BL 3, which has a coefficient of viscosity of about 5 poises at 35° C., and we have measured the dielectric constant of these solutions for eight wave-lengths between 328 m. and 18 cm.

The small value of the dielectric constant of the oil ($\varepsilon = 2\cdot32$) has led us to believe that its molecules were not polar. We verified that the pure solvent showed no dispersion in the region studied. For the polar solutions, however, we obtained two regions of dispersion. A typical curve is given in Fig. 1 for two concentrations of nitro-benzene. These two dispersions follow separately and closely the law predicted by Debye.

In order to explain the presence of these two regions of dispersion, we have been led to assume that they correspond to two different types of resisting media in which the molecules can rotate. The
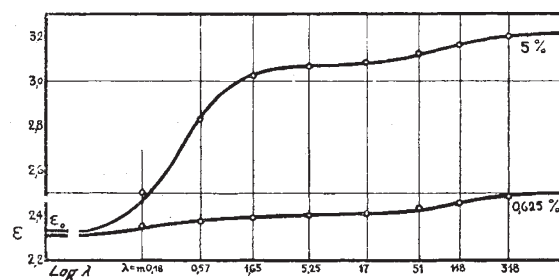

Fig. 1.　Dispersion of nitrobenzene at 20°C in Shell oil BL 3.

region of relatively long wave-length would be brought about by the friction with which the oil molecules hinder the rotation of the nitrobenzene polar molecules. The second region would be due to the viscous forces of nitrobenzene itself. Thus our experiments would show that when nitrobenzene is dissolved in viscous oil, some of its molecules form a sort of aggregate while others are relatively free. This view is in complete accord with measurements of the dispersion of amyl and butyl alcohol which we have made and with measurements of this dispersion as a function of the temperature.

A more detailed account of this work, which forms the dissertation of one of us (R. L.), is to appear soon in the *Helv. Phys. Acta*.

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[1] Williams and Johnstone, *Phys. Rev.*, **34**, 1483 ; 1930.

Reversal of Current in Rectifier Photo-Cells

I have just seen the letter on the above subject by Messrs. H. H. Poole and W. R. G. Atkins in Nature of January 28. I encountered the phenomenon to which they refer about three months ago when determining the spectral sensitivity of some gold—cuprous oxide—copper cells of the Auger type, but refrained from directing immediate attention to it as it was apparent from an examination of the results that further work was required before a completely satisfactory explanation was forthcoming.

That the cuprous oxide—copper junction is the essential factor in producing the reversal, as suggested by Messrs. Poole and Atkins, is certain, because in cells which I have since been able to