To make the film, the specimen grid is held at the extreme edge in a fine-pointed pair of forceps, and immersed in the solution. On withdrawal, it is held horizontal and allowed to dry; this takes only a few seconds. The formation of the film is easily observed during drying, and best results are obtained when up to about one-third of the grid squares remain covered. If the whole grid is covered, the film is usually found to be too thick. To achieve this, two factors can be varied. The strength of solution can be between 0·5 and 1 per cent, and the amount of liquid remaining on the grid can be varied by the manner in which it is withdrawn from the solution. With practice, good thin films can be made without difficulty. It is important to remove the grid from the forceps immediately after the drying of the film is complete, otherwise any solution remaining on the forceps will form a thick blob of 'Formvar' on the grid which is liable to charge up electrically in the microscope. It is convenient to transfer the grid quickly to a second pair of forceps and remove any small drops of liquid which may remain at the point where it was previously gripped.

The method has been used over a period for routine work and has proved to be very satisfactory.

I wish to thank Dr. T. E. Allibone for permission to publish this note.

D. E. Bradley

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston Court,
Aldermaston, Berks.
March 30.

---

[1] Dyson, J., *Nature* [171, 743 (1953)].

Frictional Electrification of Polar Polymers

It does not appear that any single mechanism suffices to explain frictional electrification completely[1,2]. The electrolytic mechanism of charge transfer has been discussed by Freundlich[3], but is generally taken to presuppose the existence of thin aqueous films on the surfaces, and to have only limited application to 'dry' solids[2]. Further, the conductance of even the thinnest of aqueous films is likely to suppress electrification on separation[4]. Nevertheless, electrolytic action accounts very satisfactorily for the behaviour of solids with polar properties. Thus Knoblauch[5] demonstrated the tendency of a large range of acids and bases to become electrified negatively and positively respectively, and obtained the best results with organic acids and bases. One concludes that the polar nature of these substances facilitated ionic processes in the presence of sorbed water molecules (not necessarily forming a separate phase), and that the acid donated excess positive ions (proton) and bases excess negative ions (hydroxyl). The results no doubt depend on the relative mobility of the ions, the larger ions tending to aggregate in both cases and were therefore less mobile than H^+ and OH^- ions.

Excellent conditions for investigating electrolytic charge separation obtain with polar polymers, and in particular textiles and ion-exchange resins. The presence of the acid or basic groups promotes water sorption and consequent ionic dissociation and mobility even at low humidities[6]. One ion is, however, firmly bound to the polymer matrix and the other is free to take part in the charge transfer. For example, consider the strongly basic resin 'De-acidite *FF*', and the strongly acid 'Permutit' sulphonated polystyrene. We have:

$$R.\mathrm{NOH} \rightarrow R\mathrm{N}^+ + \mathrm{OH}^-$$
$$R.\mathrm{SO_3H} \rightarrow R\mathrm{SO_3}^- + \mathrm{H}^+,$$

with the respective positive and negative ions firmly bound; the resins donate freely diffusible OH^- and H^+ ions respectively. This was indeed found to be true at about 30 per cent relative humidity, when the resins in powder form were shaken from a filter paper; the basic resin showed consistent positive charges and the acid resin negative charges.

Weak bases and acids were found to behave in a similar manner provided they were carefully neutralized (for example, 'Amberlite' *IR* 4*B* and 'Zeo-Karb' 216). It would seem that a similar mechanism also contributes largely to the electric charge acquired by wool keratin, which becomes positively electrified against filter paper; this is characteristic of polypeptides, which contain both basic and acidic groups against cellulose. Acidified horn keratin also becomes positively electrified against filter paper, while after treatment with dilute caustic soda it becomes negatively electrified. Similar reversals may be obtained with the resins, and in all these cases the direction of charge transfer is given by the sign of the boundary potential as deduced from the Donnan theory.

J. A. Medley

Wool Industries Research Association,
Torridon, Leeds 6.
Dec. 19.

[1] Shaw, P. E., and Leavey, E. W. L., *Proc. Roy. Soc.*, A, **138**, 502 (1932).

[2] Loeb, L. B., *Science*, **102**, 573 (1945).

[3] Freundlich, H., "Colloid and Capillary Chemistry" (Methuen, 1926).

[4] Medley, J. A., *Brit. J. Appl. Phys.* (in the press).

[5] Knoblauch, *Z. phys. Chem.*, **39**, 225 (1902).

[6] King, G., and Medley, J. A., *J. Coll. Sci.*, **4**, 1 (1949). Hearle, J. W. S., *J. Text. Inst.*, **43**, *P*194 (1952).

A New Precision Method for the Measurement of Ultrasonic Velocities in Liquids

Several methods[1] are available for the determination of ultrasonic velocities in liquids, of which the liquid film method[2] offers many advantages. The new method presented here enables a rapid determination of ultrasonic velocities with a high degree of accuracy.

The experimental arrangement consists of the usual apparatus for observing the Debye–Sears diffraction pattern in liquids. A quartz *X*-cut wedge of 1–3 Mc./sec. range is mounted in the crystal holder with *X*-axis vertical and the tapered edge parallel to the direction of the light beam, and is excited by a Hartley shunt-fed oscillator. The ultrasonic waves generated by this wedge are communicated to the liquid contained in a glass cell mounted on a levelling stand. The levelling is then adjusted so that the bottom of the glass cell is truly parallel to the surface of the wedge in contact with the liquid. A stationary ultrasonic diffraction grating can now be set up in the liquid column only at those frequencies for which the liquid column is in resonance.

Intense diffraction patterns are observed at a large number of these frequencies, which are very closely spaced. Using a slow-motion gear on the oscillator condenser and a length of liquid column of 4 cm., the frequencies of a number of these diffraction maxima have been measured and found to be exactly