As expected, the number of back-scattered electrons was increased by increasing the atomic number of the backing plate and, as with the forward scatter foil, the widest scatter angles were presented to the moulding at the closest practicable distance.

The best results were obtained using a forward scatter foil of 0·5 mm aluminium and a back scatter plate of 1·5 mm lead over the sample support tray.

Final dose distribution checks were made using the improved indicator paper above, below, and inside the moulding. The dose ratio within the moulding irradiated from one side was then found to be 1·2.

Owing to the increase in overall efficiency on using the scattering foils, the minimum indicated dose under the conditions quoted was close to the mean exposure dose as measured in the first 1·2 g/cm² of a slab of material irradiated by the 4-MeV beam without scattering foils.

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Dielectric Loss Factor of Polytetrafluoroethylene under Irradiation

THE effect of ionizing radiation on steady-state conductivity of polymeric dielectrics has been already examined by several authors. I have shown[1] that radiation affects not only the steady-state conductivity of polytetrafluoroethylene but also the transient conductivity, deduced from the current flowing through the specimen after the application of d.c. voltage. Recently I have carried out measurements of dielectric permittivity and dissipation factor under irradiation.

As a source of radiation, an X-ray equipment was used, giving dose rates in the range 0·01–100 r./sec. Circular specimens, 40μ thick, were cut from commercial polytetrafluoroethylene sheet and aluminium electrodes were evaporated on to both sides. A 'sandwich' type arrangement of two specimens was used. The dielectric permittivity and dissipation factor were measured at 50 and 1,000 c/s, 100 V and at about 21° C by the aid of a Wien's bridge (the four capacitances bridge) provided with a Wagner's earth.

The effect of radiation on the dissipation factor of polytetrafluoroethylene is much less pronounced than on the steady-state conductivity. The dissipation factor begins
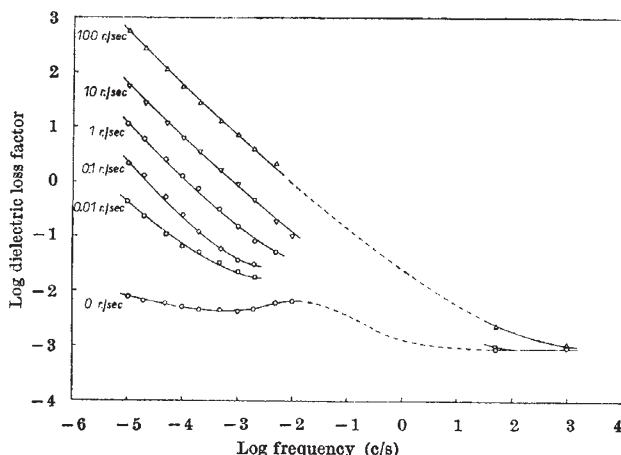

Fig. 1. Frequency-dependence of loss factor for polytetrafluoroethylene at various dose rates

to rise at 50 c/s with a dose rate of 1 r./sec, at 1 kc/s even with 10 r./sec. The dielectric permittivity remains nearly constant in the whole range of dose rates used. From these a.c. measurements the loss factor was deduced. Fig. 1 shows the dependence of loss factor on dose rate over the range 0·01–100 r./sec. The loss factors at low frequencies were deduced from d.c. measurements[1] by Hamon's method[2]. The results indicate that the variation in the loss factor with dose rate is not caused solely by the rise of steady-state conductivity.

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Heat Liberation in Alloy-junction Silicon Diodes

IN a recent communication[1], Melehy and Jarmoc have reported interesting observations of the distribution of temperature in silicon diodes carrying a relatively large current in the forward direction. It is shown here that their observations are readily explained in terms of junction theory, when account is taken of the difference in electron and hole mobilities in silicon.

Consider a p^+–n–n^+ structure biased sufficiently in the forward direction so that the injected carrier density in the n-region is greater than the equilibrium density of electrons, and there are equal densities of electrons and holes[2]. When the width of the n-region is comparable with the diffusion length, recombination of electrons and holes is known to occur[3] predominantly in the end regions, at the metal-semiconductor contact.

For convenience we consider the end regions to be degenerate. An electron which surmounts the potential barriers between n^+- and n-regions, and between n- and p^+-regions, extracts heat[4] from the system at these two planes; the total energy abstracted per electron is to a first approximation $q(E_g - V_f)$, where qE_g is the band-gap energy and V_f the forward bias voltage on the diode. On arrival in the p^+-region the electron recombines with a hole and liberates energy qE_g, which may be assumed to be taken up by the lattice as heat energy. We neglect the kinetic energy of the charge-carriers, as well as heat dissipation associated with the flow of current in the n-region.

In the same way there is a transfer of heat energy by holes from the p^+–n and n–n^+ junctions to the n^+-region. However, because the electrons have greater mobility in the electric field which exists in the n-region, and the densities there are equal, the electron current in the device will exceed that of the holes; the transfer of heat energy to the p^+-region will therefore outweigh that to the n^+-region in the ratio $b \simeq 2·8$ at room temperature, and we may expect the temperature in the p^+-region to rise above that in the n^+-region, as observed[1].

Furthermore, if the mobility ratio b is sufficiently large the heat extracted by electrons in the vicinity of the n^+-region may exceed that liberated by holes arriving there, and the temperature at this side of the diode will fall below the ambient. With a suitable semiconductor (for example, indium arsenide) a p^+–n–n^+ structure may thus act as a thermoelectric refrigerator by virtue of the flow of non-equilibrium charge-carriers.

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