relative to the mean is 1·5 per cent for concentrations of 10–25 mgm. nickel per 100 ml. For concentrations down to 2 mgm. nickel per 100 ml. it is still about 3 per cent. The accuracy is equal to the precision if the amount of other cations is not more than ten times that of the nickel; for example, in a copper-nickel alloy (Belgian one franc coin) we found 24·55 per cent nickel, whereas chemical analysis gave 24·52 per cent nickel.

For alloys containing very low amounts of nickel, for example, ordinary steels, it is necessary to add to the developing solvent 4 per cent acetylacetone. In British Chemical Standard No. 239 (0·3 per cent carbon steel), which according to the certificate contains 0·23 per cent nickel, we found 0·21 per cent.

Full details of this investigation will be published elsewhere. Acknowledgment is made to Prof. E. Maes, head of the laboratory, for permission to publish this communication.

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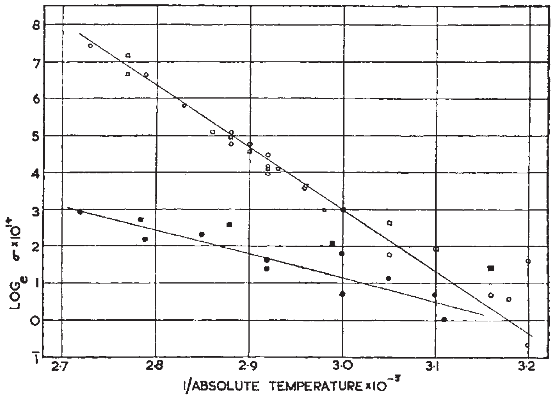
## Effect of Temperature on the Conductivity induced in Insulators by X-Rays

During the course of an investigation into the conductivity induced in insulating materials by X-rays, it was observed that the conductivity of a length of polythene cable that had been irradiated six months before showed very marked dependence on temperature. In the case of similar cable unirradiated the effect was much less pronounced. Two samples of unirradiated cable were tested.

The previously irradiated cable had been subjected to a total of just under $5 \times 10^5$ r. given over the space of about a month at qualities of radiation ranging in value from 90 kV. H.V.L. = 1 mm. aluminium, equivalent wave-length 0·55 A., to 230 kV. H.V.L. = 2·3 mm. copper, equivalent wave-length 0·10 A.

The cable, mounted as a flat spiral inside a metal box, was heated by a stream of hot air flowing around it. A potential difference was applied between the sheath and central conductor of the cable, and the current flowing through the insulation was measured by means of a high resistance and D.C. amplifier. The voltage gradient was 775 volts per cm. The temperature was raised in steps to the highest value, and reduced in similar fashion. It was maintained within ± 2° C. of any required value until the conductivity reached equilibrium value. Because of the smallness of the currents being measured, the accuracy was rather low at the lower temperatures.

The results are presented in the accompanying graph, showing an approximately straight-line relation between the logarithm of the conductivity and the reciprocal of the absolute temperature. Thus the equation $\sigma = \sigma_0 \exp(-W/kT)$ which holds for semi-conductors[1] appears to be applicable. From the slope of the graphs the value of $W$ for the irradiated cable is found to be 1·45 eV., and for the unirradiated cable 0·50 eV.




Irradiated cable: ○, ascending temperature; □, descending temperature.
Unirradiated cable: ●, ascending temperature; ■, descending temperature

This suggests that conductivity in the latter may be due to electrons at a shallow level with respect to the conduction band, and in the former to positive holes produced by the radiation at a deeper level. If this is correct, then the contribution to the conductivity of the irradiated material made by the holes outweighs that due to impurity electrons as the temperature is raised.

It was pointed out by Farmer[2] that polystyrene shows a delay in returning to its original state after being irradiated. Polythene possesses a similar property, and it is a remarkable thing that six months after being disturbed, the mechanism of conductivity in the material had not returned to normal.

*Note added in proof.* The results obtained by Fowler and Farmer[3], for polythene cable both untreated and while undergoing irradiation, showed similar conductivity – temperature relationships to the above. They found much lower values of $\sigma$ for unirradiated cable, and a value of $W = 1·5$ eV. This is difficult to understand, as the specimens used were obtained from the same supplier. It appears that there must be some variation in the treatment of the polythene during manufacture. The higher conductivity could be associated with increased impurity content. The value of $W$ for the cable undergoing irradiation was found to be 0·42 eV., and this is consistent with the supposition that radiation raises electrons from non-conduction levels to a level that is shallow with respect to the conduction band. Further measurements on various specimens of polythene are required to resolve the differences between the results.

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