with a Unicam spectrophotometer at 304 mμ. The results, which show the anticipated increase of the hydrogen-ferrous ion ratio with increasing ion density of the radiation, are given in Table 1.

Table 1. RATIO OF HYDROGEN AND FERRIC ION YIELDS IN OXYGENATED SOLUTIONS

Type of radiation	$G(\text{H}_2)/G(\text{Fe}^{3+})$
Cobalt-60 γ-rays	0.0258 ± 0.0008
250-kV. X-rays	0.0305 ± 0.0009
50-kV. peak X-rays	0.0327 ± 0.0014

It is known that the hydrogen yield under constant irradiation increases slightly as the system becomes depleted of oxygen³, but conditions were maintained constant throughout the measurements, so that no significant error was introduced on this account. It was estimated that the increase in hydrogen yield over a complete irradiation was of the order of 2 per cent under the experimental conditions.

Following the generally accepted mechanism for this oxidation in aerated solution, we have:

For this overall decomposition of the water, the stoichiometry demands that:

$$G_{-\text{H}_2\text{O}} = 2G_{\text{H}_2} + G_{\text{H}} = 2G_{\text{H}_2\text{O}_2} + G_{\text{OH}} \quad (1)$$

Of these products, hydrogen is inert, one molecule of hydrogen peroxide oxidizes two ferrous ions, one hydroxyl radical one ferrous ion, and one hydrogen atom, after conversion to HO_2 by dissolved oxygen, three. The yield of ferric ions is thus:

$$\begin{aligned} G_{\text{Fe}^{3+}} &= 2G_{\text{H}_2\text{O}_2} + G_{\text{OH}} + 3G_{\text{H}} \\ &= 2G_{\text{H}_2} + 4G_{\text{H}} \\ &= 4G_{-\text{H}_2\text{O}} - 6G_{\text{H}_2}, \text{ from (1) above} \end{aligned}$$

From this result, writing $G_{\text{H}_2}/G_{\text{Fe}^{3+}} = R$, we have:

$$G_{\text{Fe}^{3+}} = 4G_{-\text{H}_2\text{O}}/(1 + 6R)$$

In order to compute the appropriate yields of ferric ion from the results in Table 1, information is therefore necessary concerning $G_{-\text{H}_2\text{O}}$ as a function of radiation quality. This is a less sensitive function of ion density than is the ferric ion yield, varying only from 4.5 ± 0.1 for cobalt-60 γ-rays to 3.5 ± 0.1 for the radiations from the $^{10}\text{B}(n, \alpha)^7\text{Li}$ process, and information as to its behaviour over this wide region of ion density is now available (Barr and Schuler, Brookhaven National Laboratory, New York, private communication). From this it may be predicted that the value of $G_{-\text{H}_2\text{O}}$ appropriate to 250-kV. X-rays will be 4.4 ± 0.2 , the corresponding quantity for 50-kV. peak X-rays being 4.2 ± 0.2 . Using these figures, we derive:

$G_{\text{Fe}^{3+}}$ (250-kV. X-rays)	14.9 ± 0.8
$G_{\text{Fe}^{3+}}$ (50-kV. peak X-rays)	14.0 ± 0.8

The yields of hydrogen are thus 0.45 ± 0.02 and 0.46 ± 0.02 molecules per 100 eV. for the two types of radiation respectively, that with cobalt-60 γ-rays being 0.40 ± 0.01 . With electrons of initial energy less than 40 keV., the yield of ferric ions may be expected to be a sensitive function of this energy, and the integral yield obtained with soft X-radiation must therefore be specific to the irradiation conditions, particularly to the degree of filtration of the primary beam.

We would like to record our gratitude to the Radiotherapy Department of the Western General Hospital, Edinburgh, for allowing us to use its Siemens 250-kV. X-ray sets, to the Physics Department of this Hospital for its co-operation in the

irradiations, and to the Edinburgh Royal Infirmary for the loan of its Philips 50-kV. contact therapy unit.

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¹ Miller, "Actions Chimiques et Biologiques des Radiations", 2me. série (Masson et Cie, Paris, 1956).

² Dewhurst, *Trans. Farad. Soc.*, **49**, 1174 (1953).

³ Schwarz, *J. Amer. Chem. Soc.*, **77**, 4960 (1955).

Optical Properties of 'Cellophane'

IN *Nature* of November 10, p. 1072, Dr. E. F. Fahy and Prof. M. A. MacConaill discussed this subject.

Some years ago, I investigated the use of 'Cellophane' for a device which was to rotate the plane of polarization of light and, among the specimens examined, I came across a variety which in double thickness behaved like a quarter-wave retardation plate. Subsequent investigation proved that the material was in fact birefringent, and by stacking several thicknesses (interleaved with a highly refractive oil), refractive indices of 1.588 and 1.594 were measured on a Rayner gemmological refractometer. This material, under the proprietary name of 'Styrafoil', is being manufactured by Messrs. BX Plastics, Ltd., in a variety of thicknesses for use as an interlayer between electrical transformer windings.

The 'half-mil' thickness consistently caused a retardation of one-eighth of a wave of sodium light; this led me to build a polarization step-wedge of the material as an alternative device to the usual quartz or selenite wedge used for compensation on the polarizing microscope. It was satisfactory for general use, and of course much cheaper than the mineral variety.

If stacked strips of 'Styrafoil' are used for building a wedge, they must be cut from the same area of the sheet. This is because while the vibration directions of 'Styrafoil' are consistently at 90°, there is a tendency for them to twist about 5° per ft. of foil along the length of the roll. This is not of very great consequence, and leads to the Newton colour scale not being as brightly coloured as it would otherwise be.

From the foregoing, it would seem that the manufacture of commercial material does involve precise control of thickness, and that, in the case of 'Styrafoil', there seems no question but that the colour in polarized light is a thickness and not a surface property.

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A Case of Hæmoglobin J in an Indonesian Family

SINCE the discovery of the abnormal human hæmoglobin H by Rigas *et al.*¹, three other abnormal hæmoglobin types, I², J³ and K⁴, have been found to migrate faster in paper electrophoresis than normal adult hæmoglobin at a pH of 8.6. These four hæmoglobins can be distinguished by their differences in electrophoretic mobility at pH 8.6 ($H = I > J > K > A$), while the difference between hæmoglobin-H and