Reversing Action of Red and Infra-red Rays on Sensitised and Fogged Photographic Plates and the Absorption of the Sensitising Dye-stuffs.

By

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ABSTRACT.

With a photographic plate sensitised with iodo-green and ogged by candle-light, Terenin has obtained reversed spectra of the red and the infra-red rays up to 1·13 μ. In the presnent experiment the relation between the absorption of the various sensitising dye-stuffs and the reversing action of the red and the infra-red rays was examined, and it was found that dye-stuff which has a strong absorption band in the region of wave-lengths longer than 5500 A. U. is effective in obtaining the reversed impression. As to the nature of the fogging light, green light seems to be most effective for plates sensitised with iodo-green.

It is known that when a photographic plate sensitised with malachite-green is fogged by candle-light, the photographic impression produced by the fogging is destroyed by exposing the plate to infra-red rays. This fact was applied by Millochau[1] to the photography of infra-red spectra, and he succeeded in photographing the solar spectrum from 7500 to 9500 A. U. Quite recently this problem was again investigated by Terenin.[2] His methode of preparing the plate is as follow: 50 c. c. of ethyl-alcohol was mixed with 100 c. c. of water. One gram of iodo-green was dissolved in 100 c. c. of water, and 6. c. c. of this solution was added to the former mixture. A very sensitive photographic plate was immersed in this solution for 5 minutes, and after drying it was fogged by candle-

1. C. R., **144**, 725 (1907).
2. Zeit. f. Phys., **23**, 5 (1924).

light. With the fogged plate thus prepared, he succeeded in photographing the reversed infra-red spectra up to 1·13 μ by using a prism spectrograph.

The present writer examined the relation between the spectral region reversed by red and infra-red rays and the position of the absorption bands of various dye-stuffs used for the sensitizer. As sensitizers, iodo-green, malachite-green, methyl-green, ethyl-violet, nigrosin, fuchsin f. Bac., auramin, cyanin, and erythrosin were used. Pieces of Ellington Studio plate were sensitized with these dye-stuffs and then fogged by candle-light after being dried, following the prescription given by Terenin. The fogged plate thus prepared was placed in a plate holder of a prism spectrograph provided with a photographic lens of 50 cm. focus, and the light emitted from a carbon arc charged with salts of potassium and barium was focussed on the slit of the spectro-graph through a ruby glass filter. It was found that the spectrum was reversed in the region from λ 7500 to 9000 on the plate treated with iodo-green, malachite-green, methyl-green, ethyl-violet, auramin, nigrosin, and fuchsin respectively, and in the region about λ 8500 on the plate treated with auramin. No reversal was, however, found on the plates treated with the remaining dyes: they give only positive impressions of lines up to λ 7500 or 8500. These will be seen from the photographs given in Fig. 1, reversed lines appearing as black lines.

The difference shown by plates sensitised with the above dyes is probably due to the difference in the absorption bands possessed by these dyes. Such bands are shown diagrammatically in the curves given in Fig. 2, curves drawn above the horizontal lines respectively being roughly the absorption bands, and those below, the reversed spectral regions in the plates treated by such dyes.

It will be observed that dye-stuffs having an absorption maximum in the neighbourhood of λ 5500 to 6000 are effective in reversing the spectral lines in the infra-red region. Such was the case for iodo-green, malachite-green, methyl-green, ethyl-violet, nigrosin and fuchsin. Cyanin and erythrosin have an absorption maximum in the neighbourhood of λ 5000, but they have no such reversing property. Auramin shows a very interesting example. This has weaker absorption in the region from λ 6000 to 5500 and stronger one in the region from λ 5000 to 4700. The plate treated with this dye showed a weaker reversal in the neighbourhood of λ 8500 and this reversal was probably due to the weak absorption possessed by the dye in the region from λ 5500 to 6000.

The photographic plates sensitized with iodo-green were fogged separa-

tely by the light from an incandescent electric lamp filtered through a Wratten monochromatic filter, the time of exposure and intensity of coloured lights being so adjusted that each plate had stronger, medium and weaker foggings, and their corresponding densities were nearly equal for all the plates. The accompanying table shows the data for the exposure.

Transmission of the filter	Distance between the lamp and the plate	Time of the fogging exposure		
		Stronger	Medium	Weaker
Red	12 cm.	5 minutes	4 minutes	3 minutes
Orange	14 〃	4 〃	3 〃	2 〃
Yellowish green	16 〃	4 〃	3 〃	2 〃
Green	18 〃	4 〃	3 〃	2 〃
Blue	19 〃	4 〃	3 〃	2 〃
Violet	20 〃	3 〃	2 〃	1 〃

The plates thus treated were exposed to light from the electric arc through the spectroscope, and the intensities of the reversed spectral lines were raughly compared. The experiment is of rather a preliminary nature, but the result seems to indicate that the plate fogged strongly by the light filtered through the green screen gives the best result, recording the lines up to λ 9500. Photographs reproduced in Fig. 3 illustrate this.

Lastly, it will be interesting to mention, that when a plate sensitised with iodo-green was fogged by violet light, an isolated reversed impression of spectral lines was noted about 6400 A. U. in addition to the ordinary reversed spectra.

In conclusion, the writer wishes to express his best thanks to Prof. M. Kimura, under whose guidance the present experiments were carried out.

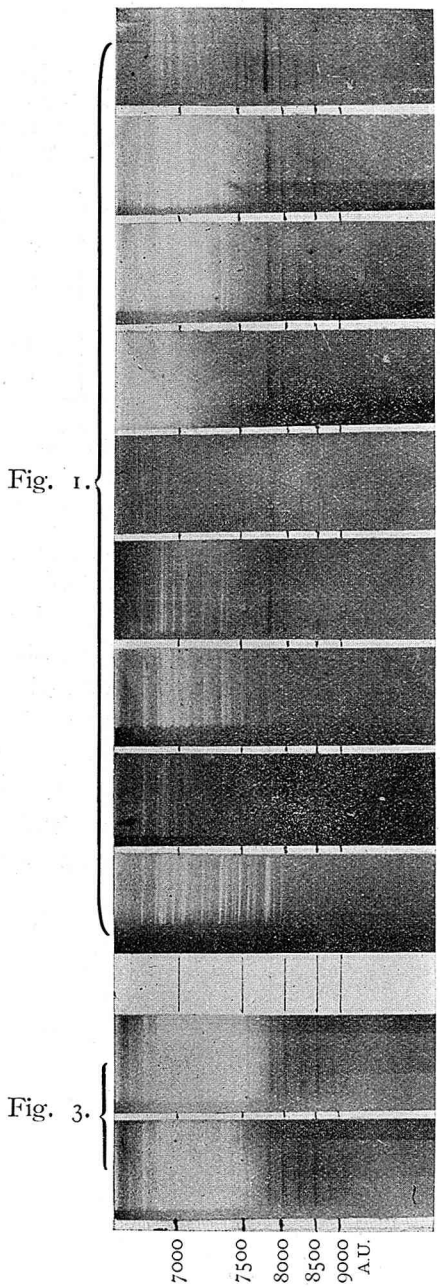
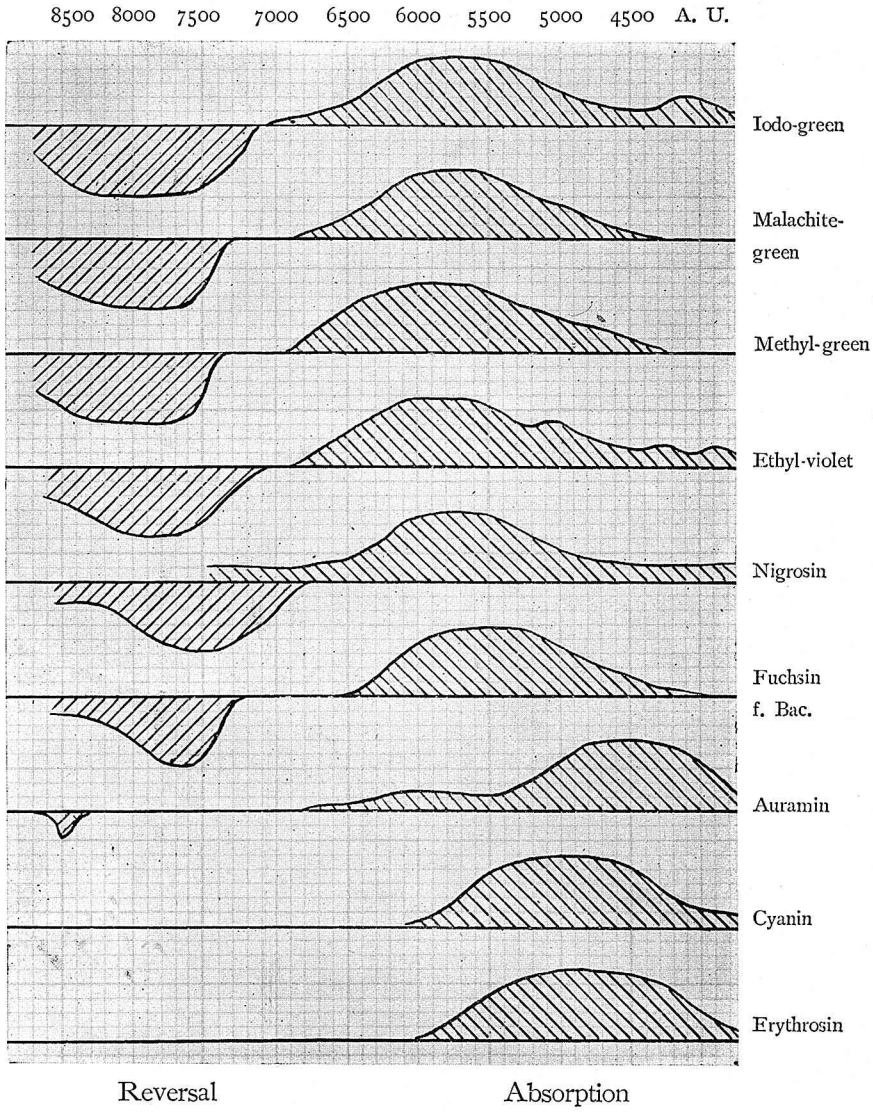

Dye-stuff used
Iodo-green
Malachite-green
Methyl-green
Ethyl-violet
Nigrosin
Fuchsin f. Bac.
Auramin
Cyanin
Erythrosin
Sensitized by iedo-green and fogged by light of yellowish green colour,
green colour
Fig. 1.
Fig. 3.
7000
7500
8000
8500
9000
A.U.

Fig. 2.


8500 8000 7500 7000 6500 6000 5500 5000 4500 A. U.
Iodo-green
Malachite-green
Methyl-green
Ethyl-violet
Nigrosin
Fuchsin f. Bac.
Auramin
Cyanin
Erythrosin
Reversal
Absorption