Studies in Photographic Sensitivity, Part IV.

Desensitizing Action of Previous Fogging by X-Rays

By

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Abstract

It was observed by Villard, Wood and others that light destroys an X-ray impression produced on a photographic plate, the amount of this depending much on the nature of the plate. In the present experiments, changes in the shape of the characteristic curves of many commercial photographic plates produced by previous fogging by X-rays were investigated, and the results were as follows. (1) In most commercial plates a fog impression produced by X-rays was not reversed dy light, but the inertia of the plates was increased by a previous exposure to X-rays. (2) The decrease in sensitivity was greater when plates were fogged before the main exposure than when they were fogged after it. (3) The sensitivity of a plate to lights of various wave lengths was decreased by an equal amount by a previous fogging by X-rays. (4) This action of X-rays remained almost the same whatever the time interval between the previous fogging and the main exposure. (5) The change in sensitivity was great for very rapid plates, but the change in contrast was generally small for all plates. (6) The decrease in the sensitivity of a plate produced by X-ray fogging was restored by a second fogging by light, and the sensitivity of a plate gained by previous exposure to a dim light (see the writer's last paper) was also restored by a slight exposure to X-rays. From these facts it was considered that the fogging by X-rays and that by light act independently of each other.

Introduction

Villard[1] found that photographic impressions produced by X-rays in certain plates i.e. Jougla green label, were almost suppressed by exposing to

1 C. R., **128**, 237 (1899)

light. Wood[1] and others also observed that a photographic image produced by X-rays can be reversed by light. But these phenomena depend much on the nature of the plates, as shown by many observers; in most commercial plates, the X-ray impression was not entirely destroyed by light, that is, the density in the part exposed to both X-rays and light was always greater than that in the part exposed only to X-rays, but was always smaller than that exposed only to light. As it seems to the present writer that this is due to a desensitizing effect of X-rays on photographic plates, the following experiments were carried out in order to examine the change produced in the forms of these characteristic curves by exposing slightly to X-ray.

Method of the Experiment

As the source of X-rays, a Coolidge tube with a molybdenum anticathode excited by a 60,000 volt transformer was used.

Four pieces were cut out from a photographic plate; the first one was

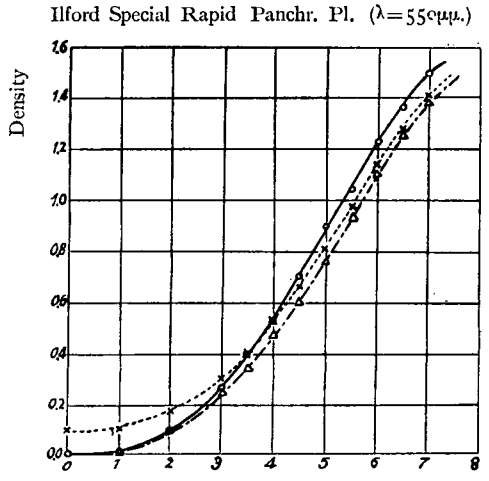


Fig. 1

Desensitizing Action of Previous Fogging by X-Rays

1 Astro. Phys. J., **17**, 361 (1903)

exposed to a sector spectrum as described in the previous paper, the second piece was first exposed to the sector spectrum, and then, this and the third piece were slightly fogged simultaneously by exposing them to X-rays for 5 seconds, the latter being exposed then to the sector spectrum. The last piece was exposed only to the sector spectrum. The densities thus obtained were measured at several spectral regions by a Moll's microphotometer.

A correction for a change in sensitivity due to fatigue of the battery was applied, when a difference between the densities of the first and the fourth piece was detected, and the fog correction was also applied by the method described in the last paper. The characteristic curves of each plate were drawn for lights of certain wave lengths from the measured densities.

The Result

The desensitizing action of a previous fogging by X-rays is easily understood from the curves given in fig. 1, the characteristic curve of an untreated plate being shown with a full line, that of the treated one with a dotted line. The curve represented with a broken line was obtained by applying the correction for the fog to the density of the latter at each exposure. As is seen from the curves, the fog due to X-rays is not reversed by light. If the light destroyed the fog produced by X-rays, the characteristic curve of the treated plate should once descend below the fog density with an increasing exposure, but there is no such tendency. But the density of the treated plate at a higher exposure is always smaller than that of the untreated one, that is, the inertia of the treated plate is increased by this treatment.

The characteristic curves of untreated plates and those of treated plates, one treated before the main exposure and the other after it, were taken with plates of various kinds, and they are given in fig. 2. The correction for the fog density was applied to the measured density at each exposure for all treated plates.

In all plates, the inertia of the plate was increased without exception by the previous fogging with X-rays, this change in inertia being especially marked for high speed plates, but in the case where the auxiliary exposure to X-rays was given after the main exposure, this increase in inertia was small. The change in the contrast was generally small, and in many plates the contrast was increased by a small amount, but in certain plates it was found to be decreased. The relation between the increase in density and the exposure is also represented diagrammatically in the same fig. 2.

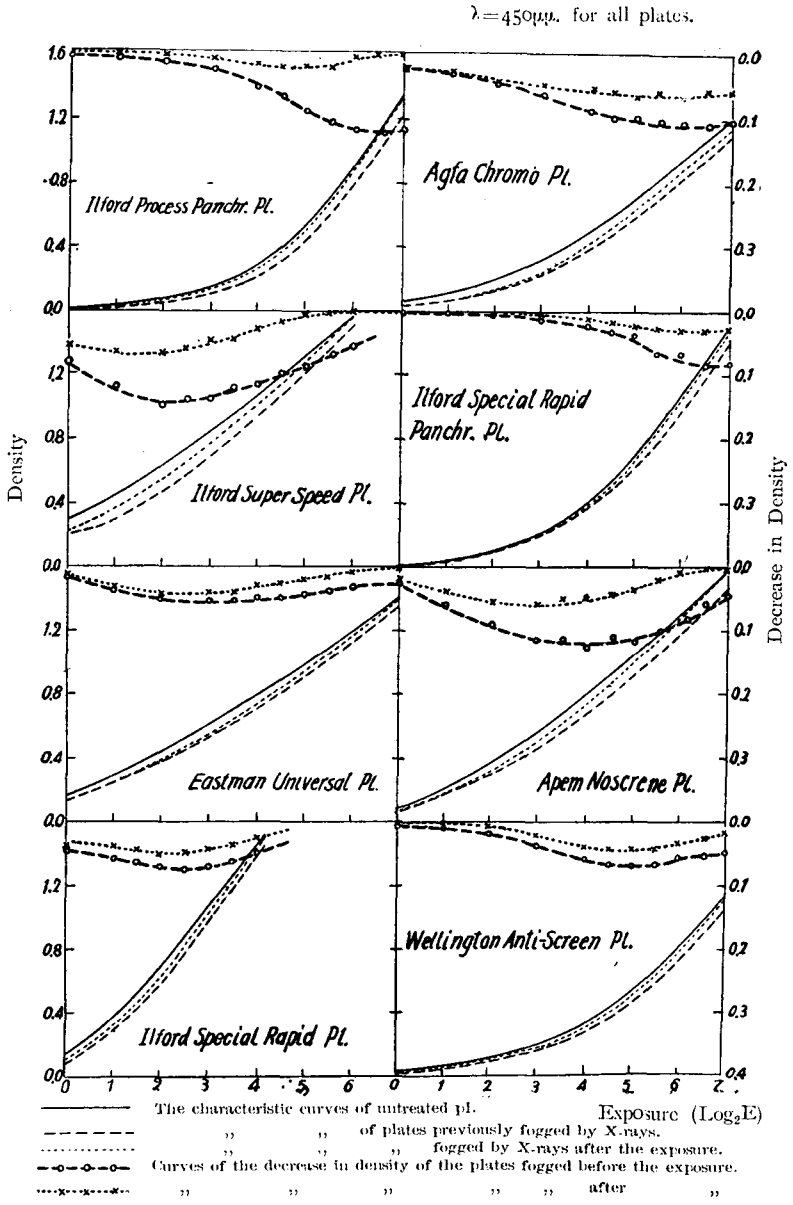


Fig. 2

Effect of Slight Fogging due to X-Rays on the Characteristic Curves

In the following experiments, the amounts of change in sensitivity produced by X-ray fogging were compared by comparing the maximum decrease in density instead of $\triangle$ log i, because the variation in the inertia was generally small, and runs generally parallel to the maximum decrease in density.

Effect of Fogging by X-Rays on the Sensitivity of Plates to Lights of Various Wave Lengths

The influence of previous fogging by X-rays on the sensitivity of plates to lights of various wave lengths was examined with several kinds of plates. The decreases in sensitivity measured at different parts of the sector spectrum were found to be equal to each other within the limits of experimental error. Fig. 3 shows the relation between the maximum decrease

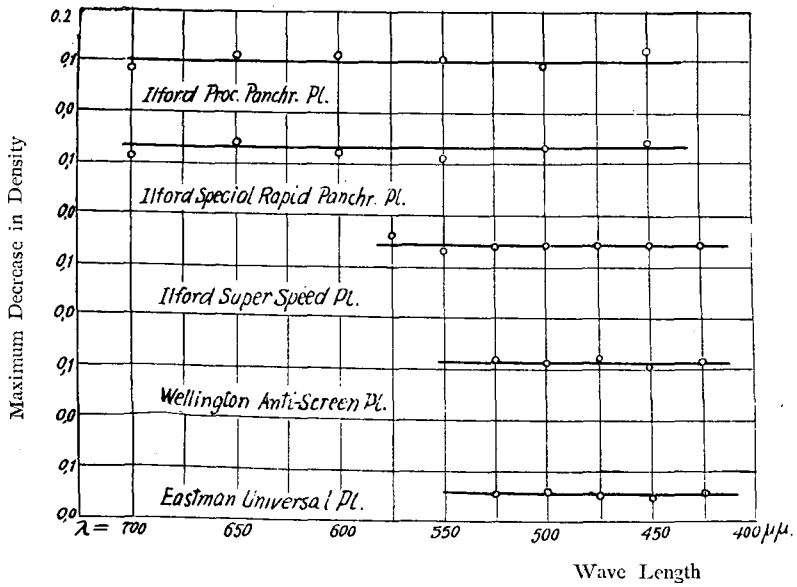


Fig. 3

Effects of Previous Fogging by X-Rays with Lights of Various Wave-Lengths

in density and the wave lengths of the light used for the exposure. From this result, it may be concluded that X-rays desensitize plate equally for all the spectral regions examined.

Variation in Fog Density

Next, the influence of the length of the exposure to X-rays on the desensitizing action of the rays was investigated. The greater the density due to X-ray fogging the larger became both the inertia and contrast for Ilford Super Speed Plates. Fig. 4 shows the characteristic curves for plates previously exposed to X-rays for various times and also shows the variation in the decrease of density with exposures.

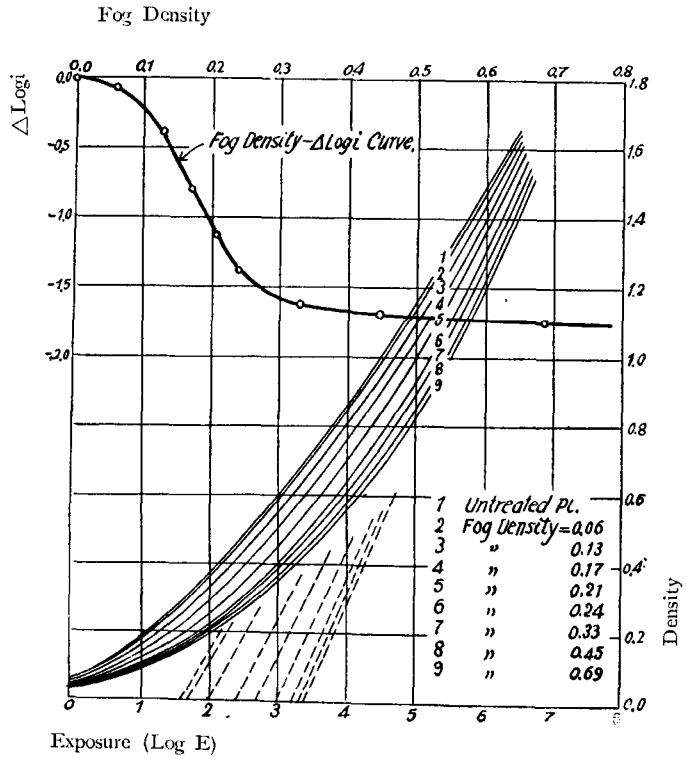


Fig.4

Showing the Effect of Previous Fogging due to X-Rays with Fogging Exposures of Various Lengths

Plate I also represents the sector spectra taken with plates exposed previously to X-rays for various times, the back ground of each plate being printed to give an equal blackening. It can be easily seen from the photo-

graphs that the sensitivity of plates previously exposed to X-rays becomes gradually smaller with increasing time of exposure to the X-rays.

Life of the Desensitized Plate

A number of pieces cut out from a large photographic plate were slightly fogged by X-rays, and were exposed separately to the sector spectrum, at various periods after the previous fogging. As is seen in fig. 5, the amounts of desensitizing action were found to be almost equal within

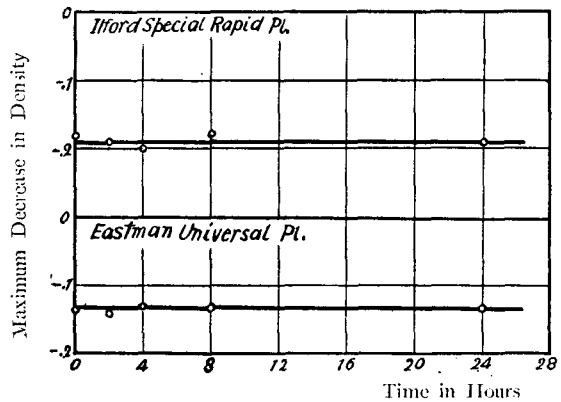


Fig.5

Life of Plates Desensitized by X-Rays

the limits of experimental error. Thus it may be considered that the desensitizing action of X-ray fogging does not decay, but is permanent.

This fact also indicates that the action is quite different from that of light fogging, the latter being temporary, as shown in the last paper of the writer.[1]

Combined Effect of Preliminary Exposures to X-Rays and to Light

It was observed in a preceding experiment[2] that a previous slight fogging by light increases the sensitivity of certain photographic plates more than that given by the law of fogging, and that in the present experiment a similar treatment by X-rays decreases it. Thus it will be interesting to

1, 2 These Memoirs, **12**, 111 (1929)

examine how previous foggings by light and X-rays act on a photographic plate.

Five pieces were cut out from a photographic plate; the first piece was exposed to the sector spectrum without any treatment, the second and the third pieces were exposed to a dim light simultaneously, the former being then exposed to the sector spectrum, while the latter was again exposed to the X-rays for a short time together with the fourth piece. After this treatment, the third, fourth and fifth pieces were exposed to the sector spectrum.

The characteristic curves and △D-logE diagram for the three fogged plates are shown in fig. 6, A, L representing the curve obtained for the plate fogged by light only, X by X-rays only, and L & X by both. Fig. 6, B represents also similar curves in the case where the order of the two previous exposures was reversed. All these curves were taken with Ilford

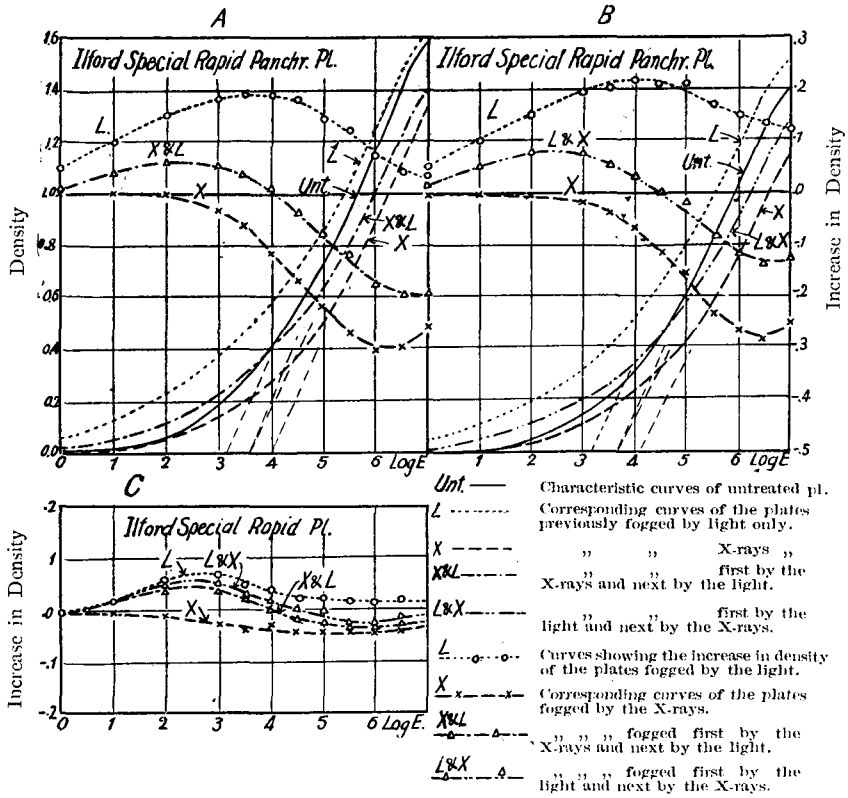


Fig. 6

Effects of Double Foggings by Light and X-Rays

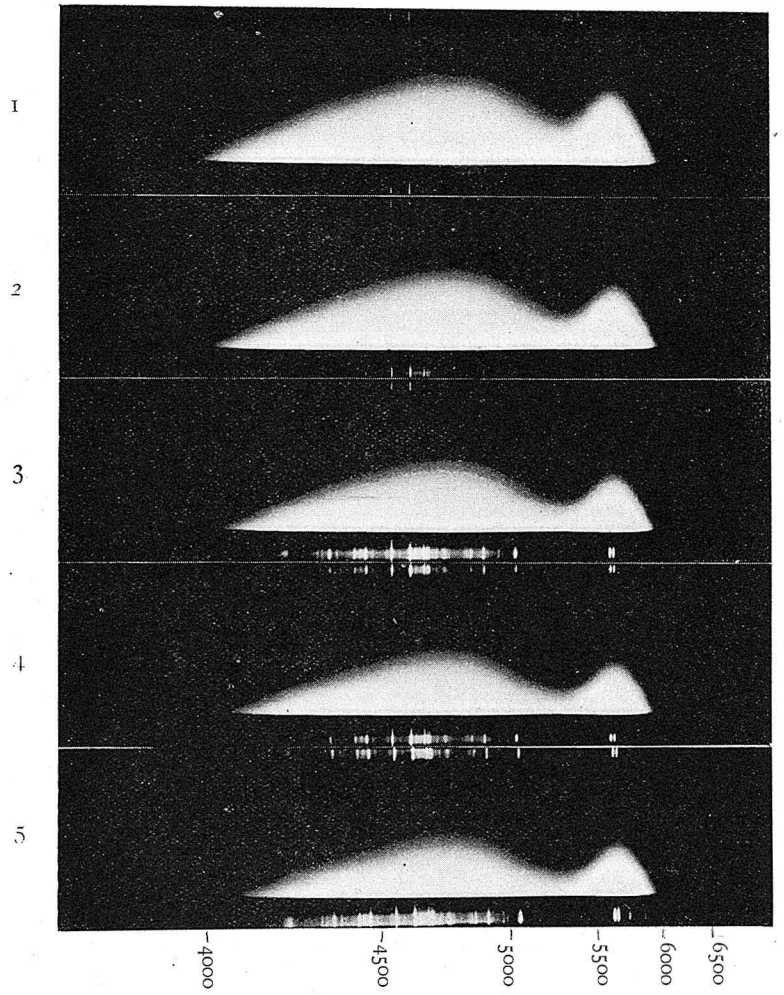
Special Rapid Panchromatic Plates. The curves shown in fig. 6, C are taken with Ilford Special Rapid Plates.

The $\triangle$D-logE curves for the plates fogged by X-rays before and after the light fogging were found to be quite similar, and the increase in density for the plate fogged by X-rays and light is approximately equal to the sum of the corresponding increases of density obtained by fogging due to X-rays and light separately.

From these results it may concluded that the sensitizing action of light and the desensitizing action of X-ray fogging act independently of each other, thus giving the effect equal to their algebraic sum.

In conclusion, the author's sincere thanks are due to Prof. M. Kimura for his kind guidance and the great interest he has taken in this investigation and also to President T. Maruyama of the Konan college for his kind offices.

Plate I



1. Sector spectrum taken with an untreated plate.
2. „ „ taken with a fogged plate by X-rays for 2 seconds.
3. „ „ „ „ „ „ „ for 4 seconds.
4. „ „ „ „ „ „ „ for 6 seconds.
5. „ „ „ „ „ „ „ for 8 seconds.

(Plate: Ilford Super Speed Plate.)