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Post exposure latensification of a multilayer color film

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Post Exposure Latensification of a
Multilayer Color Film

BY

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Submitted in partial fulfillment of the requirements of the degree Bachelor of Science in Photographic Science at the Rochester Institute of Technology, Rochester, N.Y.

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POST EXPOSURE LATENSIFICATION
OF A MULTILAYER REVERSAL COLOR FILM

by

Thomas A. Tietjen
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POST EXPOSURE LATENSIFICATION
OF A MULTILAYER REVERSAL COLOR FILM

Abstract

A uniform secondary exposure of low intensity is made to a normal or underexposed primary latent image for approximately 5-15 minutes, to increase the effective speed index. This is first studied from a white light approach similar to that used in single emulsion negative materials.

In addition, the ability to manipulate and align individual layers by selective filtering was also studied. Red, green and blue filters, matched closely to the spectral sensitivity of each layer, were used separately and conjunctively towards achievement of the desired levels of effective speed, contrast, color balance and maximum density.

Latensification by a secondary white light exposure increases the effective A.S.A. speed of specific layers by as much as $2\frac{1}{2}$ f/stops.

Through selective filtering, an ability to increase speed and align two or more layers has been demonstrated.

The effective overall speed of Ektachrome-X film has been increased by a factor of $\sqrt[3]{2}$, but at the expense of losses in $D_{max}$, contrast; and color balance.
INTRODUCTION

Several methods of latent image intensification, either before or during development, are available to the photographer which enhance the effective emulsion speed of a given film.

These break down into basically three groups consisting of baths; vapors; and either pre and/or post secondary exposure to uniform light of very low intensity and long duration.

Some noteworthy advantages of intensification of the latent image are: lower auxiliary illuminating intensities; ability to use existing or low-level light; increased depth of field with smaller f/stop values; manipulation of individual layers of a multilayer material, and in particular, no vapors or wet baths to mix or prepare with the secondary exposure method.

This project makes use of the post exposure method in application to a reversal color film.

Ideally, this secondary exposure should increase effective speed but not alter the characteristics of Dmax., contrast, or color match between the normal and latensified film.

In a report by Kenneth M. Carey in 1954, reference is made to preliminary work with reversal material, but was abandoned due to pressure on negative-positive materials. No reference is made to any publication of this work. A claim of 1/2 to 3/4 of an f/stop was gained in reversal material.
Objectives

The primary objectives were as follows:

1. To increase effective emulsion speed by 2-3 f/stops.
2. To maintain Dmax, to 2.40 or above.
3. To maintain color match between primary and secondary exposures.
4. To hold contrast to +5; -10%.

Anticipated Variables

1. Speed.
2. Contrast.
3. Dmax.
4. Color shift, ie; interimage effect or cyan undercut due to higher contrast of cyan forming layer.
5. Lapse time--latensification to development.
6. Reciprocity failure.
7. Spectral quality of latensifying source.

Possible Variables

1. Basic exposure; repeatability of sensitometer.
2. Interimage effects as a result of alteration to first developer.
3. Interimage effects due to higher (intermediate) contrast and sensitivity of the magenta forming layer.
4. Lapse time--basic (primary) exposure to latensification.
Experimental Procedure

The selection of film for this project of necessity, had to be one which I could process myself with specific alterations where necessary, according to designed tests. Also the availability of chemicals, and, from the same batch origin were important considerations.

Selection of a popular amateur film would necessarily have the widest interest range. Ektachrome-X (daylight) seemed a logical choice to prove or disprove the objectives of this project.

As a source for the basic (primary) exposures, the E. G. & G. electronic flash sensitometer Mark VI was selected for stability of intensity and color which is a close approximation to direct noon sunlight. A calibrated no. 2 step tablet was attenuated with a 2.3 neutral density filter in the light path. Output intensity of the sensitometer was monitored occasionally by use of an integrating exposure meter, type 1501A by General Radio. A K and M Tri-level point source was used for latensification, positioned 6 feet from the glass of an 18" X 24" NU-ARC vacuum frame to the envelope of the exposing lamp. Approximately 0.30 foot candles intensity, as measured by a Weston Model 756 foot candle meter, were provided by the "low" position. Best latensified results were obtained with this source attenuated with a 4.0 N.D. filter giving approximately 3.0 X 10^-5 foot candles. 35mm test strips 5" long were held in individual pockets mounted on bellows cloth, which masked half way across width of film for entire 5" length. This provided a direct control and comparison.
for each strip regardless of any processing variable.

Identification of strips was made with a sharp stylus immediately after latensification. After coding of individual tests they were placed in double light tight - moisture seal packets and stored in a freezer as were sensitometric strips awaiting latensification.

Development was carried out with racks designed specifically for 5" strips to be used in 5 x 7, ½ gal. tanks. Chemicals, mixed in one gallon batches, were temperature controlled to ± 10°F. and stored under ideal conditions in full stoppered bottles. Agitation was performed as per the "lift; tilt; dip" recommendation of the E-2; E-3 process instructions. Pre-exposed Kodak control strips were included with all but the first two processes. All density readings (126/ea. strip) were made on a Mackbeth Quantalog TD-102 densitometer. Effective speed was measured by the A.S.A. Standard of PH2.21-1961.3

Experimental Results

Preliminary testing was devoted to the establishment of the basic exposure on the E. G. & G. sensitometer.

Selection of the 10^{-2} flash time more nearly matched that found on camera shutters. In order to simulate high speed flash exposure times, a 10^{-3} and 10^{-4} flash time is provided, widening the capability to include tests on reciprocity failure. Two variable area filters are generally included with the E. G. & G.5 to equate the 10^{-2} and 10^{-3} flash times to the same intensity level of 40 M.C.S. for the 10^{-4} time. Measurement of equality revealed an

-5-
imbalance between the three levels of exposure duration. Because the filters were located late in the project, no reciprocity tests were made.

In order to center the maximum and minimum density response of the test material over the 3.0-.05 step wedge, attenuation of the flash intensity was necessary. Ideally, this should be done without altering the spectral quality of the source.

A 1.25% attenuator was fabricated from three perforated metal sheets having different hole configurations. Test results produced a better visual neutral than with neutral density but disagreed with recorded data revealing a 'bump' in the curve, indicating uneven transmission. Subsequent attenuation was made with neutral density filters.

The need for order and good housekeeping became increasingly evident during early testing.

Several methods of identification and coding for tests and strips were evaluated. Ink from a Bates numbering machine would not dry sufficiently and posed the possibility of contamination in processing. Stick on electrical wire numbers were too clumsy to position in the dark. Corner-clipping and a diamond tipped stylus for glass marking proved somewhat satisfactory.

Latensification exposures of 3.0 x 10^{-5} foot candles for 10 minute increments up to 1 hour show little improvement in speed to offset the drop in Dmax. for durations longer than 20 minutes.
A 5-minute latensification to white light (SEE FIG. 1) produced approximately a factor of (6) increase in red layer index with a Dmax. of 2.20; however, the green and blue were increased by only 3/4 and 1/4 f/stop with 2.6 and 3.20 maximum density respectively.

A lower red curve was anticipated, due to the low color temperature produced by the "low" level position of the point source. Maneuvering the green and blue curves to align with the red was the objective in subsequent testing.
A 50% increase in the first development (SEE FIG. 2) has increased the effective speed by a factor of (3) maintaining color balance and contrast up to 2.4 density. However, a 5 minute latensification (white light) lowered Dmax. to 1.25, 1.70 and 2.56 for red, green and blue respectively.

An additional 5 minute secondary (red) exposure, with normal development, depressed the red curve to 0.45 density. Green and blue went to 2.12 and 2.88 respectively.

5 minutes additional green, with normal development, produced 1.94, 1.92 and 3.00 respectively for red, green and blue curves.
FIG. 3

Approximately 2.4 \( f/\) stops (factor 6) increase in red index, and \( \frac{1}{8} \) & \( \frac{1}{4} \) for green and blue respectively, is produced by \( 5\frac{1}{2} \) minutes additional blue latensification and normal development. (SEE FIG. 3)

A loss of contrast and color balance accompanied the gain, especially with 50% increase in first development. (SEE FIG. 4)

Further investigation of color latensification with less overall white light (2 minutes) plus selective amounts of red, green and blue of 1, 3 and 10 minutes (SEE FIG. 5) met requirements for 2.40 Dmax but curve shifting
occurred for red and green layer. Additional green and blue secondary exposures appear necessary to bring curves into balance. Approximately 3/4 f/stop is realized here for red layer; 1/3 for green and negligible for blue.

Except for a slight reduction in red density, selective amounts of 3, 5 & 10 minutes of red, green & blue respectively with no previous white light exposure, produced little change between normal & latensified exposures.
A slight increase in Dmax. was obtained in the red layer with lapse time of 2 to 96 hours between latensification and processing. (See FIG. 6)

However, green and blue layers increased slightly up to 48 hours.
LATENSIFICATION TO PROCESSING
G TEST

FIG. 6
Conclusions

Latensification with white light and normal processing has produced an increase of ~\( \times 6 \) for the red layer.

It has been shown that additional secondary exposure through the use of selective filtering, has maneuvered the green and blue layer closer to the red, and while this results in contrast loss, a speed increase has been achieved. It should be possible to correct the color imbalance between layers with proper amounts of green and blue exposure using the technique as described in this project.

Forced development, although not part of the primary hypothesis, produced an effective speed increase by a factor of ~(3) and maintained color balance and contrast up to 2.40 density. However, when used conjunctively with latensification, a loss in contrast, color balance and Dmax. results plus increased gain.

In effort to show comparison of results more practically, a table-top scene incorporating the three primary colors, plus white, black and brown was created with shadows and highlights.

A 3 x 2 x 2 test array was run to include most possible combinations. Comparisons which best portray the results are indicated below the following table.
NORMAL EXPOSURE
(1) control
(4) + 25% 1st Dev.
(9) Lat. + 25%
(10) Lat.

ONE STOP UNDER EXPOSURE
(2) control
(5) + 25% 1st Dev.
(8) Lat. + 25%
(11) Lat.

TWO STOPS UNDER EXPOSURE
(3) control
(6) + 25% 1st Dev.
(7) Lat. + 25%
(12) Lat.

(1)--------->(2)--------->(5)= (1) For contrast, Dmax. and color match.

(1)--------->(10)---------> = ~1 stop increase with loss in contrast, Dmax. and color match.

(11)--------->(8)---------> = ~1 stop increase.

(8)--------->(1)---------> = ~1 1/2 stop increase with loss in contrast, Dmax., color match plus increased grain.
Recommendations

Although much work has gone into the preparation of this project, the surface -- of the subject -- has barely been scratched.

The use of latensification to increase the effective speed index of a reversal material has appeal in specific considerations where lower contrast is not detrimental, or in fact, desired. One application may be with an inherently contrasty material such as Kodachrome, where duplication is difficult.

A secondary source balanced in color temperature to that of the reversal material should minimize additional selective filtering, however, it appears that alignment of the layers for color balance will require some filtering.
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