# A Sharp Reversal Color Print Film

By R. G. L. VERBRUGGHE

**Gevachrome Print Film, T. 9.02, is a color reversal film primarily intended to make prints from professional color reversal originals. The film permits the printing of a soundtrack from a negative soundtrack as well as from a positive. Film structure, sensitometric characteristics and printing behavior are discussed and processing formulas and procedure are given.**

### Introduction

Gevachrome Print Film, T. 9.02, is a multilayer color reversal film for printing release copies from color reversal originals. It may also be used for 16mm reductions from 35mm color release prints.

Presented on April 18, 1967, at the Society's Technical Conference in New York by R. A. Eynard, Agfa-Gevaert, Teterboro, N.J., for the author, R. G. L. Verbrugghe, Gevaert-Agfa, N. V., Mortsel (Antwerpen), Belgium. (This paper first received on April 17, 1967, and in final form on August 22, 1967.)

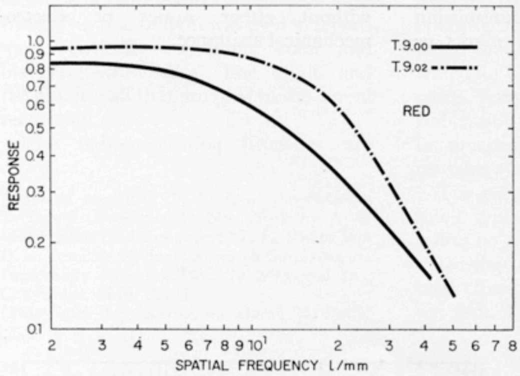
T. 9.02 is the third in a sequence of Gevachrome films. The first one, T. 9.00, was introduced in Europe in 1960. On this film, either a silver sulfide soundtrack, printed from a positive sound original, or a silver track, printed from a negative sound original, could be made. Although this film was considered to have good quality, for use at that time, it was recognized that a product with better definition was necessary for use in the United States. Distribution of T. 9.00 was confined to Europe, while research in the field of professional color reversal print films was continued. Areas of intensified research were in the enhancement of definition, soundtrack improvement and color rendition.

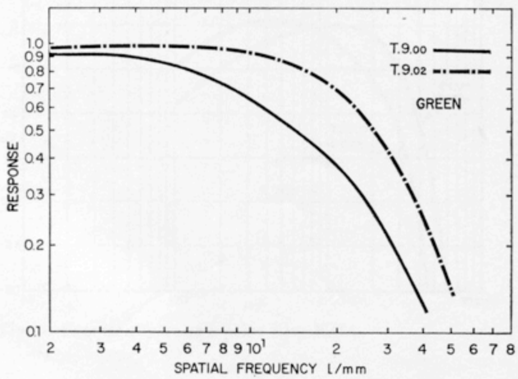
In 1964, T. 9.01 was introduced. It was exclusively made for the large share of users who required higher definition, lower contrast and higher exposure latitude. This was achieved at the expense of the possibility of printing both types of soundtracks. To improve the definition, use was made of thinner emulsion layers, especially for the blue sensitive top layer. Furthermore, sharpening dyes were incorporated in the emulsions and a silver dispersion black antihalation layer was coated between the emulsion layers and the support.

A colloidal silver yellow filter was also placed in between the blue and green sensitive layers. Some changes were also made which affected the spectral sensitivity and the color couplers, to improve color rendition and dye stability.

Unfortunately, this type of filter and antihalation layer excludes the use of a silver soundtrack. Continuous efforts in research made it possible, in 1966, to design Gevachrome Print Film, T. 9.02, with higher definition and having also the possibility of recording both negative and positive sound originals.


**Fig. 1. Schematic cross sections of Gevachrome Print Films, T. 9.00, T. 9.01 and T. 9.02.**



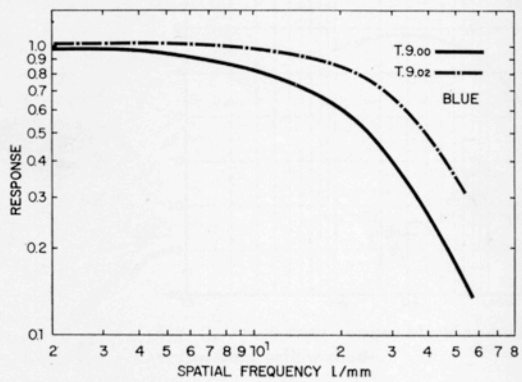




**Fig. 2. Modulation transfer function curves of T. 9.00 and T. 9.02 measured for red, green and blue light.**

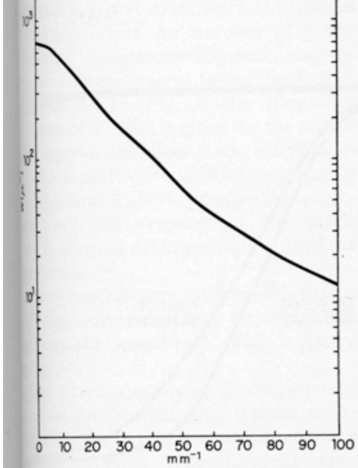
### Structure

In Fig. 1, the structure of T. 9.02 is compared with that of the previous types. Changes made for T. 9.02 were:

(1) The T. 9.01 colloidal silver filter layer has been replaced by a yellow nonmigratory dye.

(2) The silver dispersion antihalation layer of T. 9.01 has been changed to a carbon black backing layer. This backing also provides excellent antistatic characteristics over the previous antihalation layers.

(These two changes make possible the




ᵢ. 3. **Wiener Spectrum of density ctuations on T. 9.02 for a neutral nsity of 1.00.**

e of both a silver and a silver sulfide undtrack.)

(3) The total emulsion thickness has en reduced from 15 $\mu$ to 11.5 $\mu$ to in-rease definition.

(4) New fine grain emulsions, incor-orating sharpening dyes, are used in or-er to increase definition and to reduce ght scattering in the emulsion during xposure.

### hotographic Characteristics

#### *age Structure*

The high definition of T. 9.02 can best e examined by means of the modulation ansfer function (MTF) curves.

In Fig. 2 they are given for T. 9.00 and T. 9.02. The curves have been measured r green, red and blue light and are ob-ained from exposures, producing neutral ray images from sinusoidal targets.*

Granularity of the print in part de-ends on:

(1) the granularity of the original,

(2) the MTF of the total print system, nd

(3) the granularity of the printing aterial itself.

In Fig. 3, the Wiener spectrum of den-ity fluctuations on T. 9.02 is given for a eutral gray density of 1.00. As a result of he high sharpness and low granularity in T. 9.02, as shown in Figs. 2 and 3, the efinition loss between original and print as been reduced.

#### *nsitometric Curves*

To meet the different requirements of elevision and theater release prints, T. 9.02 has been designed to give a amma range from 1.10 to 1.50 without ffecting the color balance. These differ-ent gamma values may be obtained by changing the color development time, from four to six minutes. The relation-ship can be regarded as linear.

The sensitometric curves for the repro-duction of a neutral scale are given in Fig. 4. These curves are plotted in equivalent neutral density.

Figure 5 shows the D–log E curves for selective exposures measured through green, red and blue filters.

The subtractive method of printing is recommended for the Gevachrome T. 9.02. It involves the use of a light source, having a color temperature of 2900 to 3000 K. The spectral composition of the light can be modified by the use of color correction filters, so as to obtain the correct color balance in the reversal print.

Additive printing is only recommended when higher contrast is required. In this type of printing an increase in contrast of 5 to 10%, depending on the characteris-

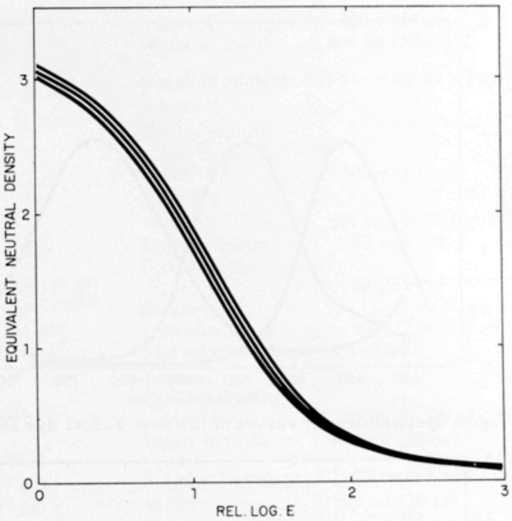



**Fig. 4. Sensitometric curves of T. 9.02 for the reproduction of a neutral gray scale.**

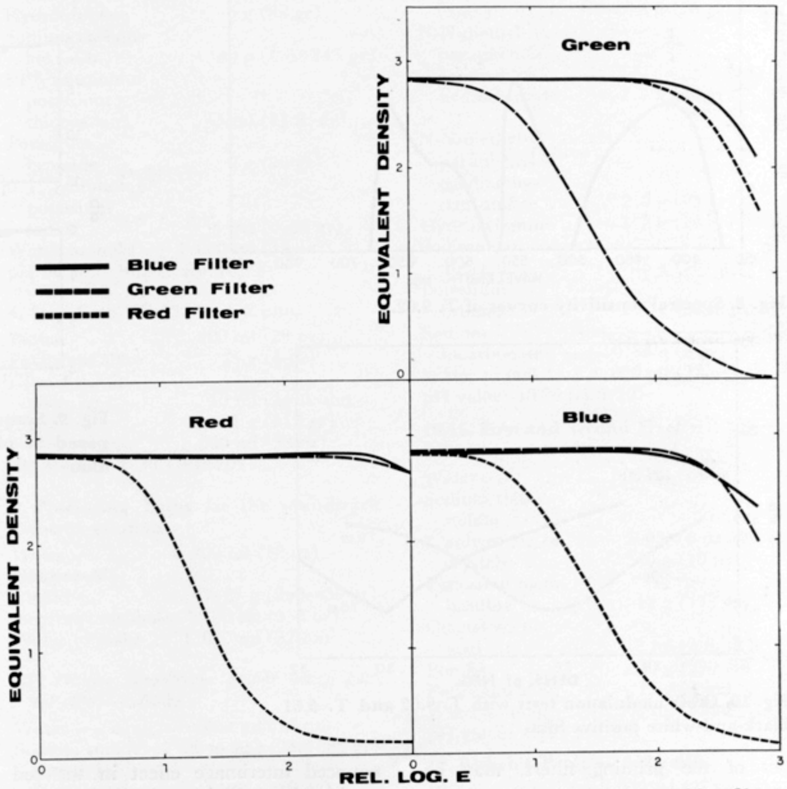



**Fig. 5. Selective exposures for T. 9.02 measured through red, green and blue filters. Curves are plotted in equivalent density.**

*M. De Belder, J. Jespers and R. Verbrugghe, "On the evaluation of the modulation transfer unction of photographic materials," *Phot. Sci.*, 314–318, Sept.-Oct. 1965.

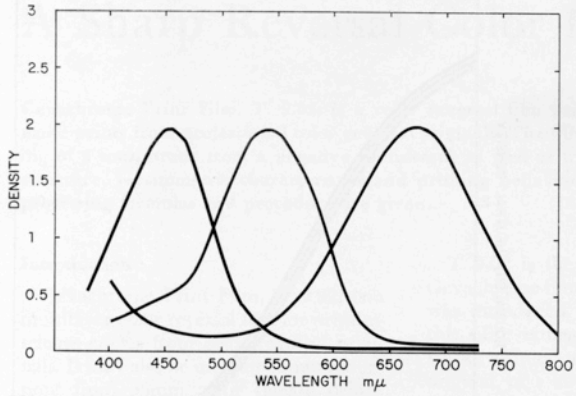



**Fig. 6. Spectral density curves of the new T. 9.02 dye set.**

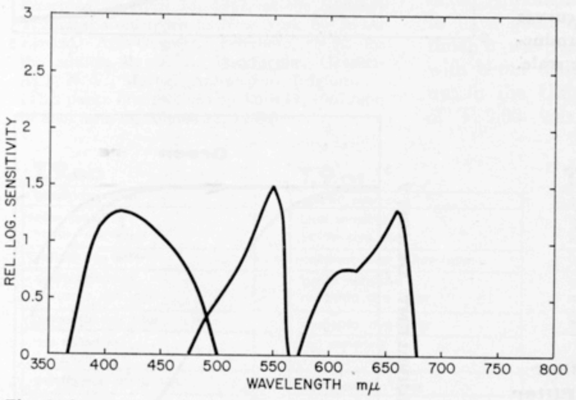



**Fig. 8. Spectral sensitivity curves of T. 9.02.**

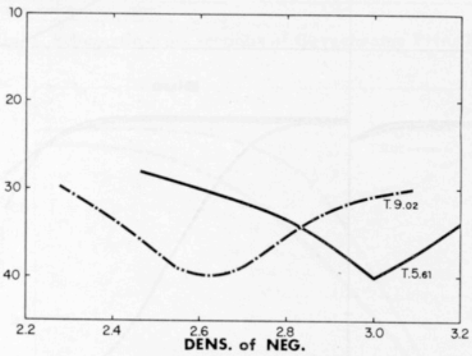



**Fig. 10. Cross modulation tests with T. 9.02 and T. 5.61 black-and-white positive film.**

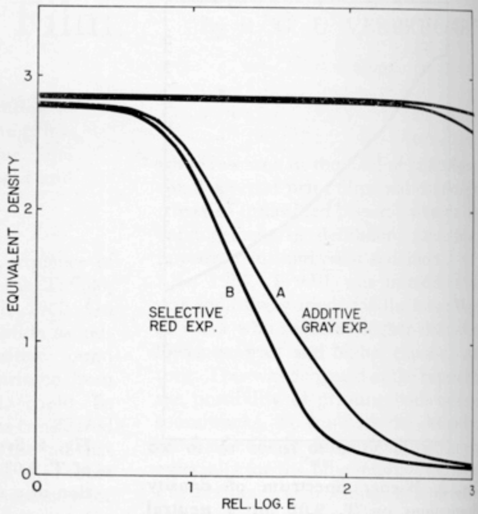



**Fig. 7. Interimage effect for the red sensitive layer.**

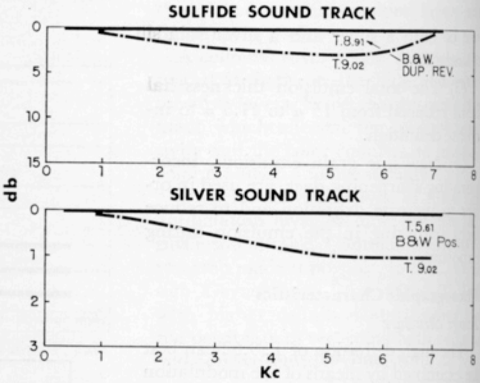



**Fig. 9. Frequency response curves for T. 9.02, as compared to black-and-white T. 8.91 duplicating reversal film.**

tics of the printing filters, may be expected.

*Spectral Density Curves*

In comparing T. 9.00 with T. 9.02, changes in the dye set should be noted. The spectrophotometric curves of the new T. 9.02 dye set are given in Fig. 6. They differ from the previous T. 9.00 in that new magenta and cyan color couplers are used. The new couplers represent a marked improvement in dye stability.

*Interimage Effects*

The combination of new emulsions and a new developer have given a pronounced interimage effect in the red sensitive layer. This results in very saturated reds, as may be seen in viewing actual pictures. The interimage effect is less pronounced in the green sensitive layer and nonexistent in the blue one. Figure 7 shows the interimage effect for the red sensitive layer. Curve A represents a cyan layer obtained from red, green and blue additive exposures, producing a neutral gray. Curve B gives the cyan layer from a selective exposure through a red filter. Both curves are drawn in equivalent densities.

*Spectral Sensitivity*

The spectral sensitivity characteristics of T. 9.02 are very similar to those of the T. 9.00. The sensitization of the cyan dye layer, however, has been slightly changed in order to give a better color rendition. The practical significance of this modification can be demonstrated by the fact that T. 9.02 gives brighter, more saturated reds and less cyan in the magentas than was the case in the former types. The greens and the cyans are also more saturated and show less magenta contamination. Spectral sensitivity curves of the new T. 9.02 are given in Fig. 8.

*Safelights*

A sodium vapor light source, with an Agfa-Gevaert 08 safelight filter to reduce the unwanted wavelengths, is best suited for darkroom illumination.

*Soundtrack Printing*

As mentioned before, T. 9.02 has the distinct advantage of being able to produce either a sulfide soundtrack (positive sound original) or a silver soundtrack (negative sound original). The best reproduction is obtained with the silver soundtrack, where, by exposing through cyan filter, the soundtrack is confined the top layers, for the sake of better finition. Frequency response may be garded as equivalent to the black-and-hite film. In Fig. 9 the frequency sponse of T. 9.02 is given for the sulfide ack and for the silver track, referring to e black-and-white T. 8.91 duplicating versal, and T. 5.61, positive fine grain. he frequency response of the sulfide ack is about 3 dB lower than that of the ver track.

Cross modulation tests reveal that a ide exposure range may be used when posing the soundtrack. This is shown Fig. 10.

The silver soundtrack is obtained by lective application of a viscous fixing ath after the first development, and by a lective viscous redevelopment after eaching; the procedure is explained in e appendix, where the solutions for ocessing are also given.

The sulfide track, being a reversal ack, demands a complete exposure of e three layers, through the same color alancing filters so as to produce a neutral e image in the picture area. After first evelopment, the unexposed silver is con-erted to unsoluble silver sulfide, by lective application of a sulfiding viscous lution to the soundtrack area. The rmula of this solution is given in the ppendix.

### rocessing Procedure

Processing of T. 9.02 is the same as for ll other Gevachrome professional re-ersal films, and for those to be made vailable in the near future.

The processing procedure is given elow. Processing solutions, times and emperatures are given in the Appendix.

*rocess Sequence T. 9.02; Temp. 77 F*

| | |
|---|---|
| 1. Prebath | 10 s |
| 2. Spray rinse | 10–30 s |
| Backing removal | |
| 3. B&W developer | 2–2½ min |
| 4. Stop bath | 1–2 min |
| 5. Wash, re-exposure and squeegee | 1–1½ min |
| 6. Pos. soundtrack, sulfide paste | 20–60 s |
| Neg. soundtrack, fixing paste | 20–60 s |
| 7. Wash | 1–1½ min |
| 8. Color developer | 4–6 min |
| 9. Spray rinse | 10–20 s |
| 10. First fixer | 1–2 min |
| 11. Wash | 1–1½ min |
| 12. Bleach | 2–2½ min |
| 13. Wash | 50–60 s |
| 14. Neg. sound redeveloper | 20–60 s |
| 15. Wash | 50–60 s |
| 16. Second fixer | 1–2½ min |
| 17. Wash | 2–2½ min |

## APPENDIX

### Processing T. 9.02

*(Bath Formulas for 77 F; Amounts in Metric Units — USA Units in ( ))*

**1. Prebath GP-681 — 10 s**

| | |
|---|---|
| Water | 800 ml (24 oz) |
| Calgon (sodium hexametaphosphate) | 2 g (29 gr) |
| Sodium sulfate (anh.) | 100 g (3 oz 145 gr) |
| Borax | 15 g (½ oz) |
| Sodium hydroxide | 0.8 g (11½ gr) |
| Water to make | 1.000 ml (32 oz) |
| pH value: 9.30 (±0.15) | |

**3. Black & White Developer GP-110 — 2 min**

| | |
|---|---|
| Water | 800 ml (24 oz) |
| Calgon | 2 g (29 gr) |
| Metol | 3 g (44 gr) |
| Sodium sulfite (anh.) | 50 g (1 oz 290 gr) |
| Hydroquinone | 6 g (88 gr) |
| Sodium carbonate (anh.) | 40 g (1 oz 145 gr) |
| 50% solution of potassium thiocyanate | 5 ml (1¼ fl. dr) |
| Potassium bromide | 2 g (29 gr) |
| 0.1% solution of potassium iodide | 6 mg (0.09 gr) |
| Water to make | 1.000 ml (32 oz) |
| pH value: 10.20 (±0.10) | |

**4. Stop Bath GP-332 — 1–2 min.**

| | |
|---|---|
| Water | 900 ml (28 oz) |
| Potassium alum | 15 g (½ oz) |
| Glacial acetic acid | 10 ml (2½ fl. dr) |
| Borax | 21 g (315 gr) |
| Water to make | 1.000 ml (32 oz) |
| pH value: 4.30 (±0.20) | |

**6. Processing baths for the soundtrack Gantrez solution**

| | |
|---|---|
| Water | 700 ml (72 oz) |
| Gantrez-AN-4651 | 17–27 g (260–430 gr) |
| Isopropyl alcohol | 100 ml (3.3 oz) |
| Water to make | 1.000 ml (32 oz) |

*(A) Positive Soundtrack: Sulfide toning paste GP-485 — 20–60 s*

| | |
|---|---|
| Water | 400 ml (12 oz) |
| Sodium sulfide | 20 to 40 g (290–585 gr) |
| Gantrez solution (see above) | 300 g (10 oz) |
| Boric acid | 8 g (117 g) |
| Water to make | 1.000 ml (32 oz) |

*(B) Negative Soundtrack: Fixer paste GP-383 — 20–60 s*

| | |
|---|---|
| Water | 600 ml (16 oz) |
| Ammonium thiosulfate | 400 g (13 oz 145 gr) |
| Gantrez solution (see Appendix Sec. 4) | 300 g (10 oz) |
| Water to make | 1.000 ml (32 oz) |

**Developing paste GP-84 — 20–60 s**

*Solution A*

| | |
|---|---|
| Gantez solution (see Appendix Sec. 4) | 300 g (10 oz) |

*Solution B*

| | |
|---|---|
| Water | 565 ml (18 oz) |
| Hydroquinone | 60 g (2 oz) |
| Sodium sulfite (anh.) | 60 g (2 oz) |
| Sodium hydroxide | 80 g (2 oz 290 gr) |

Mix solution A with B, and add:

*Solution C*

| | |
|---|---|
| Ethylenediamine (60–70%) | 20 ml (5.5 fl. dr) |
| Water to make | 1.000 ml (32 oz) |

**8. Color Developer GP-29 — 4–6 min**

| | |
|---|---|
| Water | 900 ml (28 oz) |
| Calgon | 1 g (15 gr) |
| Sodium sulfite (anh.) | 4 g (58 gr) |
| N-N-diethyl-paraphenyl-enediamine hydrochloride | 2.7 g (40 gr) |
| *or:* | |
| N-N-diethyl-paraphenyl-enediamine semi-sulfate | 2.9 g (43 gr) |
| Hydroxylamine | 1.2 g (18 gr) |
| Sodium carbonate (anh.) | 25 g (365 gr) |
| Potassium bromide | 2.2 g (32 gr) |
| Sodium bicarbonate | 0.55 g (8 gr) |
| Water to make | 1.000 ml (32 oz) |
| pH value: 10.70 (±0.10) | |

**10,16. First and Second Fixer GP-308 — 1–2 min**

| | |
|---|---|
| Water | 800 ml (24 oz) |
| Sodium thiosulfate anhydrous, or | 200 g (6 oz 290 gr) |
| crystals | 300 g (10 oz) |
| Potassium metabisulfite | 12 g (175 gr) |
| Glacial acetic acid | 12 ml (3 fl. dr) |
| Borax | 20 g (290 gr) |
| Potassium alum | 15 g (½ oz) |
| Water to make | 1.000 ml (32 oz) |
| pH value: 4.10 (±0.25) | |

**12. Bleach GP-446 — 2–2½ min**

| | |
|---|---|
| Water | 900 ml (28 oz) |
| Potassium ferricyanide | 75 g (2½ oz) |
| Potassium bromide | 15 g (½ oz) |
| Glacial acetic acid | 10 ml (2½ fl. dr) |
| Sodium acetate | 5 g (73 gr) |
| Potassium alum | 15 g (½ oz) |
| Water to make | 1.000 ml (32 oz) |
| pH value 3.20 (±0.10) | |