

Eastman Color High-Speed Negative Film 7292

By Steven J. Powell and Frank R. Reinking

A new 16mm high-speed color negative film incorporating the new T-Grain emulsion technology is described. This film provides excellent resolution, granularity, and color reproduction that result in much improved prints and telecine transfers.

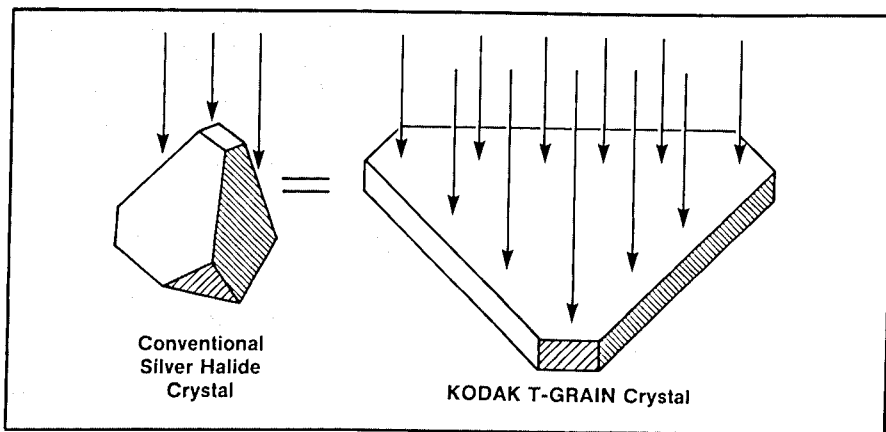


Figure 1. Schematic diagram of relative cross-sectional area per unit volume of T-Grain crystals vs. conventional silver halide crystals.

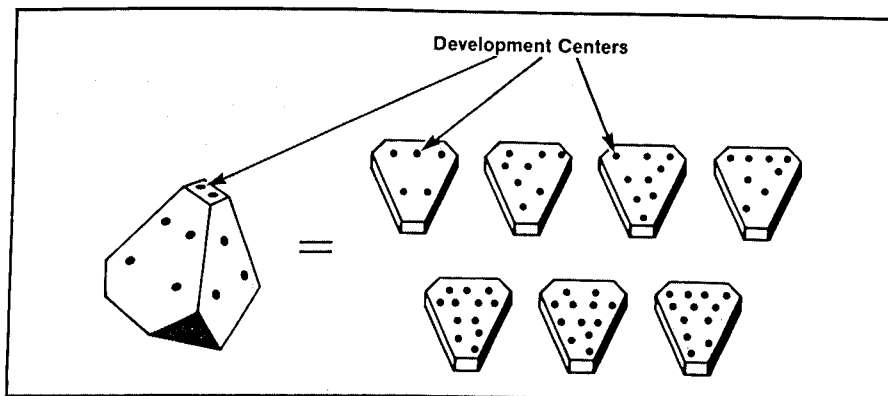


Figure 2. Schematic diagram of potential increase in number of development centers provided by T-Grain emulsions.

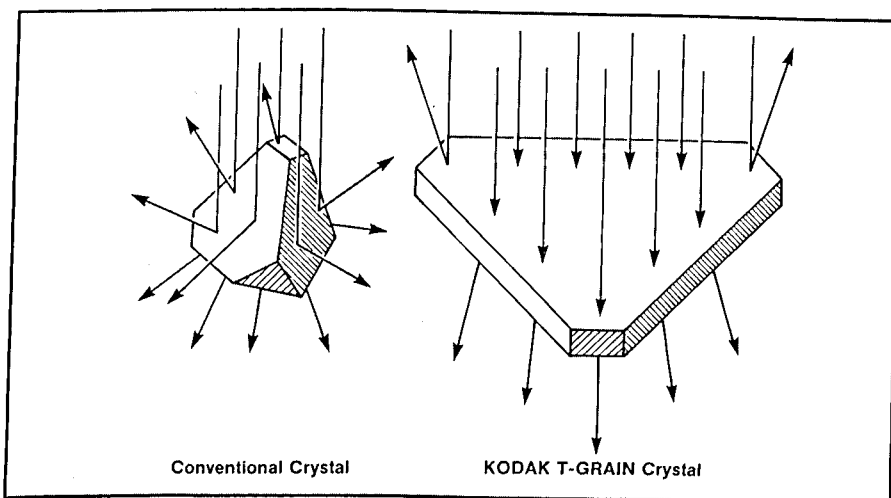


Figure 3. Effect of crystal geometry on light scatter.

In 1983, Eastman Kodak Co. demonstrated a significant advance in photographic emulsion technology with the introduction of Kodacolor VR 1000 film, which incorporates Kodak T-Grain emulsions. This class of emulsions, characterized by their tablet-like crystal structure, provides previously unobtainable advantages.

T-Grain Emulsion Technology

T-Grain emulsions present a large cross-sectional crystal area per unit volume of silver halide, as shown schematically in Fig. 1. As a result, when compared with normal silver halide crystals, the same volume of T-Grain crystals can have a much larger capacity to capture incident photons. This physical property is particularly beneficial at low light levels.

The high surface-to-volume ratio of T-Grain crystals creates the potential for granularity reduction. A given volume of silver can provide many more silver halide crystals of a given diameter in a T-Grain emulsion than in a conventional emulsion. As shown in Fig. 2, this results in many more development centers, and mathematical models have shown that granularity is inversely related to the number of development centers contributing to a given density. That is, as the number of development centers increases, the granularity decreases.

Finally, the special geometry of T-Grain emulsions results in less light scatter within an emulsion layer (Fig. 3). In practical terms, less optical scatter means increased sharpness.

These benefits — increased sensitivity, reduced granularity, and improved sharpness — greatly interested Kodak's photographic scientists. Consequently, the professional motion-picture development group set about to determine how this class of

Kodacolor, VR, T-Grain, and Wratten are trademarks.

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emulsions could be used, in combination with other proprietary emulsion technology, in the company's line of films.

Stringent demands are placed on image quality by the 16mm film system, and T-Grain emulsions are par-

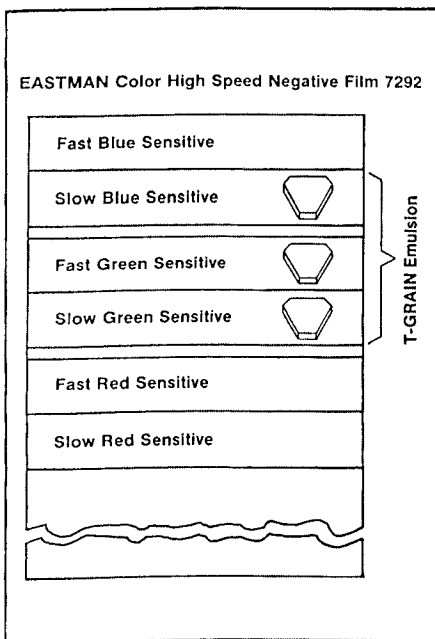


Figure 4. Cross-sectional diagram of 7292.

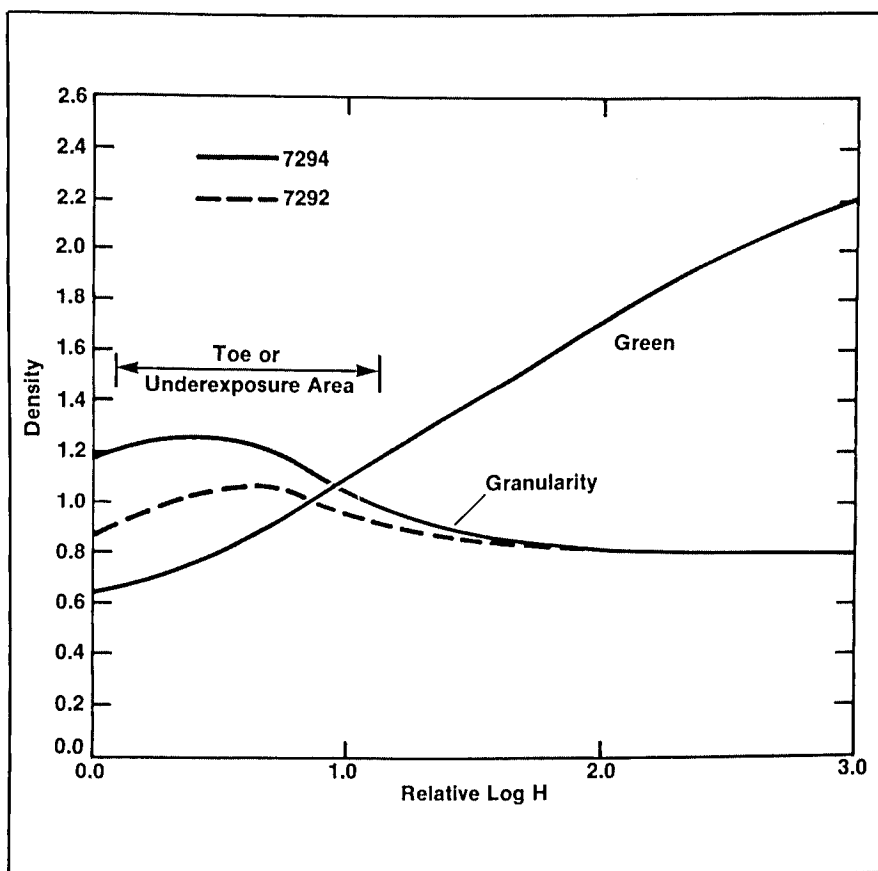


Figure 6. RMS granularity comparison (green) of 7292 and 7294.

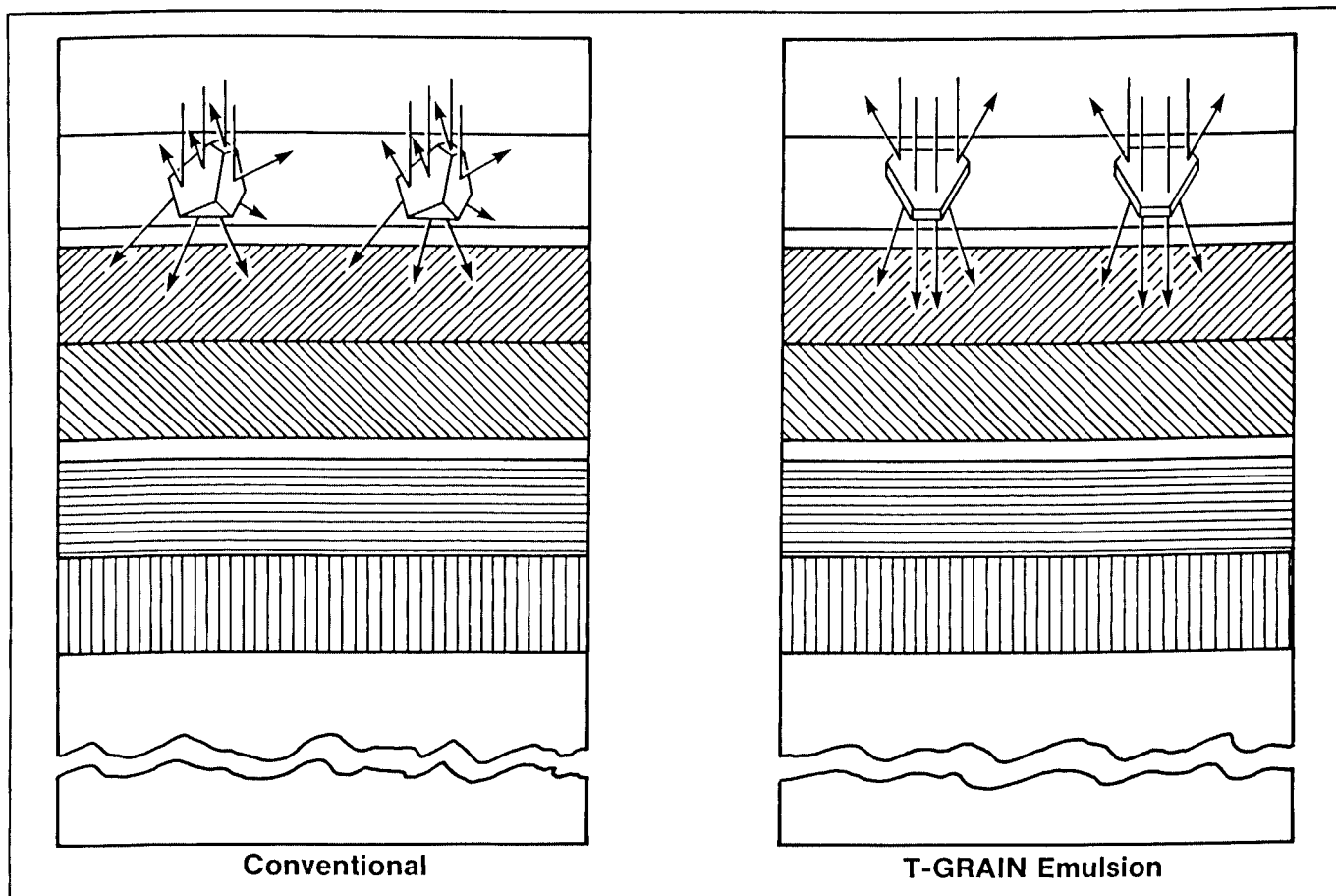


Figure 5. Effect of T-Grain emulsion in slow blue-sensitive layer on light scatter beneath.

ticularly efficient as high-speed emulsions. Therefore, it was logical to evaluate the quality improvement T-Grain emulsion technology could provide to the high-speed camera negative films, in particular, Eastman color high-speed negative film 7294. The result of this research is Eastman color high-speed negative film 7292, which will replace 7294.

Film Structure

As shown in Fig. 4, 7292 film has a multi-layer structure typical of color negative films. Each of the red, green, and blue-sensitive layers is composed of two separate coats, with the upper, or fast, layer of each pair containing

the larger-grained, faster silver halide emulsions and the lower, or slow, layer containing the finer-grained, lower-speed emulsions. T-Grain emulsions are used in the two green-sensitive layers and in the slow blue-sensitive layer.

The green-sensitive layers were targeted for improvement because of the significant part they play in the perception of screen image sharpness and graininess. Use of T-Grain emulsions in the slow blue-sensitive layer reduces light scattering within the emulsion and improves the sharpness in the layers beneath. This is shown schematically in Fig. 5. The red-sensitive layers and the fast blue-sensitive

layer employ conventional emulsion technology. In the course of the development work, the use of state-of-the-art image couplers and inhibitor-releasing couplers was examined.

Image Structure

The improvement in green layer granularity with 7292 film is illustrated in Fig. 6. This layer shows a significant reduction in granularity compared with 7294, particularly in the toe area of the curve where the largest improvements have been made. Improvements in the mid-scale-to-shoulder part of the blue-sensitive-layer granularity curve can be seen in Fig. 7. When combined, these factors re-

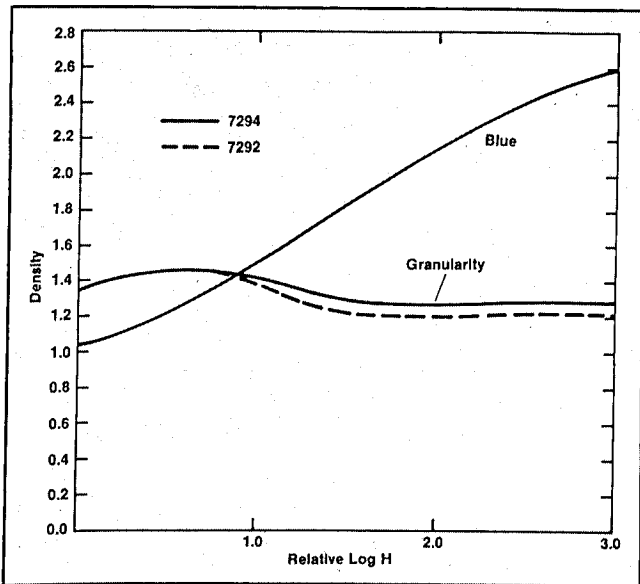


Figure 7. RMS granularity comparison (blue) of 7292 and 7294.

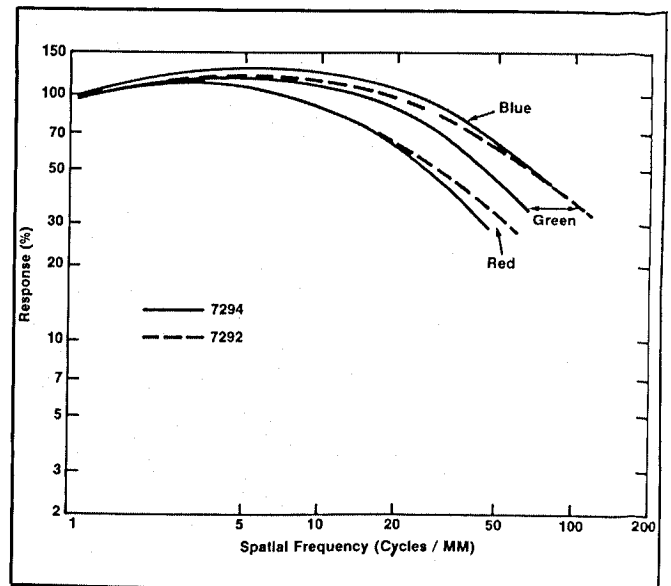


Figure 8. MTF measurements of 7292 and 7294.

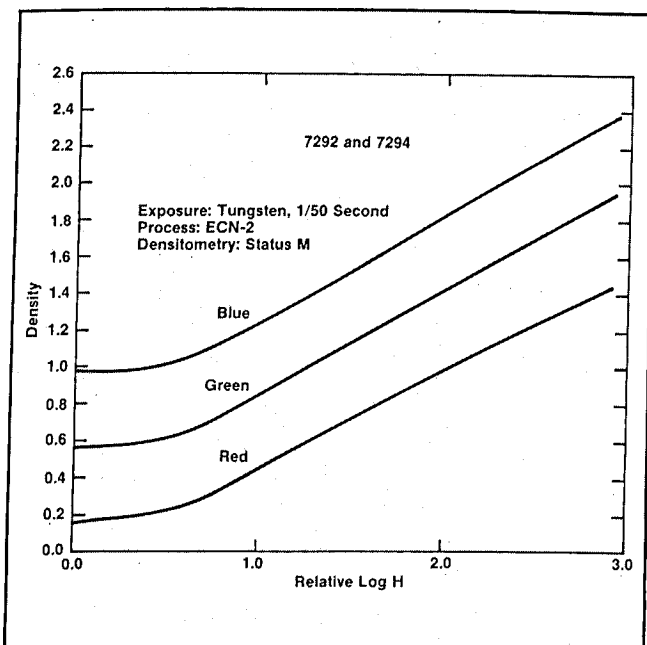


Figure 9. Sensitometric response of 7292.

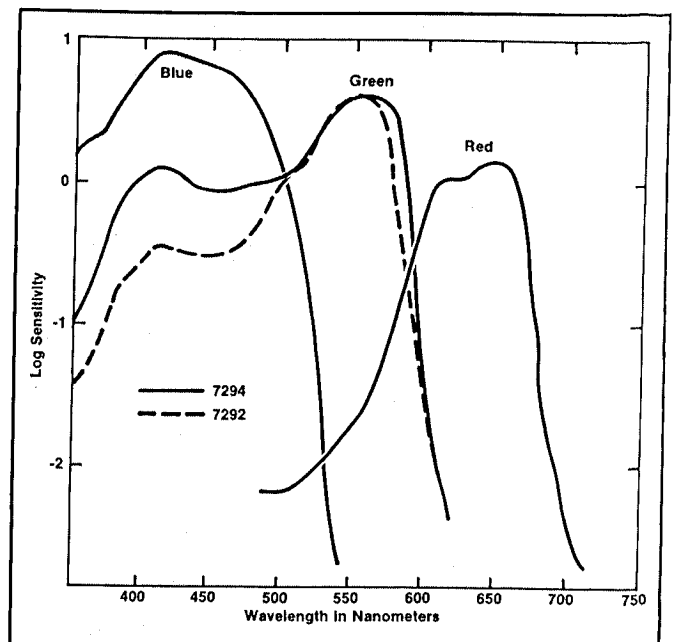


Figure 10. Spectral sensitivity of 7292.

sult in a significant reduction in screen graininess with 7292 film, particularly in shadow areas or when 7292 is exposed at exposure indices (EIs) higher than normal. Under these conditions, 7292 film yields much improved pictures compared with those of 7294.

Because T-Grain emulsions scatter less light within the emulsion layer, 7292 film has a substantial improvement in modulation transfer function (MTF), as shown in Fig. 8. This translates into improved sharpness. The perceived screen sharpness using 7292 film depends on camera and projector optics and other factors. In fact, projector lenses seem now to be the limiting factors in 16mm screen sharpness.

Sensitometry/Color Reproduction

Sensitometrically, 7292 and 7294 films are essentially the same (Fig. 9). Consequently, the 7292 film exposure recommendation remains at EI 320 (tungsten) or EI 200 (daylight), with a Kodak Wratten gelatin filter No. 85. This level of exposure makes full use of the excellent image quality designed into this film, in both film prints and video transfers. Experience indicates that 7292 film is a versatile performer in a wide range of exposure conditions, yielding significant underexposure capability with no compromise in overexposure latitude.

With the introduction of T-Grain emulsions in the green-sensitive layers, a change was incorporated in the green spectral sensitivity of 7292 film (Fig. 10). Computer predictions and picture demonstrations indicated this would result in slightly improved and more accurate rendition of some colors such as oranges, which are more saturated, cyan blues, which contain less magenta dye, and saturated blues, which contain more magenta dye. All other color rendition is essentially the same as for 7294 film. Tests demonstrate that these changes provide even better ability to intercut with Eastman color negative film 7291, both for color reproduction and image structure. A comparison of the color reproduction of 7292 versus 7294 and 7291 is given in Fig. 11.

Processing

Process ECN-2 is used for 7292 film, in exactly the same way as for 7294 and 7291. Force processing is accomplished in the same manner and

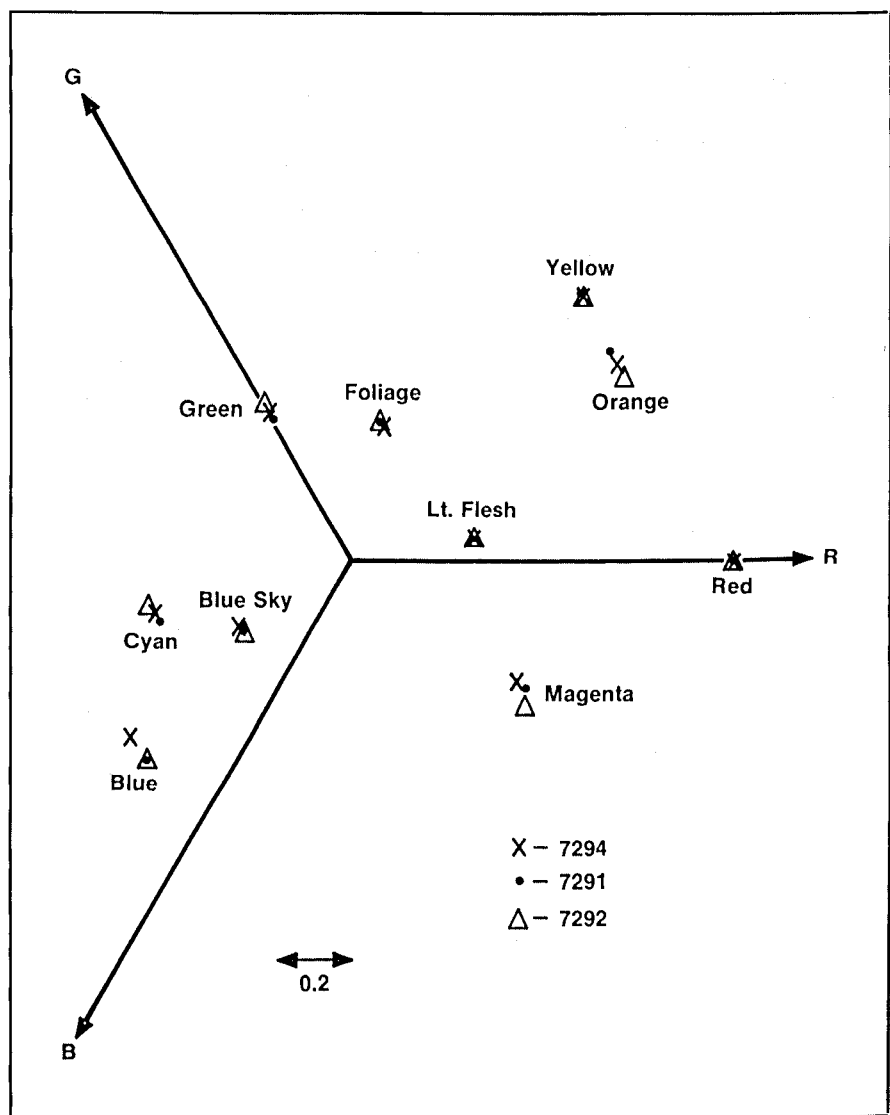


Figure 11. Color reproduction comparison of 7292, 7294, and 7291.

yields similar results when compared with a normally processed negative. Improved image structure characteristics are shown for 7292 film, when compared with comparably processed 7294. Sensitivity to process deviations is also reduced with 7292 when compared with 7294, resulting in process sensitivity more similar to that of 7291.

Film Identification/Labeling

Because of the film formulation of 7292, the color of 7292 raw stock is more red-brown, compared with that of 7294 or 7291 film. This can be of practical benefit in differentiating it from other stocks.

The processed film identification of 7292 is also different. The identification number 292 is carried on 7292 film in its latent edge print, as compared with 291 and 294 for 7291 and 7294, respectively. Labeling for 7292 film, however, has been changed to a

new four-language label that is being extended for use on all Kodak professional motion-picture films.

Conclusion

The introduction of 7292 film provides the 16mm film user with a significant improvement in graininess and sharpness for both film prints and video transfers. Together with 7291 film, this new film broadens the range of creative opportunities for the cinematographer and continues the rich tradition of quality in color negative films introduced since the early 1950s.

Acknowledgments

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