DYE COUPLER PROCESS

PROCESS

A chromogenic print was generated projecting light into an enlarger through the negative on the photographic paper. The paper has a three-layered tri-pack emulsion, composed of silver and dyes that are used to form the image. Each layer is sensitive to only one colour of light, red, green or blue, which is complementary to the dyes found in the negative. When the print is made, the colours from the negative are reversed [1, 2].

When the print is developed, each of the three layers of the exposed emulsion develops into a positive black-and-white silver image that represents a third of the recorded spectrum (red, green, or blue). During development, the developing agent reduces the latent image to silver particles which in turn oxidizes the developing agent. Where silver is present, the colour couplers react with the oxidized developing agent to form coloured dye images. The dyes are chemically synthesized in the emulsion layers where they remain in place after they are formed. After development, the paper contains the exposed tri-pack of positive silver and dyed images. The silver is converted to silver ion in a bleaching bath and then removed in a fixing bath. This leaves only a positive dyed image that is washed and then dried [3, 1, 4].

Today, the standard processing of chromogenic colour prints from negatives is designated RA-4, its predecessor was the processing EP-2. To make prints from slides, the processing colour reversal paper R-3 is used [5].

HISTORY

The process derives from the German chemist Benno Homolka, who in 1906 found out the basics of colour couplers during his studies on the latent image as oxidising agent [6].

However, it was chemists Rudolph Fischer and Hans Siegrist who coined the term “colour development” and first patented the integral tri-pack. Despite his efforts, Fischer never succeeded in making commercially acceptable colour prints: the dye couplers present in the different layers were not isolated, they tended to migrate and react with adjacent chemicals. The result was an image characterized by inaccuracies in the reproduction of the original colour [1].

This issue was solved by Leopold Godowsky and Leopold Mannes around 1930, who combined the couplers with the developer, introducing them during the development. This idea led in 1935 to Kodachrome, the first practical colour transparency film [1]. One of the innovations of the Kodachrome was a single exposure to register the latent image of all three primary colours. The upper emulsion layer was sensitive only to blue; below there was a yellow filter that adsorbed blue light to avoid the exposure of the underlying emulsion. The positive was obtained after the negative developed by inversion of the tones. During the second development, silver salts, in the form of halides, were washed away, what remained was a colour image [7].

This was a practical, accurate and inexpensive method for making a colour image. However, there were some disadvantages, such as low speed, a complex development that required specialized laboratories, and the difficulty of obtaining prints from slides. Despite that, it was a huge success, becoming one of the icons of colour photography [1].

The first subtractive colour reversal film with a tree layer and colour coupler incorporated in the emulsion was created by Agfa in 1936. The Agfacolor Neu overcame the coupler’s layers migration problem by making their molecules very big.
This was possible thanks to the studies of Agfa chemists Wilhelm Schneider and Gustav Willmanns who created molecules with long hydrocarbon chains that fixed the couplers in gelatin. Seeing as how the couplers were

incorporated into the tri-pack, only a developer solution was needed to obtain the positive image [1].

Kodak, working on the same issue, found a different solution: there were created insoluble chains shorter than Agfa chains. In this way, the couplers were insoluble in water, but soluble in oil. The colour couplers were dissolved in a resinous binder and dispersed in the gelatin emulsion in the form of tiny drops. Based on this discovery, Kodak in 1942 introduced Kodacolor, the first negative film and related printing paper with integrated couplers. The cost-effectiveness and simplicity of the treatment, compared to the solutions proposed by competitors, decreed the immediate success of this product which soon became very popular even among amateurs [1].

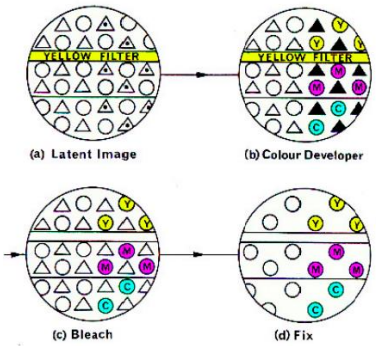

Fig. 1

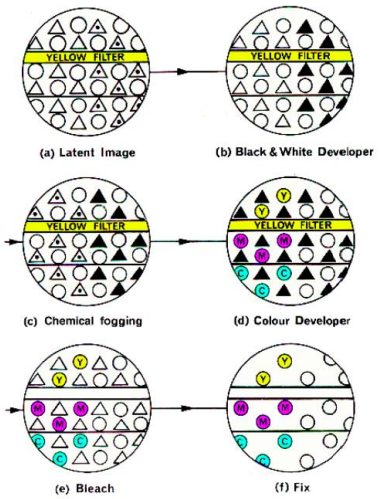

Fig. 2

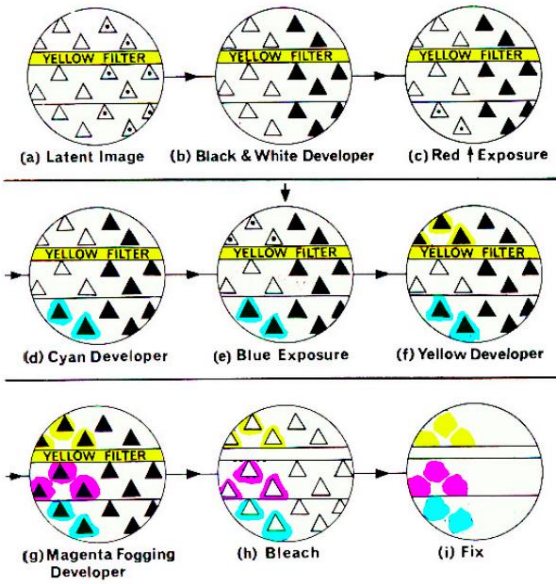

Fig. 3

Fig. 1 *Diagrammatic representation of a cross-section of an integral tri-pack material with incorporated couplers being processed to give a negative image [8].*
△ unexposed silver halide grain.
◬ exposed silver halide grain.
▲ developed grain of silver.
○ particles of coupler.
Y particle of yellow dye.
M particle of magenta dye.
C particle of cyan dye.

Fig. 2 *Same as Fig. 1 but showing the processing sequence necessary to obtain a positive image directly on the film (reversal process) [8].*

Fig. 3 *Same as Fig. 2 but using the method where the three couplers are in three different developers instead of in three layers of the tri-pack [8]*

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