Systems for rendering color

Additive

Subtractive

Main processes for color photography

Additive

– Screen filter

Subtractive

– Assembly
– Dye imbibition
– Chromogenic
– Silver dye bleach
– Dye diffusion transfer
Additive Screen Filter Processes

- Joly 1895
- MCDonough 1897
- Dufay 1905 (Dioptichrome), Autochrome 1907
- Omincolor 1907
- 1908 Dufaycolor
- Paget 1913
- Agfa color 1916
- Finlay 1929
- Lumiere Filmcolor 1929
- Dufaycolor Motion Picture Film 1935

Additive Color in Principle

Screens

Filters

Final image
McDonough’s additive screen and photograph

The early additive photograph, left, was taken by an American, James McDonough, in 1894, using the regular ruled screen shown ×50, below. In the original picture, the tomatoes were orange-red; but the screen has shifted and this color cannot be reproduced.
Unidentified Photographer, James McDonough, screen filter photograph, detail, circa 1894. GEH Collection.


Charles Zoller, Autochrome, ca. 1907. GEH Collection
Unidentified photographer, Autochrome (detail), ca. 1907. GEH Collection


Omnicolor transparency, ca. 1907. GEH Collection

Unidentified Photographer, Dufaycolor, ca. 1935. GEH Collection

Subtractive Color: Based on Combinations of Cyan, Yellow and Magenta Dye
Main processes for color photography

Additive
– Screen filter

Subtractive
– Assembly
– Dye imbibition
– Chromogenic
– Silver dye bleach
– Dye diffusion transfer

Assembly Process
Based on superimposing layers of pigments (and sometime dyes) usually in a gelatin matrix onto a paper final support. Some key products and dates:
– Tri Chrome carbon 1862
  • Pigments bound in layers of gelatin sensitized with dichromate and hardened by light and developed in water.
  • Duxachrome 1929
– Carbro 1912
  • Pigments bound in layers of gelatin sensitized with dichromate and hardened / “tanned” by contact with metallic silver light and developed in water.
– Dye Toning Process, Chromotone 1935
  • Dyes bound in layers of gelatin mordanted to silver.
Successive layers pigmented layers, usually in bichromated gelatin, are applied to a secondary support.

Colors rendered in the final image.

Portrait of Enzio Pinza, Nickolas Murray, Carbro (Print), GEH Collection

Dye Imbibition
- Hydrotypes 1881
- Sanger-Shephard 1900
- Pinatype 1905
- Kodachrome (2-color)
- Technicolor (2 color) 1927 and (3 color) 1933
- Eastman Wash-Off Relief 1935
- *Kodak dye Transfer 1945*

Dye Imbibition

Dye -Imbibition Process
Cross Section

Gelatin layer containing mordanted dye aggregates

Baryta layer

Paper

Colors rendered in the final image

Dye Transfer Print Made from Separation Negatives Exposed in a Mikut Color Camera. 

Hoedt Studio, Dye Imbibition. GEH Collection
Hoedt Studio, Dye Imbibition. GEH Collection

Chromogenic (dye coupler): some major products
- Kodachrome 1935
- Agfacolor 1936
- Kodacolor 1942
- Agfa / Ansco Printon 1945
- Ektachrome 1946
- Ektacolor 1949

Chromogenic Processes - Cross Section

Blue sensitive layer
Green sensitive layer
Red sensitive layer

U.V. filter, gelatin super coat
Yellow filter (minus blue light)
Anti halation layer
Film base

Colors rendered in the final image

The diagram shows a simplified structure for a color transparency. Negatives often use a similar layer sequence while prints typically have the cyan or magenta layers on the top and the yellow layer on the bottom.

Clark, Walter, Portrait of Mannes and Godowsky KODACHROME (transparency), GEH Collection.


MINICOLOR (Kodachrome prints), 1940’s. GEH Collection


Silver Dye Bleach

– Christenson 1918
– Gasparacolor 1933
– Azochrome 1940
– *Cibachrome 1963 (Ilfochrome 1991)*
Silver Dye-Bleach Processes
Cross Section

- Anti-abrasion layer
- Yellow filter
- Clear interlayer
- Polyethylene (RC) or polyester (opaque white or clear)
- Matte gelatin non-curl layer

Colors rendered in the final image:
- Black
- Blue
- Green
- Red
- Yellow

Wittmer, Albert, Azochrome (print) ca. 1940. GEH Collection

Dye Diffusion Transfer

- Polaroid Polacolor 1963
- Polaroid SX-70 1972
- Kodak 1976
- Kodak Ektaflex 1981
Dye Diffusion-Transfer Processes – Cross-section

The top layers of the print consists of a gelatin super coat, a mordant layer & the received dyes

The diagram shows a simplified structure for a Polacolor print.


Condax, Philip, Polaroid SX-70, Portrait of Ansel Adams. GEH Collection

CDD sensor with Bayer filter
CDD sensor with Bayer filter

Omnicolor (detail), ca. 1907. GEH Collection