

# 20<sup>th</sup> Century Materials, Processes, Technologies



## Photographic Process ID Webinar #2

Image Permanence Institute  
2017-2018

James and Marjorie Carver  
Instant (Diffusion Transfer)

# Resources

## Web Resources

- Graphics Atlas
  - [www.graphicsatlas.org](http://www.graphicsatlas.org)
- George Eastman Museum Photographic Processes Series
  - YouTube
- Lingua Franca: A Common Language for Conservators of Photographic Materials
  - iTunes App
- The Atlas of Analytical Signatures of Photographic Processes
  - [www.getty.edu/conservation/publications\\_resources/pdf\\_publications/atlas.html](http://www.getty.edu/conservation/publications_resources/pdf_publications/atlas.html)

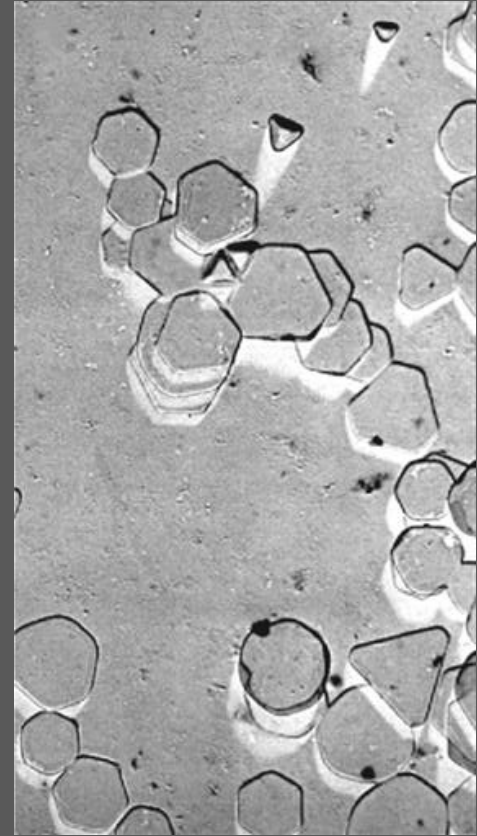
## Print Resources

- *Twentieth Century Color Photographs: Identification and Care* by Silvie Penichon
- *Photographs of the Past: Process and Preservation* by Bertrand Lavedrine
- *In the Darkroom: An Illustrated Guide to Photographic Processes Before the Digital Age* by Sarah Kennel

# What is a Photograph?

- An Image
  - Light Sensitivity of Chemical Compounds
    - Silver Salts
    - Chromium Salts
- A substrate

Salts (Chemistry): an ionic compound which is made up of two groups of oppositely charged ions (positive and negative)



Scanning electron microscope image of silver bromide crystals

# 19<sup>th</sup> C Processes into 20<sup>th</sup> C

- Collodion POP, 1885-1910
- Gelatin POP, 1885-1910
- Matte Collodion, 1895-1910
- Carbon, 1868-1940
- Gum Dichromate, 1894-1930s
- Cyanotype, 1842-1950
- Platinum, 1880-1930
- Gelatin Dry Plate, 1880-1925



Collodion POP



# 20<sup>th</sup> C Processes

- Silver Gelatin DOP, 1890-2000
- Screen Plate, 1907-1935
- Carbro, 1925-1950
- Dye Imbibition, 1945-1990
- Chromogenic, 1942-Present
- Instant (Diffusion Transfer), 1948-2008

# Negative

A tonally reversed image on a transparent support.

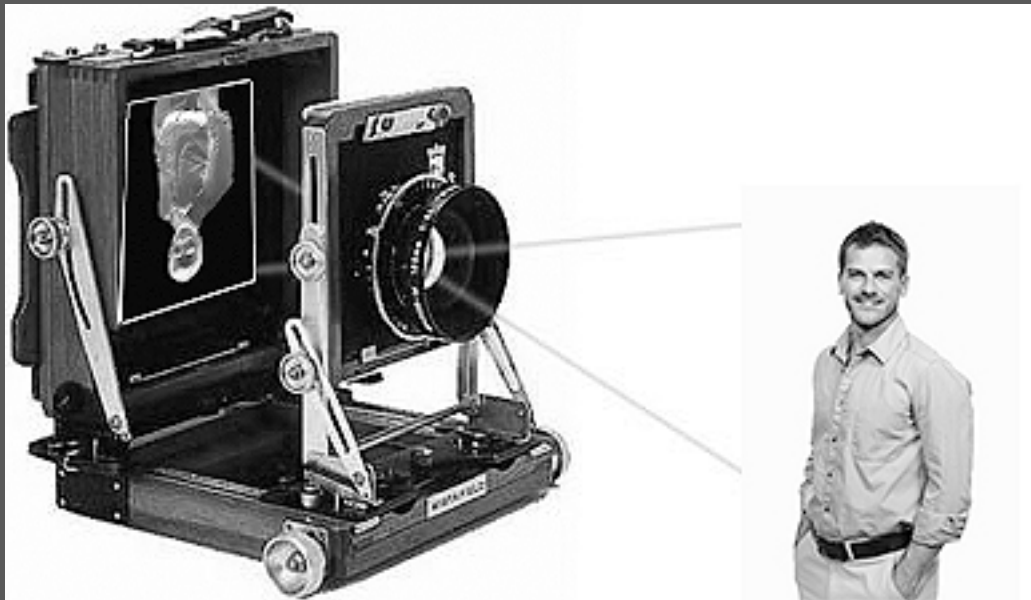
- Glass plate
  - Flexible strip film
  - Sheet film
- Black and White  
And  
Color



35mm negative on cellulose  
nitrate support

# Negative

All light sensitive materials exposed to light through a camera produce a negative image.



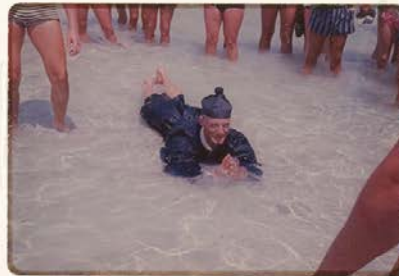
More light is reflecting off the light surfaces like the man's shirt exposing the light sensitive material creating darker hues.

Less light is reflecting off the dark surfaces, like the man's hair. Little to no material is exposed creating light hues.

# Positive Transparency

A positive image on a transparent support

- Lantern slides
  - 35 mm slides
  - 4x5 or 8x10 transparencies
- Black and White  
And  
Color



35mm chromogenic slide  
transparency

# Print

A positive image on an opaque support



Silver Gelatin DOP

# Photographic Printing



Contact print:

The negative is placed in direct contact with the light sensitive paper.



The print is the same size as the negative.

Toned Silver Gelatin DOP  
Gelatin dry plate negative

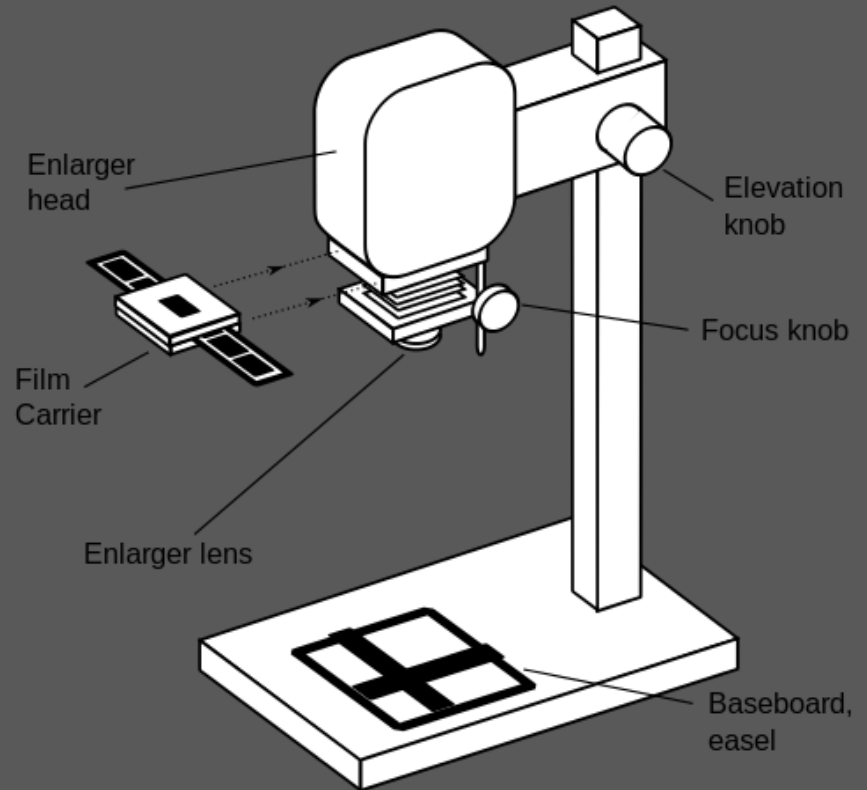


# Photographic Printing

## Enlargement:

A small negative is placed in an enlarger, the image is projected onto light sensitive paper.

The negative is smaller than the print.



# 20<sup>th</sup> C Photographic Materials

## Image Material

- Metal, Pigment, Dye

## Image Binder

- Gelatin

## Primary Support

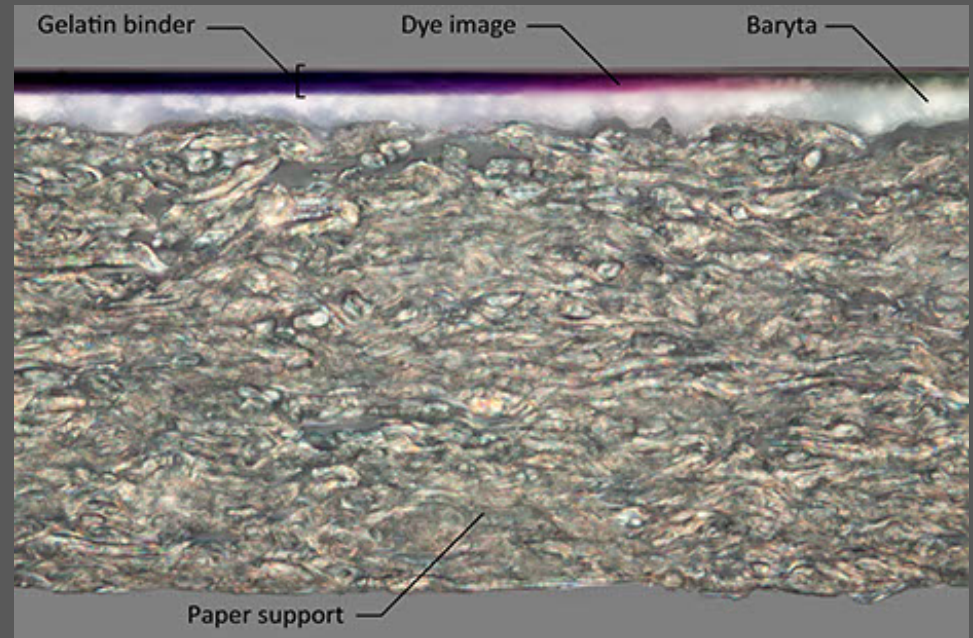
- Paper, Glass, Plastic

## Support Coating\*

- Baryta, Plastic

## Additives \*

- To support, binder



\*not always present

# Image Formation

## Silver Developing Out Process (DOP)

- Black and White, Color
  - Negatives
  - Prints
  - Positive Transparencies

Photography  
is awesome!



# Developing Out (DOP): Overview



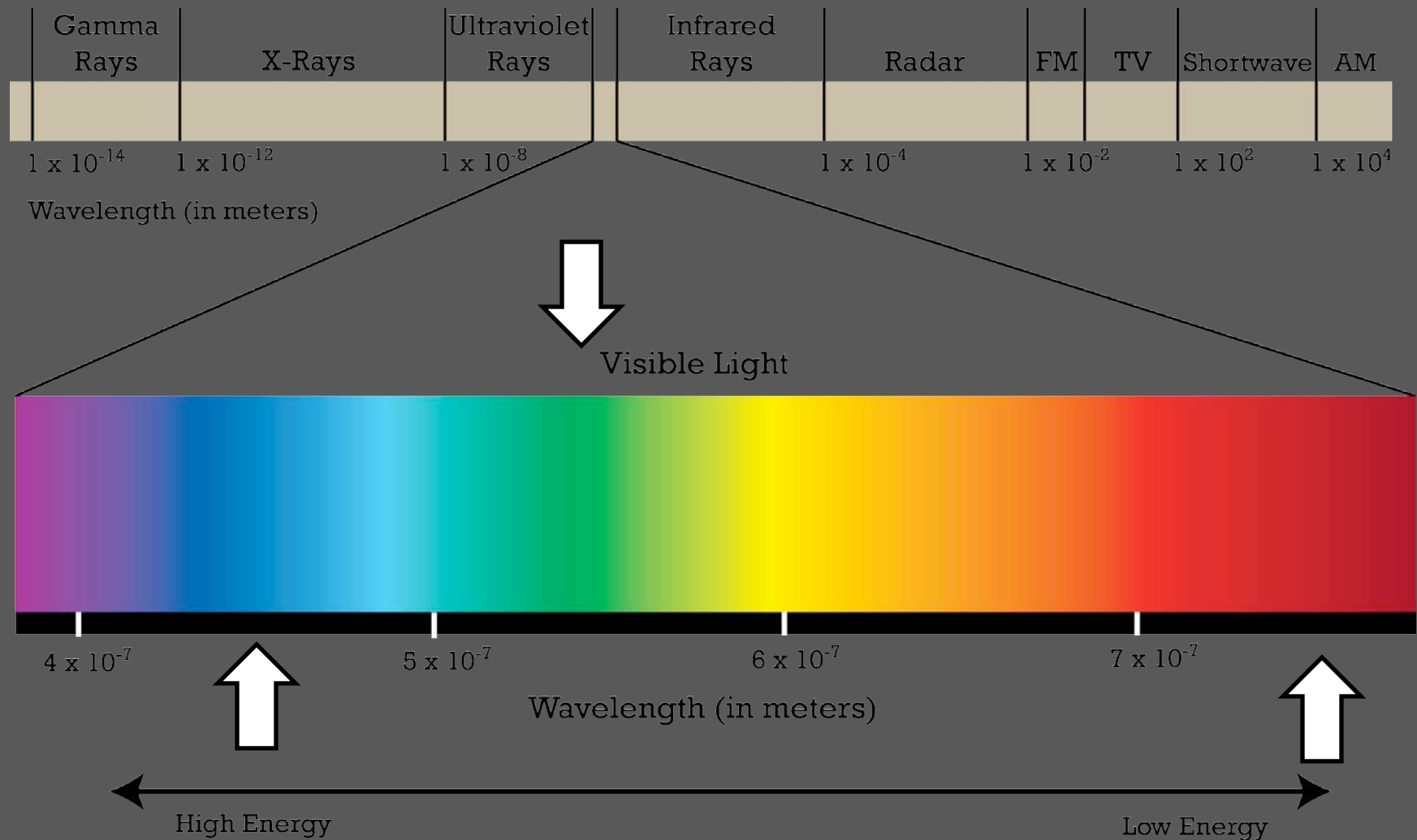
- Negatives, 1839-present; Prints, 1900-present
- Short exposure
- Latent image is formed (invisible)
- Silver halide reduced by chemical reaction to silver image particle
- Sensitive to blue, green, and red light after 1906
- Produces large image particles
- Black image colors

# Silver Image Formation

# The Periodic Table

1 H																	2 He	
3 Li	4 Be																	10 Ne
11 Na	12 Mg																	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
55 Cs	56 Ba	57-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo	
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

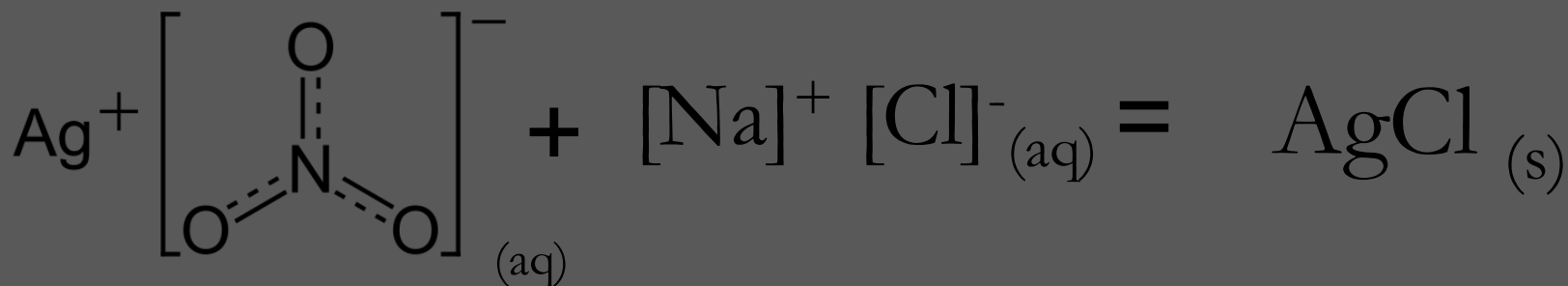
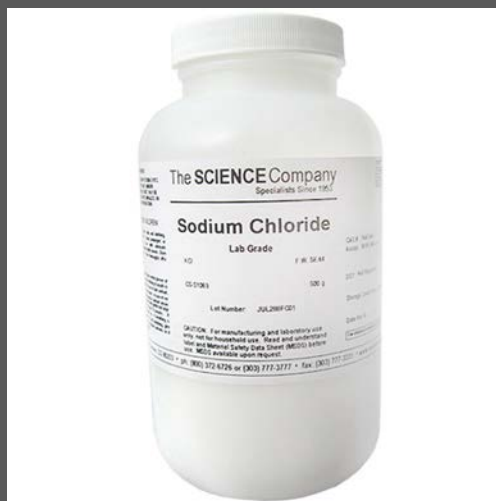




## The Electromagnetic Spectrum



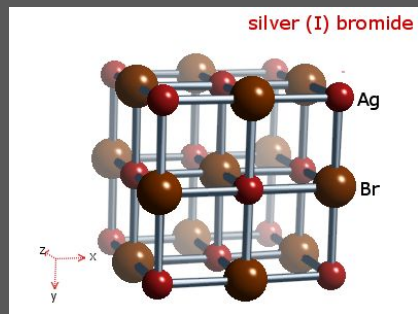
# Silver Image Formation



# Silver Image Formation

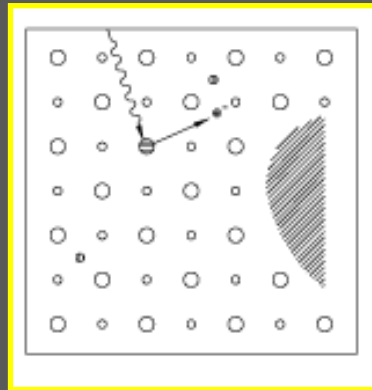


# Silver Image Formation



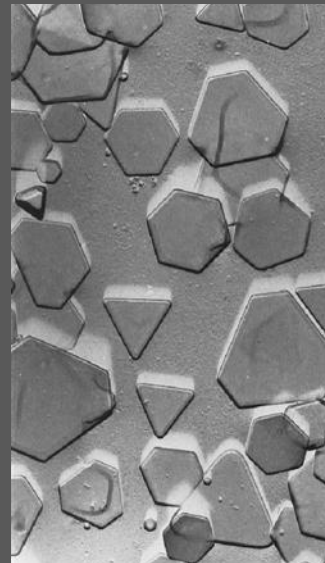
3D Model of AgBr

=



2D Model of AgBr

=



Actual AgBr crystals

=

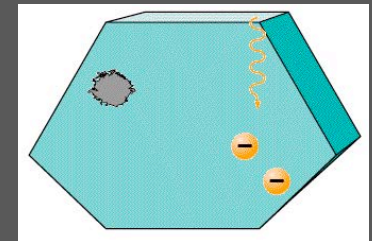
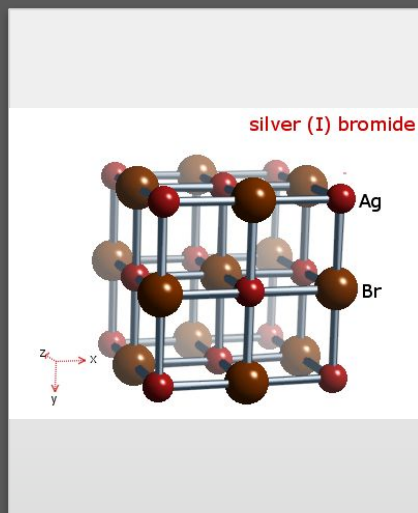


Illustration of AgBr crystals

# Silver Image Formation

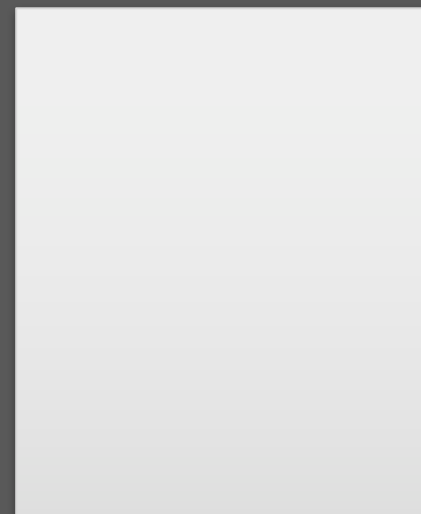


Silver Bromide

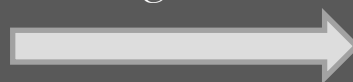
+



=



Light



Latent image

# Silver Image Formation



## Development

- Reduce exposed silver halides to silver image particle



## Fix

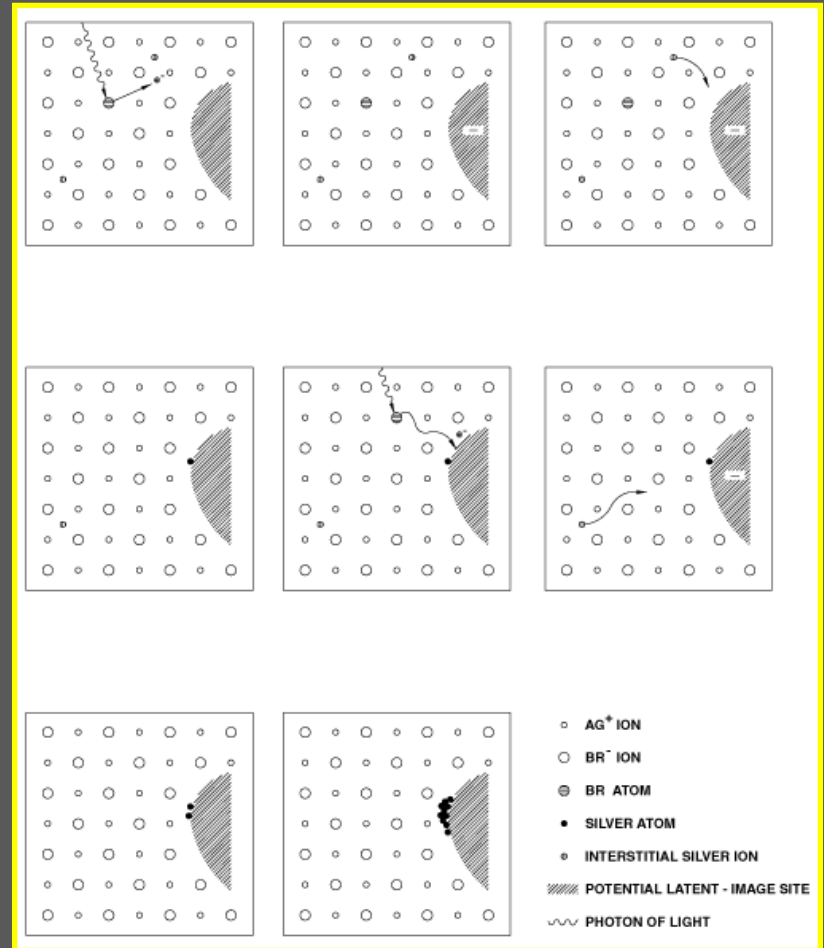
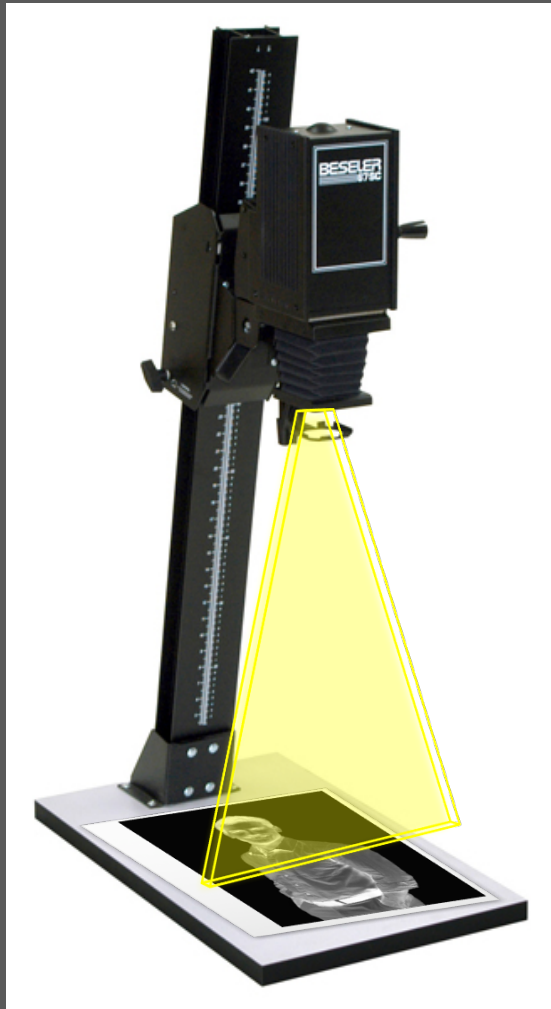
- Break up unexposed silver halides



## Wash

- Remove broken silver and halide ions
- Remove fix chemical

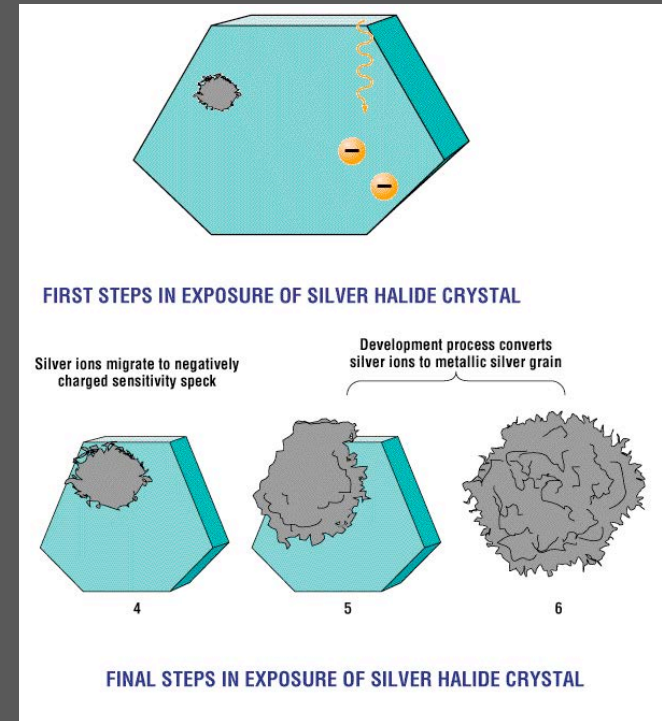
# Silver Image Formation





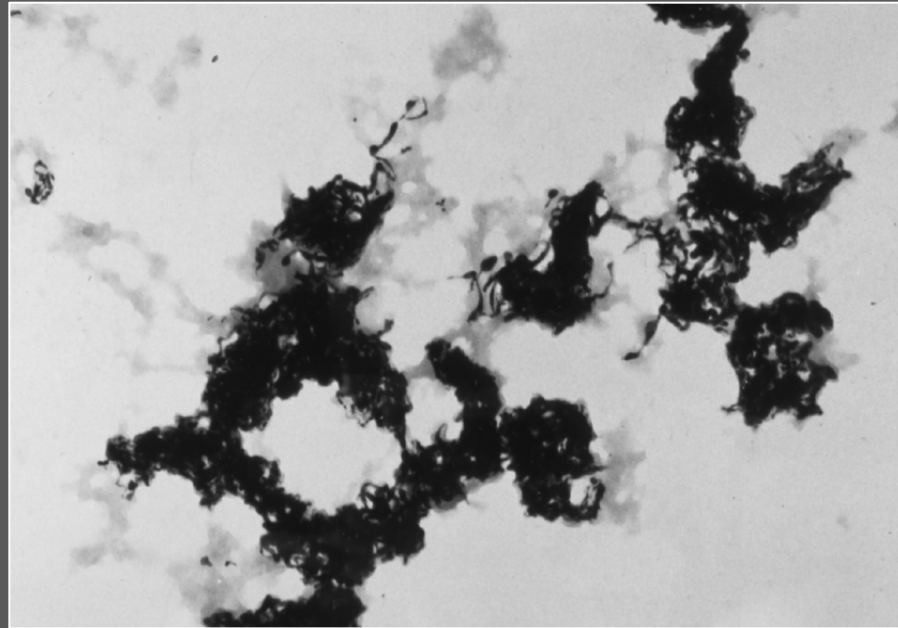
# Silver Image Formation

During development, the exposed silver halide is chemically reduced to silver metal



# Silver Image Formation

Image material and formation influences image tone



Large, filamentary silver image particles = Black image tones

# Calming Manatee



<http://calmingmanatee.com/30>



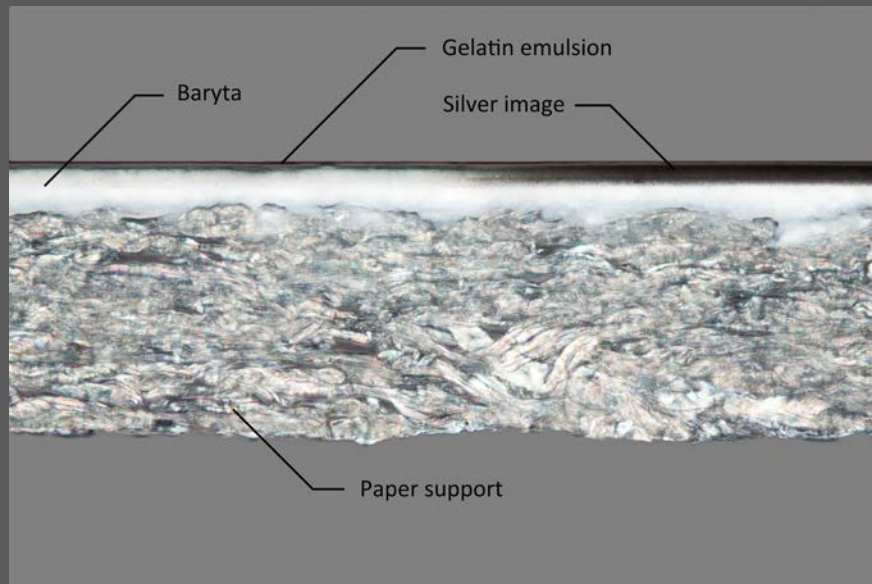
NATIONAL ENDOWMENT FOR THE  
**Humanities**



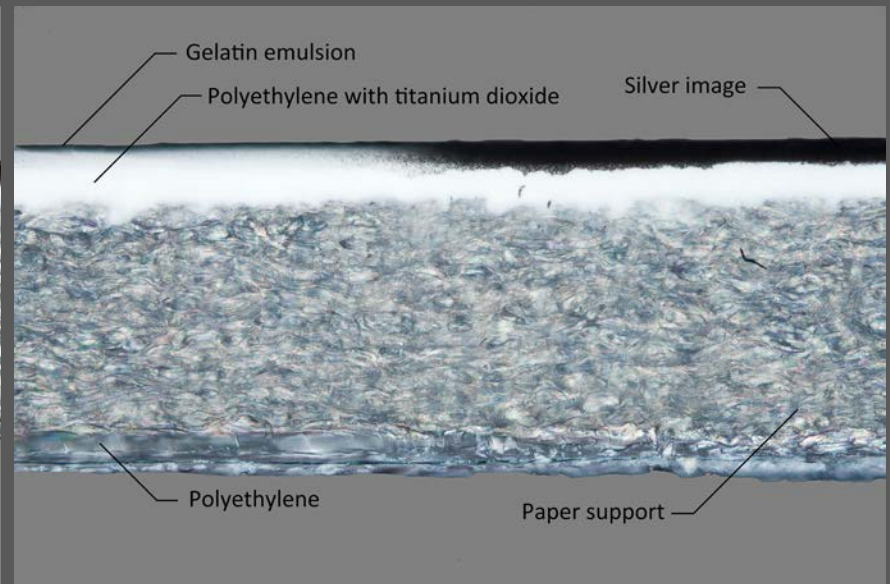
IMAGE  
**PERMANENCE**  
INSTITUTE

# Materials: Silver Gelatin DOP

- Image: silver
- Binder: gelatin
- Support: paper
- Support coating: baryta or polyethylene



Baryta paper

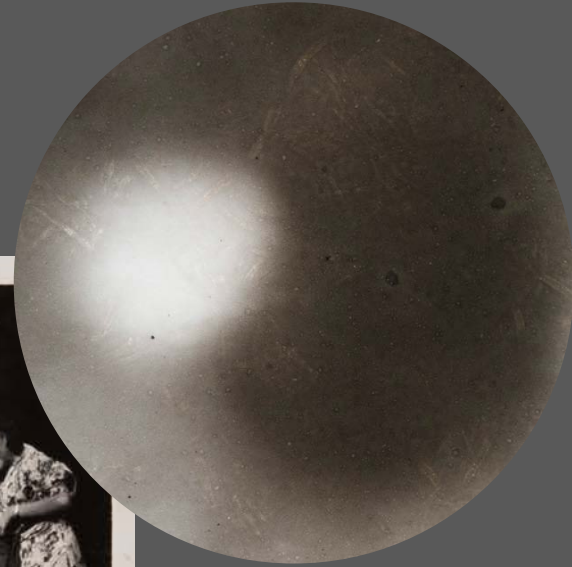


RC paper



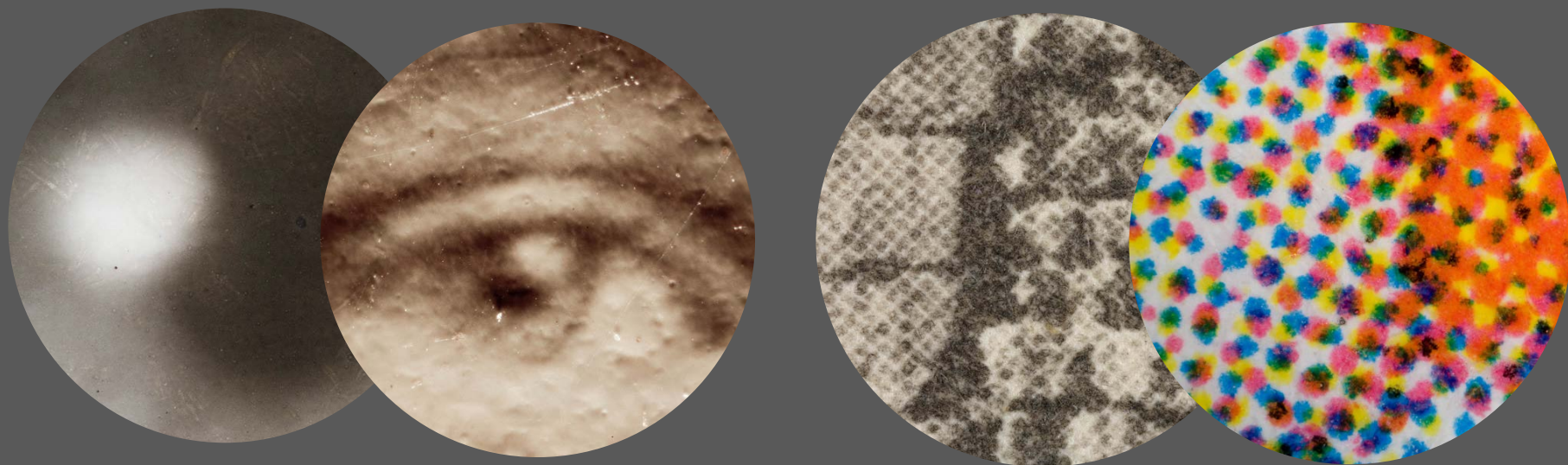
# Untoned Silver Gelatin DOP

- Black image tone
- Continuous in tone



50x magnification

# Continuous in Tone vs Patterned



Continuous in tone

Patterned

50x magnification



# Toned Silver Gelatin DOP



- Sulfur Toning
  - Silver converted to silver sulfide
  - Brown image tones
- Selenium toning
  - Silver converted to silver selenide
  - Purple/red image tones

# Toned Silver Gelatin DOP

## Sulfide and Selenium toning



These prints were toned successively in the same toning bath containing a mix of polysulfide toner and selenium toner. The selenium slowly depleted resulting in stronger sulfide toning of the last prints.

# Silver Image Deterioration

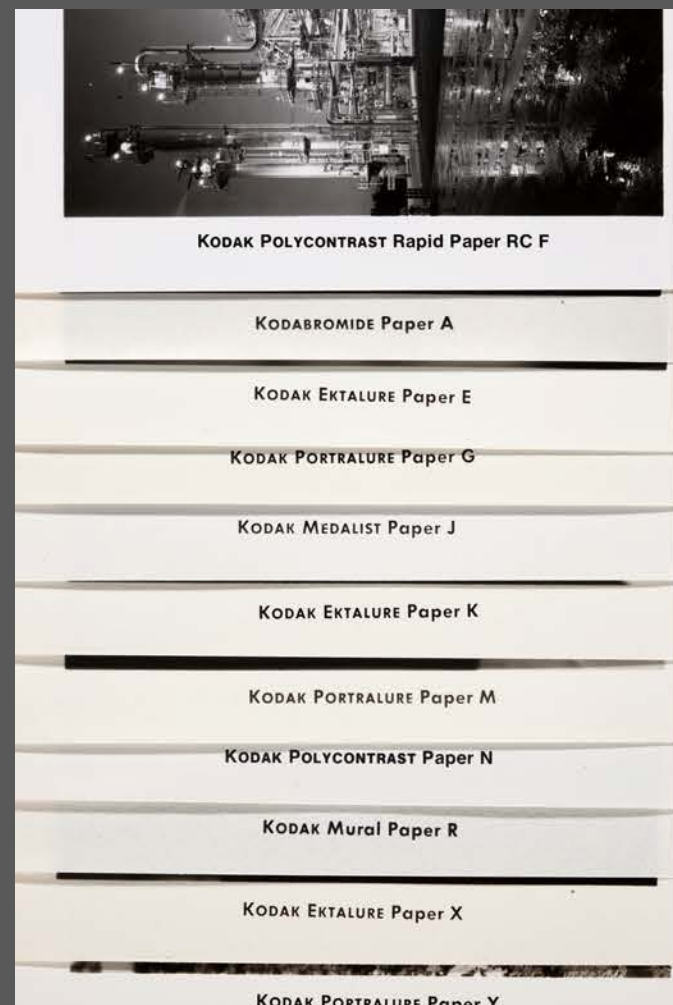
- Image fading
- Change in image tone
  - brown, yellow-brown
  - Silver mirroring



# Silver Gelatin DOP

## Modifications:

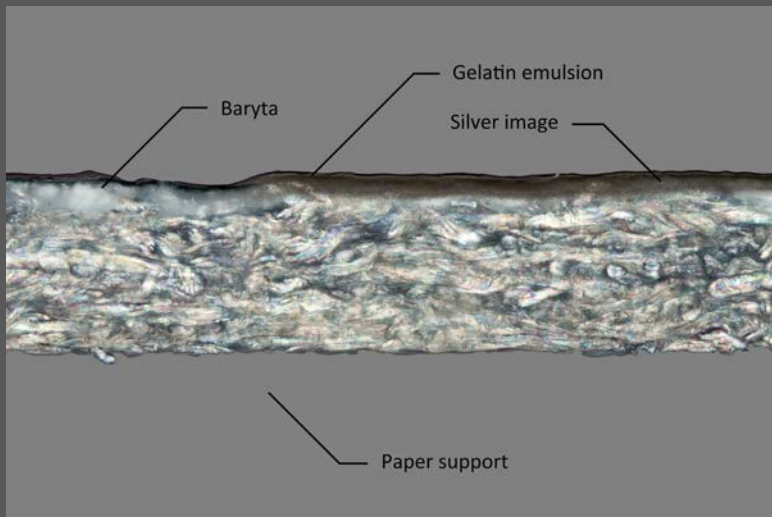
- Image tone
- Base tints
- Surface Characteristics





# DOP: Surface Characteristics

## Thickness of the baryta



Thin Baryta



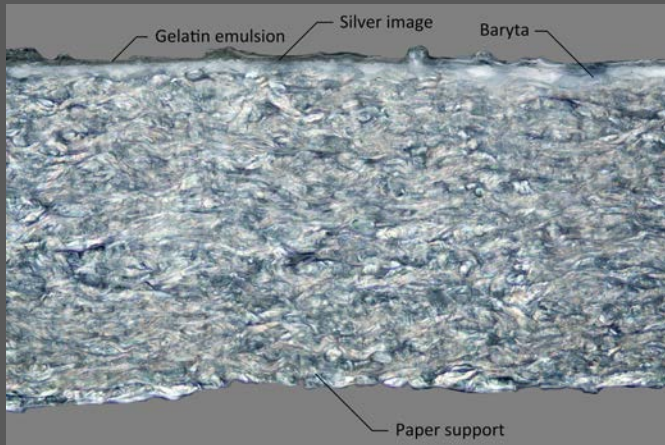
Semi-Matte Sheen



Paper fibers visible  
50x magnification

# DOP: Surface Characteristics

## Matting agents

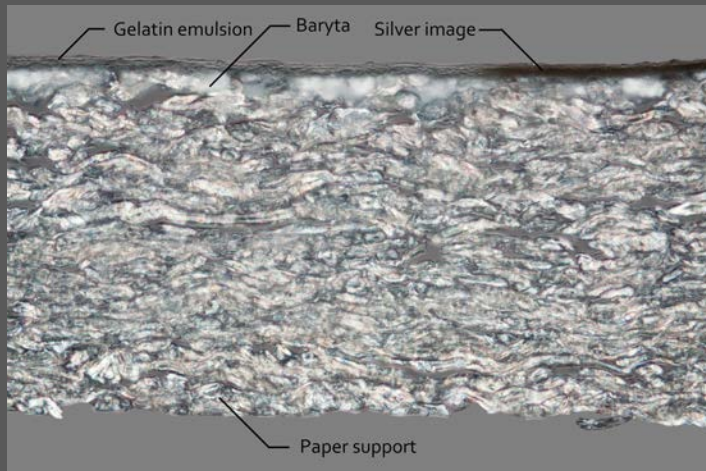


Textured  
50x magnification



# DOP: Surface Characteristics

## Applied texture



Semi-matte sheen



# DOP: Surface Characteristics

Surface sheen characteristics: Matte to Glossy



# Silver Gelatin DOP

## Modifications: Dyes

- Added to make paper brighter (OBAs)
- Added to binder, baryta, paper support to alter the color of the highlights



Imaged with daylight balanced lighting



Imaged with UV light

# Color Photography

Color photography is an illusion

- The image is composed of additive or subtractive color elements, which the eye blends together to produce full color.



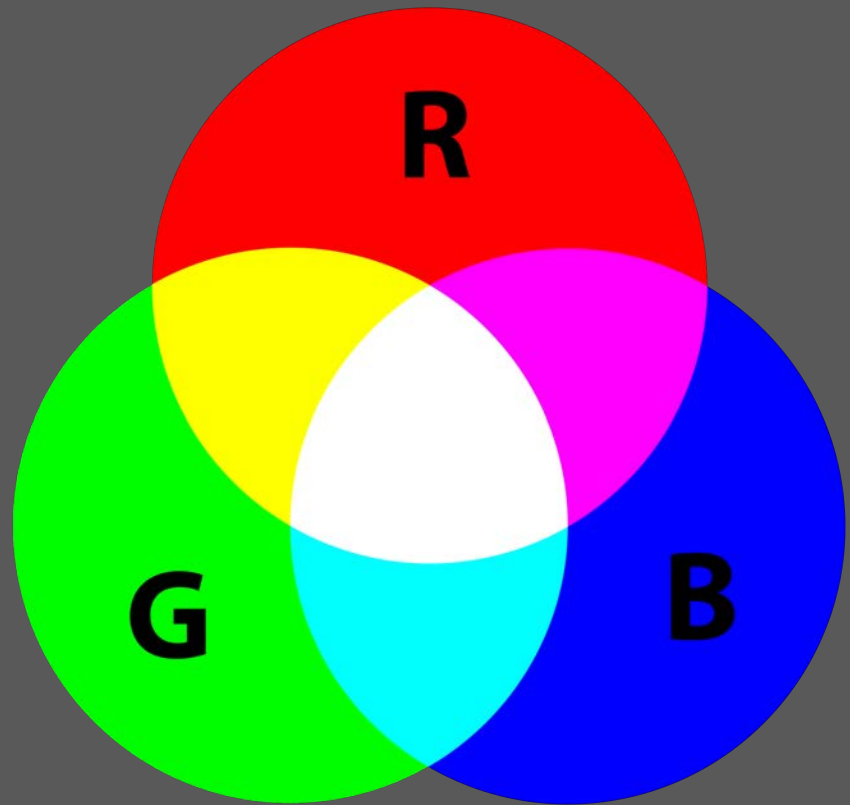
George Seurat, *A Sunday on La Grande Jatte*, 1884



# Additive Color

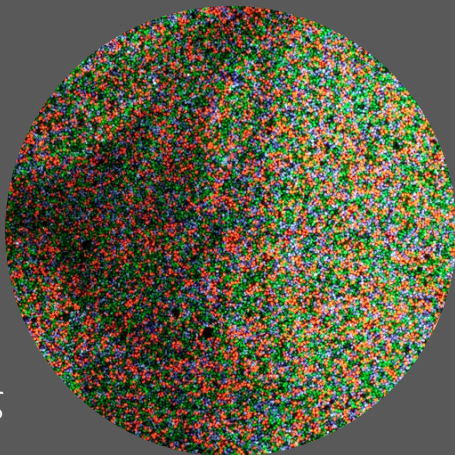
Mixing Red, Green, Blue light = White

Viewed with  
transmitted light



# Screen Plate: Autochrome

- Type: transparency
- Image: silver and dyed potato starch grains
- Binder: gelatin
- Support: glass or plastic
- Support coatings: varnishes



50x mag



# Screen Plate: Autochrome

- Transparency
- Patterned image structure
  - Random additive color dots (dyed potato starch)
- Glass or plastic support

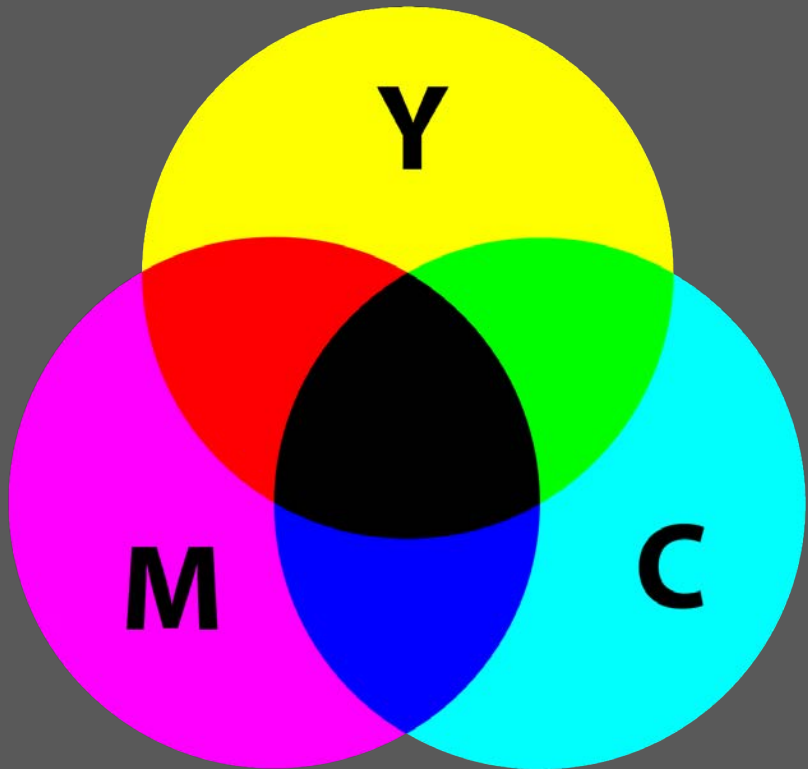


# Subtractive Color

Combining Cyan, Magenta, Yellow = Black

All other color processes

- Subtractive color
  - Cyan, magenta, yellow
  - Superimposed to produce full color





# Color Assembly

Processes:

- Carbro
- Dye Imbibition



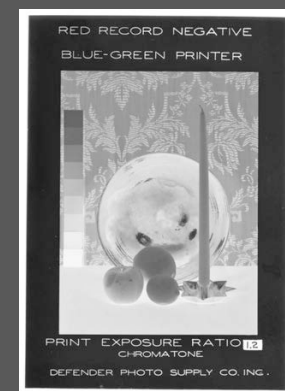
Carbro



Dye Imbibition

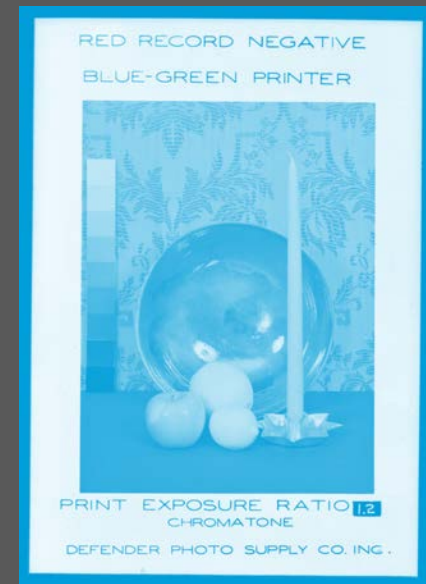
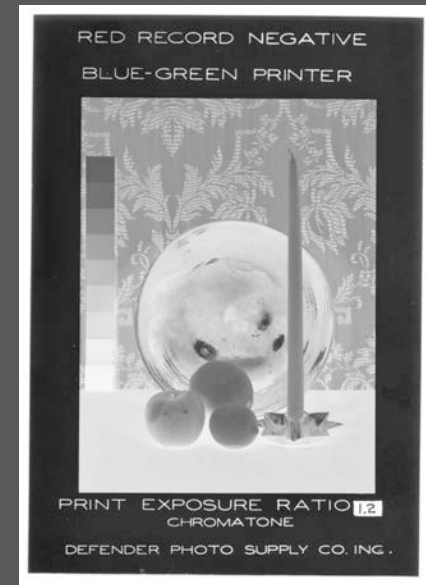
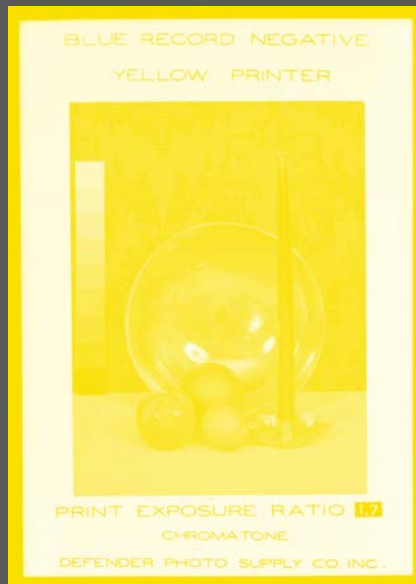
# Color Assembly

- Separation negatives
  - 3 silver gelatin DOP negatives
  - Each exposed through a red, green, or blue filter
  - Record of the red, green, blue light
- Subtractive Color
  - Separations used to print cyan, magenta, yellow images
- Assembly
  - 3 color images superimposed to produce full color image



# Color Assebly





RED RECORD NEGATIVE  
GREEN RECORD NEGATIVE  
BLUE-GREEN PRINTER  
MAGENTA PRINTER

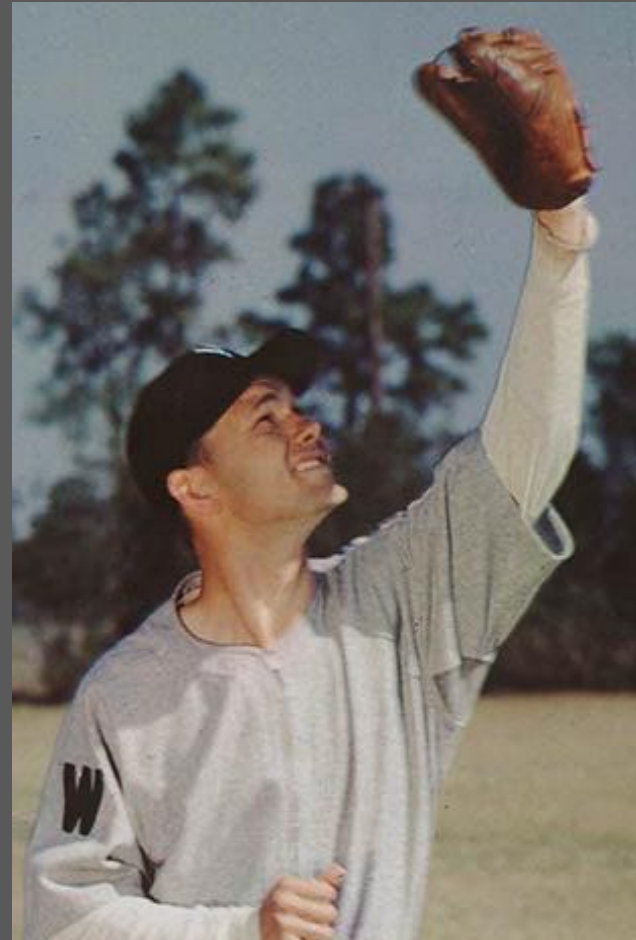


PRINT EXPOSURE RATIO 1:2.0  
CHROMATONE  
CHROMATONE  
DEFENDER PHOTO SUPPLY CO. INC.  
DEFENDER PHOTO SUPPLY CO. INC.



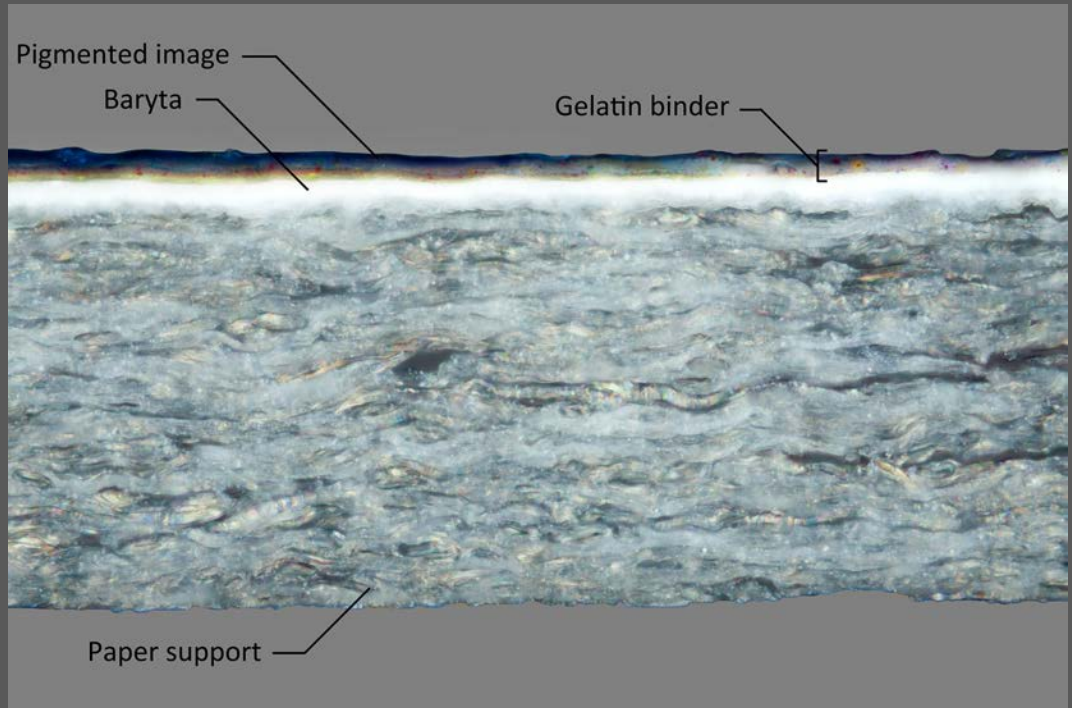
# Carbro

- Separation negatives used to print 3 silver gelatin prints
- Dichromated gelatin sheets squeegeed in contact with prints
- Gelatin hardens where it is in contact with silver metal
- Unhardened areas remain soluble and are washed away



# Carbro

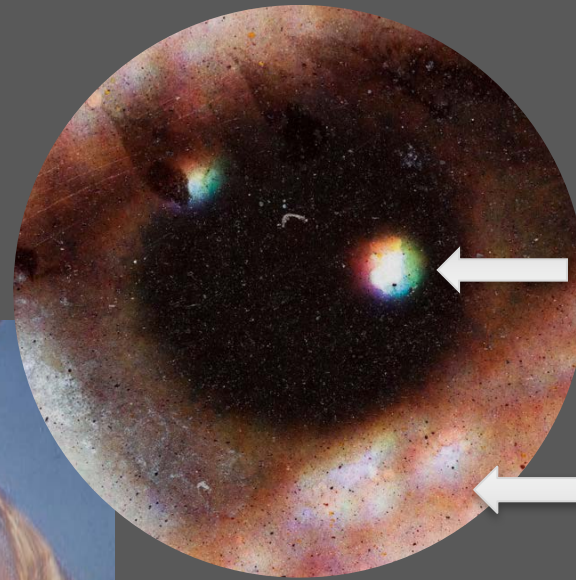
- Type: print
- Image: pigment
- Binder: gelatin
- Support: paper
- Coatings: baryta
- Additives: matting agents





# Carbro

- Differential gloss
- Pigment particles (continuous in tone)
- Misregistration



Misregistration

Pigment particles

50x Magnification



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IMAGE  
PERMANENCE  
INSTITUTE

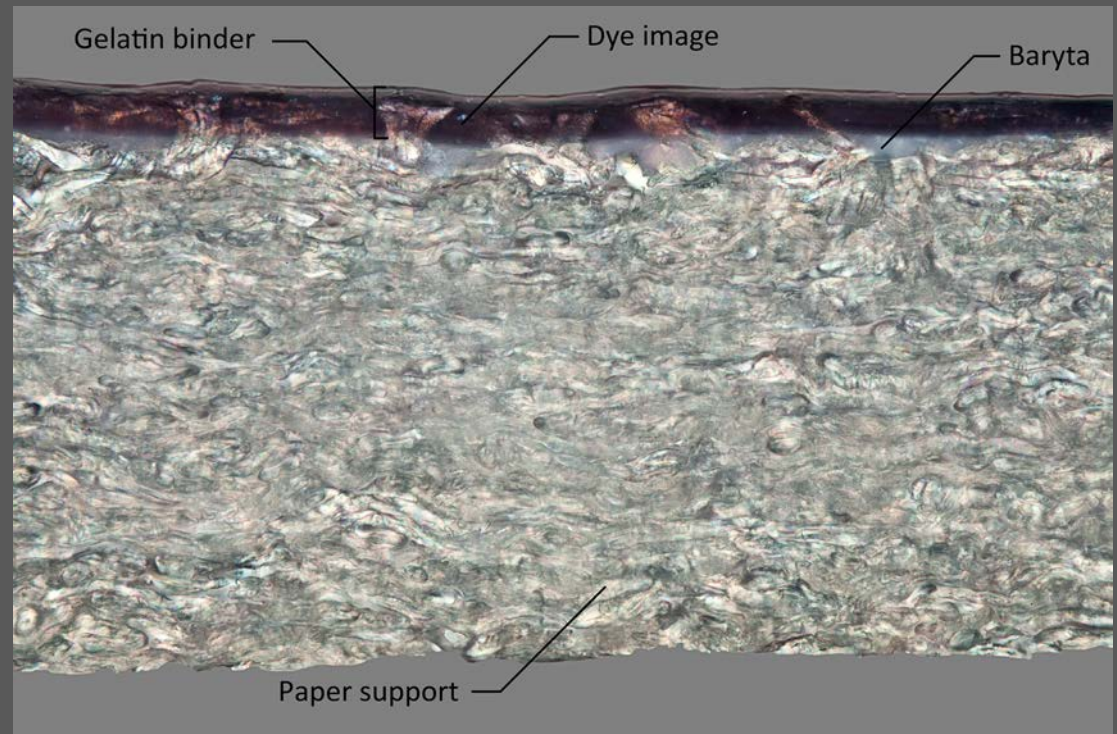
# Dye Imbibition

- Separation negatives printed onto printing matrices
  - Matrices: dichromated gelatin on plastic support
  - The gelatin hardens where it is exposed to light
  - Unhardened areas remain soluble and are washed away
- Matrices dyed, cyan, magenta, or yellow
- Dye is transferred to receiving paper



# Dye Imbibition

- Type: print
- Image: dye
- Binder: gelatin
- Support: paper
- Coating: baryta





# Dye Imbibition

- Misregistration
- Continuous in tone
- Diffuse image



Diffuse image,  
Misregistration

# Integral Tripack

- Processes:
  - Chromogenic
  - Silver Dye Bleach
  - Instant Color (Dye diffusion transfer)
- Chemistry
  - Red, green, and blue light sensitive silver gelatin layers (separations) are superimposed on a single support.
  - Cyan, magenta, yellow dye is also in corresponding RGB layer

# Chromogenic Image Formation

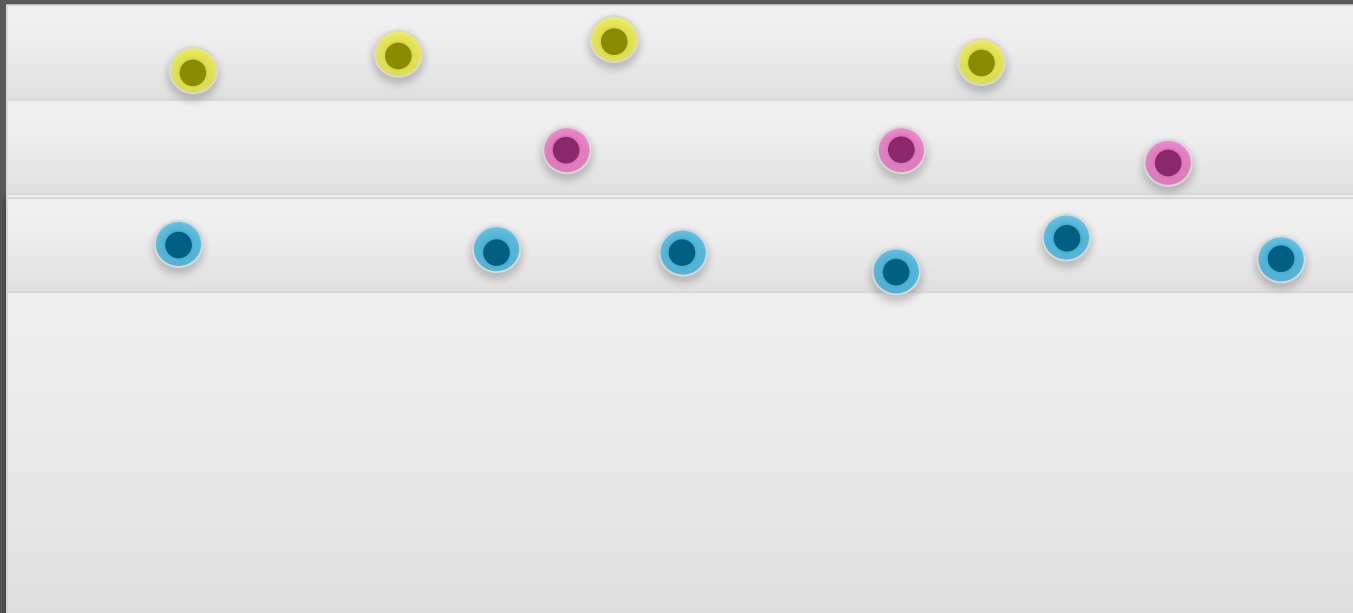
- exposed silver salts reduced to silver metal





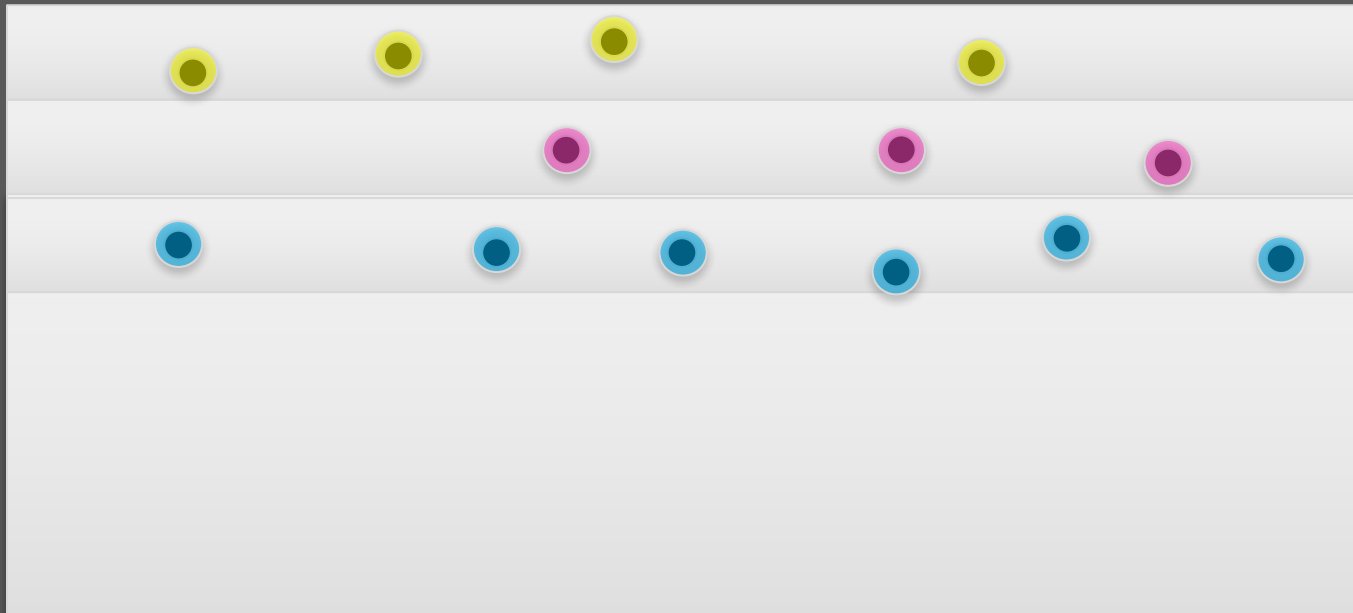
# Chromogenic Image Formation

- the dye couplers react with the oxidized developer
- dye couplers form dye clouds where silver is present



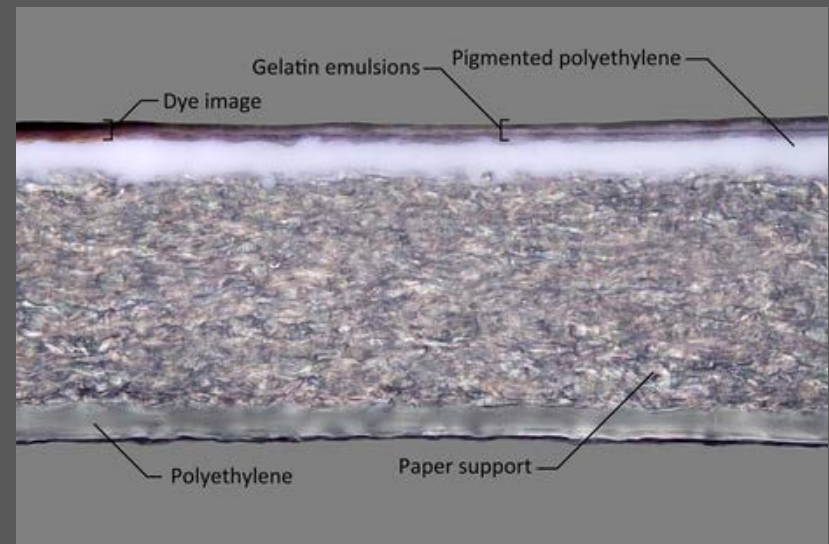
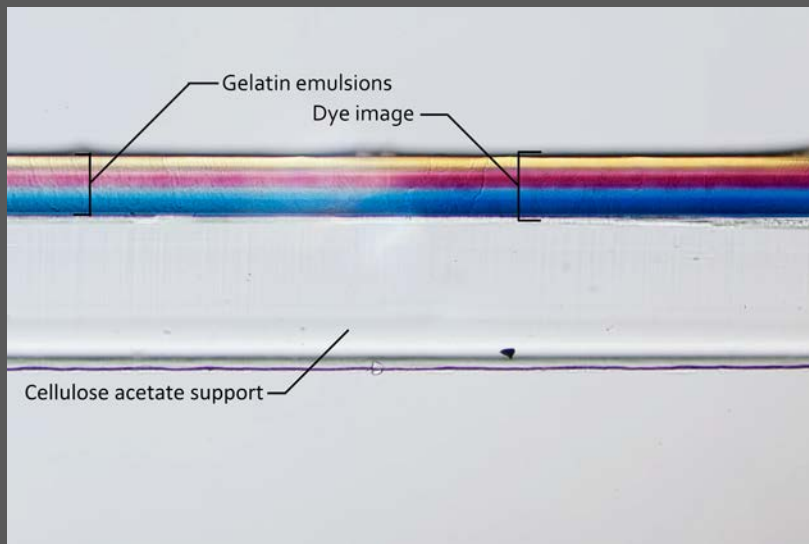
# Chromogenic Image Formation

- Silver chemically removed



# Materials: Chromogenic

- Type: print, negative, positive transparency
- Image: dye
- Support: paper, plastic
- Binder: gelatin
- Coatings (prints): baryta, resin coated



# Chromogenic

- Continuous in tone (10x)
- Image Grain (50x)
  - Dye clouds
- Backprint or Back stamp



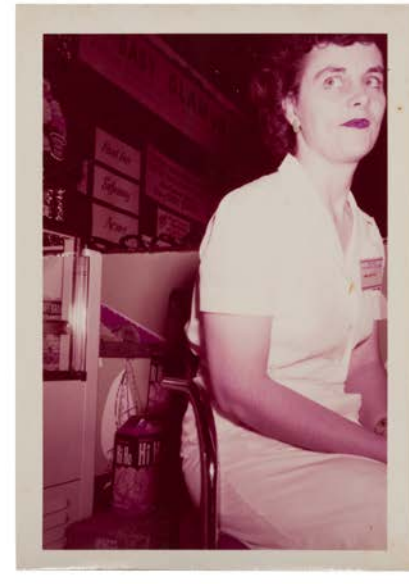
50x mag



10x mag

# Chromogenic

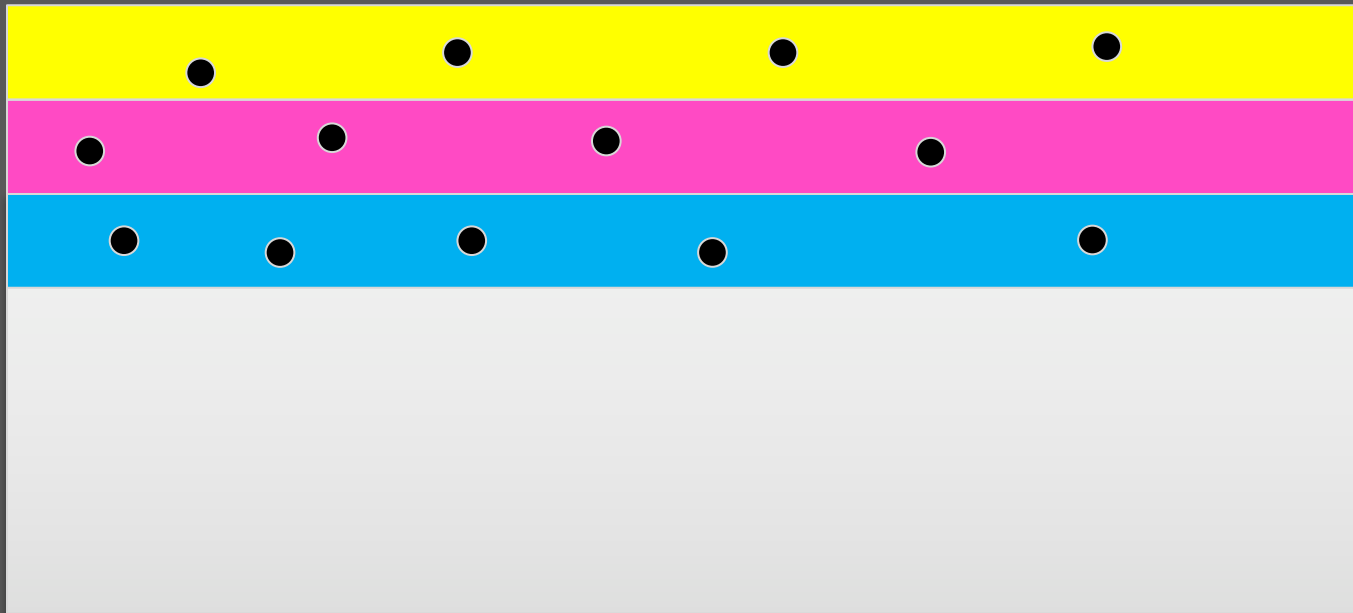
- Highlight yellowing
  - Color Shift
  - Fading





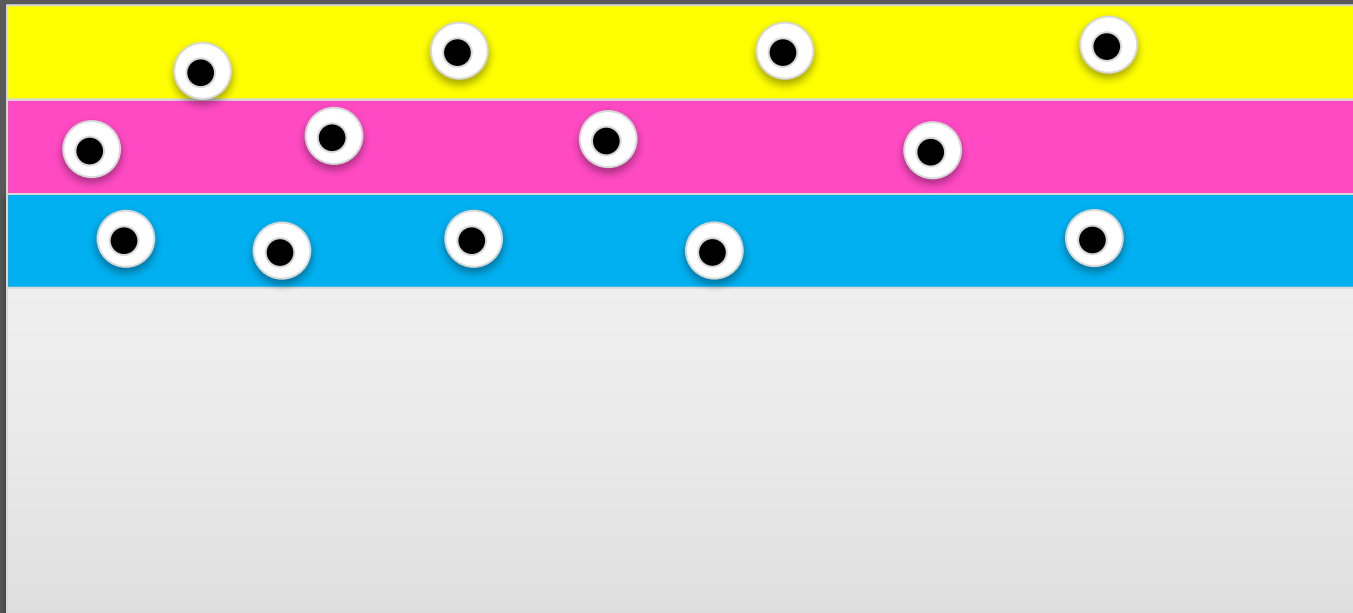
# Silver Dye Bleach Image Formation

- exposed silver halide reduced to silver metal



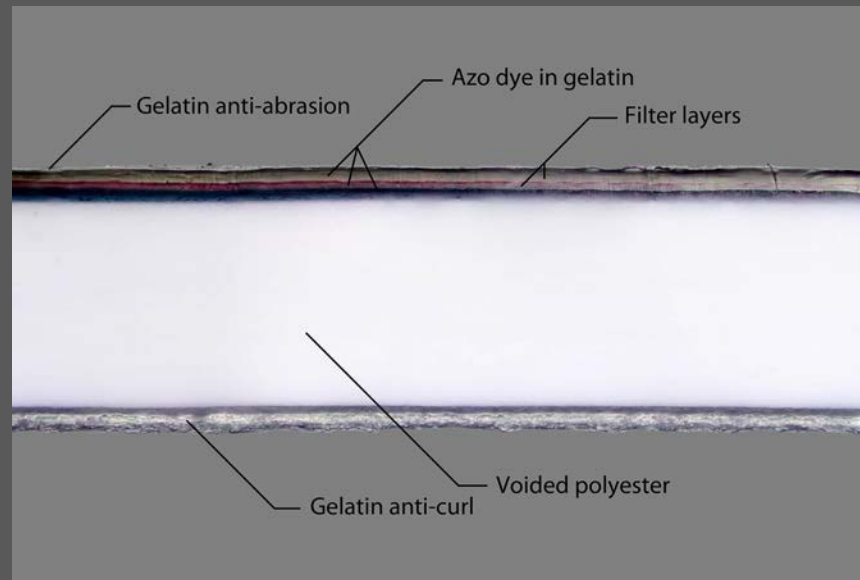
# Silver Dye Bleach Image Formation

- dye around silver is bleached
- Silver chemically removed



# Materials: Silver Dye Bleach

- Type: print, positive transparency
- Image: dye
- Binder: gelatin
- Support: plastic, RC paper

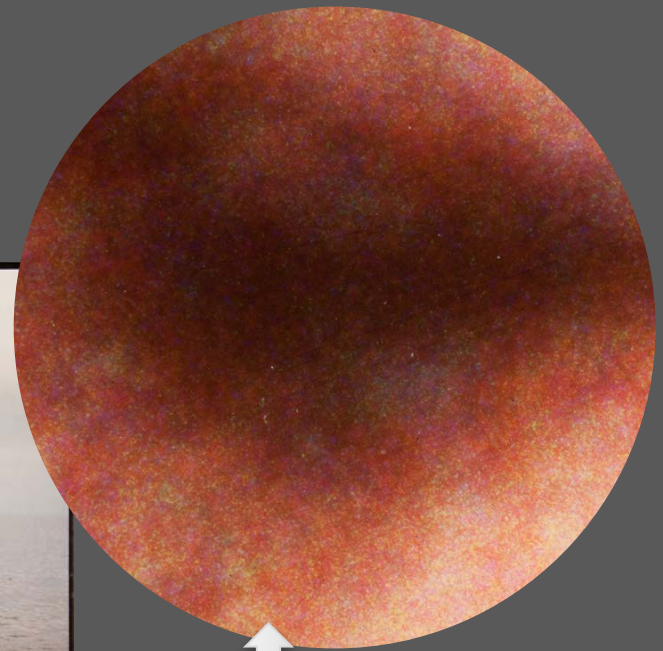


# Silver Dye Bleach

- Continuous in tone (10x)
- Image grain (50x)
  - Bleach halos
- Black borders
- Plastic or RC support



50x magnification



Bleach halos

# Instant (Diffusion Transfer)

- Type: print
- Image: silver, dye
- Binder: synthetic polymer
- Support: paper, plastic





# Diffusion Transfer & Dye Diffusion Transfer

- Continuous in tone
- Backprint
- Remnants of adhesive along borders



50x mag

# Instant (Internal Dye Diffusion Transfer)



- Continuous in tone
- White plastic frame with reagent pod
- Backprint

# Survey & Thank You

Thank you!

- National Endowment for the Humanities Division of Preservation and Access
- The Andrew W. Mellon Foundation

Next Webinar

- Wednesday, November 8, 2:00pm EDT
- 21<sup>st</sup> Century Materials and Technologies

Survey!

- A brief survey will appear at the end, please give us feedback!