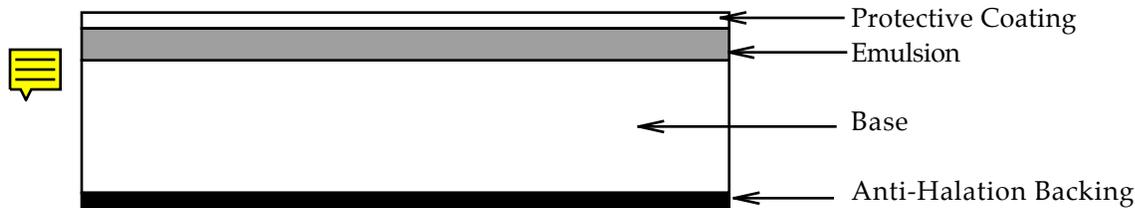


PHOTOGRAPHIC FILMS

A camera has been called a “magic box.” Why? Because the box captures an image that can be made permanent. Photographic films capture the image formed by light reflecting from the surface being photographed. This instruction sheet describes the nature of photographic films, especially those used in the graphic communications industries.

THE STRUCTURE OF FILM



Photographic films are composed of several layers. These layers include the *base*, the *emulsion*, the *anti-halation backing* and the *protective coating*.

THE BASE

The base, the thickest of the layers, supports the other layers. Originally, the base was made of glass. However, today the base can be made from any number of materials ranging from paper to aluminum. Photographers primarily use films with either a plastic (polyester) or paper base. Plastic-based films are commonly called “*films*” while paper-based films are called “*photographic papers*.” Polyester is a particularly suitable base for film because it is *dimensionally stable*. Dimensionally stable materials do not appreciably change size when the temperature or moisture-level of the film change. Films are subjected to heated liquids during processing (developing) and to heat during use in graphic processes. Therefore, dimensional stability is very important for graphic communications photographers because their final images must always match the given size. Conversely, paper is not dimensionally stable and is only appropriate as a film base when the “photographic print” is the final product (as contrasted to an intermediate step in a multi-step process).

THE EMULSION

The emulsion is the true “heart” of film. It is the part of the film that records the image by physically reacting to light that reflects from the scene being photographed, passes through the camera’s lens and strikes the film. Emulsions are composed of light-sensitive materials *suspended* (hence the name emulsion) in a gelatin substance.

COLOR AND BLACK & WHITE EMULSIONS

Emulsions can be categorized in a number of ways. Perhaps the simplest way to categorize film is whether it is color or black and white. Color films are primarily used by professional photographers, and may be either *positive-* or *negative-acting*. Positive-acting films, generally referred to as *slides* or *transparencies*, use dyes to record the same colors as the scene being photographed. Negative-acting films use dyes to record the opposite color on the film as the scene. For example, a blue sky in the scene would be recorded as a yellow area on the film (yellow is the opposite or *negative* of blue). Negative-acting color films are used to make *color prints*. Graphic communications businesses generally prefer to receive color transparencies, rather than photographic prints or negative-acting color films, from their clients because color scanning equipment produces better results from transparencies.

Even though graphic communications businesses often reproduce color images, color film is seldom, if ever, used in their plants. Graphic reproduction processes require a single printing plate for each color to be printed. Those plates have only two areas – image and non-image – and are created by using black and white (or, more accurately, clear) film. Even multi-color originals must be separated into four (or more) printing colors (YMCK), which are recorded as black or clear on film. These individual films are exposed to separate plates and each plate is printed using the appropriate color of ink. When all the colors of ink are printed, the result is a facsimile of the color original.

Black and white emulsions consist of silver halide crystals suspended in gelatin. Silver is a very useful material for photographic emulsions because it turns black when exposed to light. When light reflects from a white (or light-colored) area of the original, passes through the camera's lens, and strikes the silver crystals, the crystals turn from grey to black (the same process that causes silverware to *tarnish*). Conversely, black (or very dark areas) of the original reflect little or no light. So the silver crystals do not turn black in areas representing dark areas of the original. Gray areas on the original reflect some light which causes (in some films) the silver crystals to turn partially black. The silver crystals in black and white film do not turn completely black when exposed in the camera. Rather, a tiny speck in each exposed crystal turns black. These specks create what is called a *latent image*. A latent image, like a latent talent, is there but cannot be seen. When film that possesses latent images is *processed* in a chemical called *developer*, the tiny specks in each exposed crystal grow to fill the entire crystal. Now the exposed areas are completely black. Also during processing, unexposed silver crystals are dissolved by a *fixing bath* and washed away. The result is a negative image – black where the original was white and clear where the original was black.

CONTRAST OF EMULSIONS

Films used by professional photographers and graphic communications businesses also differ in their levels of contrast. Contrast refers to the relative range of tones in a photographic image. Professional photographers use *low-contrast* or *continuous tone* emulsions. Continuous-tone emulsions are capable of recording a full-range of tones from clear through black. When printed on photographic paper, these emulsions provide a rich range of shades or colors that approximate the original scene. However, continuous-tone emulsions are not appropriate for graphic reproduction because printing plates can only contain image areas or non-image areas – not a range of tones. Therefore *high-contrast* film must be used. These films, often called *lith*, *camera-film*, *rapid-access*, *hybrid*, or by various trade names, have areas that are either black or clear (corresponding to the non-image or image areas of the plate, respectively). Gray areas are either recorded as clear or black depending on the time the film is exposed to light. For example, a gray area could leave the film clear if an exposure time of two seconds is given and turn the film black if the film is exposed longer. If gray areas are desired, as would be the case when reproducing a photograph, the illusion of varying tones is created by using a halftone screen to create dots of varying sizes – larger dots *en masse* look darker to the eye than smaller ones. However, in reality, the film is still high-contrast and consists of only black or clear areas.

COLOR SENSITIVITIES OF EMULSIONS

Color continuous-tone films used by professional photographers have emulsions that react differently to colors of light. These varying color sensitivities are necessary to compensate for different light sources. For example, florescent lighting is predominantly blue-green, so film used in that type of lighting must be balanced to accentuate red. Conversely, incandescent lighting is mostly yellow, so films balanced for incandescent lighting emphasize blue.

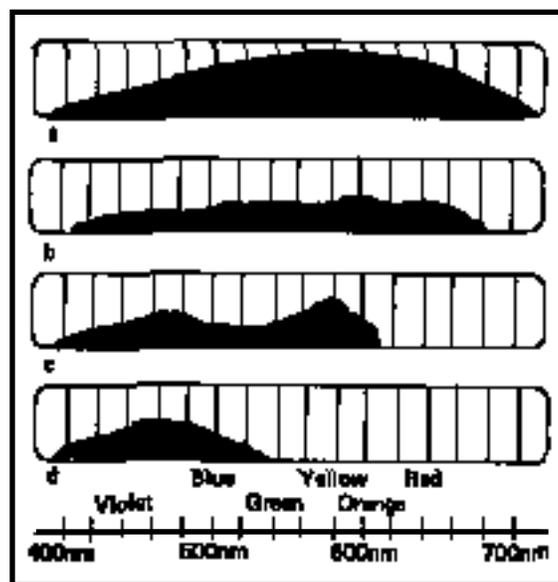
In graphic communications, the silver crystals used in black and white film are designed to be either sensitive (turns it black) or not sensitive (doesn't turn it black) to various colors. There are four categories: "daylight-handling," "monochromatic," "orthochromatic," and "panchromatic."

The silver in *daylight-handling films* can only be exposed by ultraviolet radiation, so special lamps that emit mostly UV light are necessary. White light that contains only its red, green and blue components – without any UV – does not expose this film, so the film can be handled without being exposed in virtually any room in which special filters are placed around the room lamps to filter-out UV radiation. These films require a fairly long exposure and, as a result, are not normally used in process cameras. Rather, they are used in the *stripping* or *film assembly* departments to make composites or positive or negative copies of other

films. These emulsions can also be laminated to a paper base to be used to make photographic prints, often called by the archaic term *Velox*.

Monochromatic emulsions, also called *blue-sensitive* or *color-blind*, are sensitive only to blue light. Any light source that contains blue can expose them. The silver in these emulsions is not exposed by yellow light, so yellow-lit rooms are *safe* to handle them. Monochromatic emulsions are often used in various proof and plate materials. Rooms where those materials are exposed have yellow *safe-lights*.

Orthochromatic emulsions are sensitive to blue and green light. They are not sensitive to red light, so darkrooms in which orthochromatic film is used have red safelights. Orthochromatic film is particularly useful for process-camera work in graphic communications. Because blue and green light turn these emulsions black, marks made on the original using light blue ink or pencil turn the film black and disappear. This is useful for making non-printing guidelines or comments on originals. However, the emulsion also turns black wherever there are desirable blue or green areas on the original. Thus, original images to be reproduced must be either black or red. In addition to process-camera use, orthochromatic emulsions are often used on electronic color scanners.



(a) Human Eye; (b) Panchromatic;
(c) Orthochromatic; (d) Monochromatic

Panchromatic emulsions are sensitive all all colors of light. No light can be used as a safelight, so technicians using this type of film must work in complete darkness. These films were once necessary in graphic communications to make the *Cyan Printer* negative of a process-color set using a process-camera because that negative required the use of a red filter. However, the modern use of electronic color scanners has made panchromatic film almost unnecessary. There are some cases in which an existing original contains blue-green images that cannot be repro-

duced using orthochromatic film. These images can be reproduced using panchromatic film coupled with special filters.

THE ANTI-HALATION BACKING

The bottom layer of a sheet of film is a very dark-colored material that prevents *halation*. This anti-halation backing prevents light from passing through the film and subsequently reflecting back up from any reflective surface under the film. Because light reflects at an angle, the reflected light would not return at the same angle as it struck the reflective surface. The light, travelling at an unwanted angle, would expose *halos* (hence the name *halation*) around existing images. The dark-colored material absorbs any light that penetrated the film, thus preventing the light from reflecting and causing halation. The anti-halation backing is washed away during film processing.

THE PROTECTIVE COATING

The top layer of the film protects the fragile emulsion from human hands. There is always an oily substance on skin that, if transferred to the emulsion, would effectively ruin the film. The protective coating also protects the emulsion from minor scratches and abrasions. The protective coating washes away during film processing.

COMMON FILMS USED IN GRAPHIC COMMUNICATIONS

To accomplish the many tasks required of film in graphic communications businesses, a number of different kinds of film are available. Films vary with regard to speed, light sensitivity, grain, base, contrast, developer required and whether they are positive- or negative-acting.

Line film is generally used in a process camera to photograph black and white (or red and white) line illustrations and type. Usually it is fairly fast, and is an orthochromatic, fine-grained, high-contrast, negative-acting, polyester-based film. It produces a dense black non-image area and a very clear image area. Line films may require either one of two types of developers: *lith* or *rapid-access*. *Lith* developers are more traditional and require a great deal of monitoring and mixing of chemicals. *Lith* developers wear out quickly and, as a result, it is difficult to maintain consistent development. *Rapid Access* developers require no chemical mixing nor frequent monitoring. They are more stable and produce more consistent results. Most graphic communications firms now use some type of rapid-access film and developer.

There are still some limited uses for *Panchromatic Line Film*. These films, handled in total darkness, are needed when an original to be reproduced contains images that are cyan (blue-green) in color. Because cyan exposes orthochromatic film (turns it black), cyan images disappear (are *dropped*) when orthochromatic film is

used. To *hold cyan* (prevent it from turning the film black), panchromatic film, coupled with a red filter, is necessary.

Halftone film is a variation of line film that possesses a finer grain that is better for the reproduction of small halftone dots. *Panchromatic halftone film* still has a limited use by a few firms that still make color separations on a process camera rather than on an electronic color scanner.

Contact film is a negative-acting polyester-based film used in the film assembly department to make positives from negatives or visa-versa. Today, most contact films are daylight handling and use rapid-access development. In comparison to line films, contact films are slower and do not produce as high-contrast results (however, high-contrast is assured because the original negative from which contacts are made would be high contrast).

Photographic papers (often called by the archaic Kodak trade name *Velox*) are contact films on a paper base. They are used to proof negatives and to make materials to be scanned or for use on a *paste-up*.

Duplicating film (often called *dupe film*) is similar to contact film except it is positive-acting. Positive-acting films produce a negative from a negative or a positive from a positive. They are generally used to make multiple copies of negatives or to *compose* several films onto one *composite* film.

Diffusion-transfer materials (often called by Kodak's trade name *Photo-Mechanical Transfer* or *PMT*) are exposed on a process camera. A sheet of *negative paper* is exposed using the camera. The negative paper is placed into a special processor that bathes the paper in developer and brings it into contact with a *receiver sheet*. The receiver sheet may be paper, polyester film, or plastic printing-plate material. Both sheets exit the processor temporarily laminated together. After a given time, the two sheets are peeled apart. The image formed on the negative paper has transferred to the receiver material¹. Diffusion transfer materials may be either positive- or negative-acting. They are often used to make clean paper prints of originals that are valuable, delicate or poor in quality. These prints are then used on *paste-ups* or are scanned using desk-top technology.

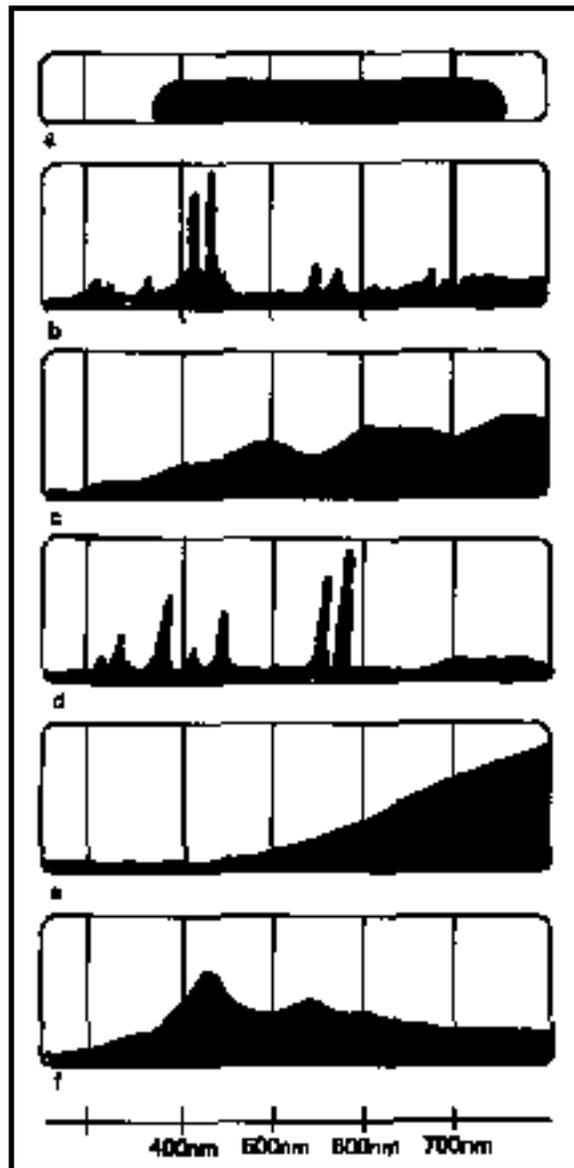
Scanner films are specifically designed to be exposed by an electronic color scanner. Such films are sensitive to the color of laser that the particular scanner uses. Similarly, *imagesetter films* are designed to be exposed by imagesetters. These films are generally processed with rapid-access developers.

LIGHT SOURCES USED IN GRAPHIC COMMUNICATIONS

Depending upon the photographic material being used, different light sources are used. Typically, the following light sources are used in graphic communications firms:

¹ This process is very similar to the old-fashioned Polaroid peel-apart films.

<i>Light Source</i>	<i>Dominant Color</i>	<i>Example Use</i>
Natural Sunlight (5400°K)	White + UV + IR	NA
Florescent (7500°K)	Cyan	Room lighting
Florescent (5000°K)	"White"	Color viewing
Florescent "Black-Light"	UV	Dylux® (bluelines)
Incandescent ($\pm 2500^{\circ}\text{K}$)	Yellow	NA
Mercury Vapor	Blue-green	Plates & most proofs
Metal Halides	Blue	Plates, proofs, contacts, dupes
Quartz-Iodine	Yellow	B/W proc. cam., contacts, dupes
Pulsed-Xenon	"White"	Color process camera
Carbon Arc	Blue	No longer used
Lasers	Vary	Scanners, imagesetters



(a) The Sun; (b) Metal Halide; (c) Pulsed Xenon;
(d) Mercury Vapor; (e) Tungsten; (f) Carbon Arc

TYPES OF PROCESS CAMERAS

