

Chapter 4 - Optics

Filtration

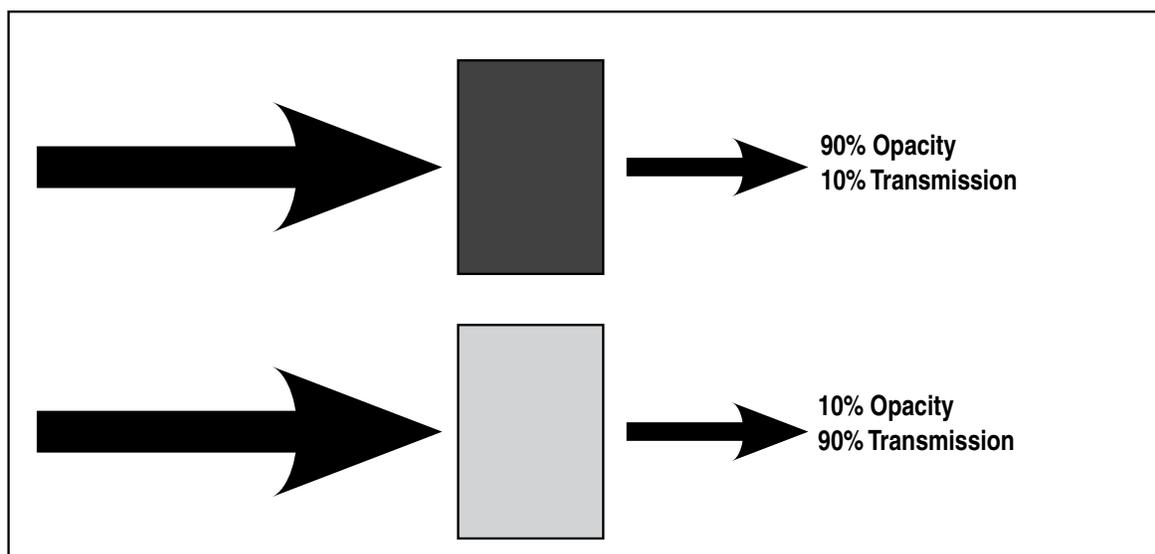
A filter modifies the original characteristics of light by reflecting, absorbing and/or transmitting portions of the light. Filters block certain wavelengths of light, while letting other wavelengths pass. These are used as operational tools in various aspects of photography — during the capture of the image as well as producing the final product.

During the chemical process of developing color films and paper, subtractive dyes, i.e. cyan, yellow and magenta, are formed. Effectively these act as filters allowing certain colors to be transmitted or reflected.

Filter properties include the type, construction, and application.

Filter Types

- Absorbance filters absorb unwanted wavelengths and transmit desirable wavelengths. Examples of this type of filter are color correction (CC) and color printing (CP) filters.
- Interference filters reflect undesirable wavelengths, while transmitting select wavelengths. Interference filters can be made thinner because they do not have absorption problems. Dichroic printing filters are a good example of an interference filter.
- Polarizing filters transmit only the light waves traveling with a specific orientation. Polarizing filters reduce glare and help produce better color saturation in photographs.
- Neutral density filters change the intensity of light without affecting the color. A filter of this nature has the same effect as an aperture, without the bulky mechanical apparatus. An ND filter that holds back half (50 percent transmittance) of the light has a density of .30, or thirty cc. A transparent substance such as air or glass approaches 100 percent transmittance.



Filter Construction

Selecting the correct filter construction assures proper performance. Filters in the image path should be thin or they may create image distortions. Filters in the light path should be large and able to tolerate heat.

- Gelatin filters are film with an emulsion coating that has a color dye. Thin film gelatin filters have excellent optical properties, but damage very easily. Many CC filters are of gelatin construction.
- Cellulose acetate filters are inexpensive but lack photographic optical clarity. Acetate filters are useful in front of light sources. Many CP filters are generally of plastic acetate construction.
- Glass dichroic filters are thin, strong and stable. Heat absorbing (UV and IR) filters made of glass are tolerant of heat. Glass lenses and filters have a high degree of optical clarity and strength.

Filter Applications

A prism bends the individual wavelengths in white light, allowing us to see the individual wavelengths as a color. Unlike prisms that display all of the wavelengths, filters refine colors that are transmitted to a specific wavelength or group of wavelengths.

- Camera filters usually have a number designation, such as 85b, 87c and so on. Camera filters fit in front of the camera lens and are useful for correcting color, as well as for creative purposes.
- CP and CC filters express the color in density points, such as 30 CC yellow, or 15 CC blue. Polycontrast filters are CP filters that have a number sequence from one to five. These filters allow for different ranges of print contrast from the same black-and-white paper.
- Scientific filters use a wavelength designation such as 551 nanometers (nm). Dichroic filters found in automatic printers are specified by wavelength, with tolerances to assure consistency from suppliers.
- Dichroic or cutoff filters can have color purity problems. As a practical matter, filters cannot be constructed to provide exact color filtration. There tends to be a slight amount of rolloff that allows other colors to seep through the filter. This contamination of unwanted color wavelengths is expressed in terms of color purity.

Reflectors

Lamps use some type of reflector to control the direction of light, intensity and color of light — all significant factors in photofinishing. Some examples are:

- Controlling the direction of light, creating even illumination for a copy stand
- Improving the intensity and efficiency by concentrating light to a specific point in automatic printers
- Filtering some wavelengths by acting as interference filters, such as allowing IR to pass through the back of the reflector

- Providing a mechanical point to position lamps and dissipate heat, such as the lamp and lamp socket found in an enlarger.

Reflectors and filters are not always obvious. Items such as clothing, curtains and walls affect the level and color of light. Black velvet fabric, for example, absorbs all light. Ultraviolet pigments in fabrics or paints can create a vivid purple cast in a photograph. The term “ambient reflection” is used to describe the condition that occurs when the color of light is altered by the elements in scene.

Lenses

The quality of a lens affects the quality of images. Photofinishing lenses found in enlargers, printers and scanners are equally as important as the original camera lens.

Lens Types

Commercial lenses are collections of individual lens elements. Many lenses have at least six elements. The design and expectations of a lens depend on its use. The focal length of a lens determines its degree of magnification.

Camera Lenses

Focal Length Determination

The focal length for a camera lens is determined by the acceptable distance between the lens and the receiving material (film or sensor). This is approximately equal to the diagonal measurement of the area receiving exposure. In the case of a 35 mm frame this equates to 43 mm. Focal lengths less than this are considered wide angle and provide close-up viewing while those greater are telephoto.

Camera lenses usually fit into categories, such as the following:

Normal Lens

A normal lens, or a lens with a normal focal length, provides the same viewing angle as the human eye. As explained above this depends upon the negative size. For example, a 50 mm lens for 135 film, an 80 mm lens for 120 film, and a 270 mm for 4x5 film would be considered “normal.”

Macro Lens

Capable of close-range focus and magnification of small objects.

Telephoto Lens

Telephoto lenses magnify the image, making the subject seem closer to the camera.

Wide-Angle Lens

A wide-angle lens has a field of view greater than a normal lens. This type of lens is associated with the “fish eye” look.

Zoom Lens

A zoom lens covers a range of magnifications. Some zoom lenses cover a range from wide-angle to telephoto. Other zoom lenses cover the ranges of many telephoto lenses.

Flat-Field Lenses

Flat-field lenses are ideal for automatic printers and enlargers. Flat-field lenses produce a sharp image over the entire paper plane.

Cluster Lenses

A cluster lens contains several small lenses side by side. The cluster lens puts several small images on print paper, saving printing time. Print packages produced for school pictures are an example of work done by cluster lenses.

Diopter Lenses

These lenses are low-power lenses put in front or behind other lenses to change the focal length.

Zoom Lens

A flat-field zoom lens covers a range of magnifications. Minilab printers make use of zoom lenses to make different size prints using the same lens.

Projection Lenses

Projection lenses are ideal for slide and movie projectors. Projection lenses transmit a lot of light and correct for screen distortions.

Ground Glass

Ground glass is a transparent sheet of glass or plastic with a fine-grain matte finish on one side. Ground glass is useful for focusing screens in cameras.

Fresnel Lens

A fresnel lens is a converging lens with some of the material removed. This makes the lens lighter and thinner than a converging lens. Fresnel lenses are useful for light collimators in spotlights, electronic flash and other illumination systems.

Lens Qualities

Photography relies on lenses to collect, condense and retransmit light toward a photographic material. The mechanics of the imaging process depend on lens factors such as contrast, resolution, color purity, focal length and depth of field.

Contrast

Lens contrast is a distinction, or separation, between colors and tones affecting the perception of image sharpness. A comparison of lens contrast is the Modulation Transfer Function (MTF). The MTF tests lens-contrast capability over a wide range of subject sizes. A lens should produce the same MTF in all areas of the image; otherwise, it has a “falloff problem.” This may be near the edges, which would be noticeable in the images.

Resolution

Lens resolution is a measure of the reproduction of fine details in the original subject by a lens. Bar charts can provide information about the resolving power of a lens. However, any measure of resolution should account for the system resolution. The system is dependent on the resolution of the sensitized material, in addition to the lens.

Lens Systems

The modulation transfer function provides scientific data about the detail and sharpness of an optical system. MTF curves from individual components can be combined to develop an MTF curve for the system. The lowest component of the system may limit the degree of detail and sharpness, limiting the MTF curve.

Distortion

Light bends while traveling through a lens. If this aberration is not corrected, individual colors can be misaligned. This imperfect registration is known as “chromatic aberration.” Chromatic aberration can occur on the lateral or longitudinal axis. Chromatic aberrations are usually eliminated from lenses when received from a manufacturer. Should the lens be dropped or damaged this defect might reappear.

Two seemingly identical lenses may not produce the same color or density results. Lenses can be color- and speed-equalized by adding a filter, or a dye coating, or by locking down the f-stop ring.