POLARIZER

They're tricky to use and often only work in certain circumstances. But when they do, WOW!

by Howard Millard with Andrew Davidhazy and Henry Horenstein

© Herbert Keppler (2)

Perfect polarizer example: Shooting from the west-gate balcony of Agra, India's Taj Mahal, Herbert Keppler used Kodak Ektachrome-X in a Nikon F with 28mm f/3.5 Nikkor lens for these two photographs made near noon–the first has a cloud covering the sun, the second is in brilliant sunlight. Note how polarizer removed reflection from water, darkened sky, added detail in building.

Why do some scenic shots have deep richness, sparkle, and snap with brilliant white clouds floating against dramatically deep blue skies? Why do yours often look flat and anemic by comparison? The answers to both questions may be as close as the nearest polarizer.

Under many conditions, the polarizing filter will indeed increase color saturation, giving you richer and more intense hues—greener foliage, redder roses, and, as mentioned, bluer skies. Some photographers use polarizing filters on their lenses as a matter of course to maximize color saturation.

And it can do more. For instance, most subjects reflect a certain amount of natural glare and reflections. A polarizing filter can eliminate these diffusing elements, resulting in richer-looking colors.

And that is not all a polarizer can accomplish. It can make your shots look as dramatic as you would like them to be (and often more dramatic than they are). It can eliminate reflections—well, sometimes, under certain circumstances and from certain angles.

If polarizers behaved like most other filters and always worked in the same manner, our story would be a short one. But they don't. They work under some circumstances, don't under others, provide partial results sometimes, vary in exposure requirements, and foul up some built-in camera exposure meters, autofocus and viewfinder information systems, but they operate nicely with many others.

Let's start with arguably the most common use of a polarizing filter: heightening the dramatic effect of scenics. Suppose you want to darken a blue sky. If you're shooting with black-and-white film, you might reach for a yellow, orange, green, or even a red filter to accomplish this, since these filters allow light of the

the one filter you can't do without

same color to pass through, but block light of a complementary color. Therefore, almost any color filter will work to darken a blue sky, except, of course, a blue filter. But these filters may affect other colors in the scene. For example, a red filter darkens a blue sky, but lightens a red barn in the same landscape. More important for most of us: Colored filters cannot be used with color films without tinting the entire picture area.

Under the right conditions, a polarizing filter will darken a blue sky without appreciably affecting any other part of the photograph, whether used with black-and-white or color film. It can do this because some of the light reflected from the sky is naturally polarized by particles in the atmosphere. By rotating a polarizing filter, you can block the polarized light, causing the sky to darken (see drawing, above). The effect can be varied by rotating the filter, allowing you to control just how dark you want the sky.

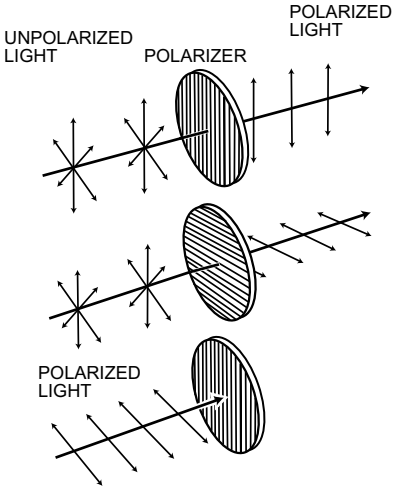
How much a polarizing filter will darken the sky depends on the state of the sky and your shooting angle in relation to it. A clear blue sky has a lot of polarized light and will darken appreciably at right angles to the direction from which the sun is shining. A gray, overcast sky polarizes virtually no light, so it will hardly be affected by a polarizer.

Here's a simple way to determine which areas of the sky will be darkened most—point your thumb upward at the sun. Then extend your index finger at 90 degrees to your thumb, like a child's imitation play pistol. By twisting your wrist while still pointing your thumb at the sun, your finger will travel along a band across the sky. This band is the area of maximum darkening for any given elevation of the sun (see diagrams on next page). As you can see, about noontime (with the sun overhead), maximum polarization (and consequently, picture darkening) takes place near the horizon in all areas. Near sunset, the polarized band is at its strongest directly overhead. In short, always use your thumb and forefinger. They will never let you down—but don't forget to twist your wrist (see drawings, next page).

We've now darkened the blue sky, thus accenting the clouds. What about enriching color saturation and eliminating or minimizing reflection—such as in a window or still water? Actually, both effects are closely allied. Polarizers have rotating mount rings, so you can turn the polarizer to either cut down or completely eliminate the polarized light reflected from the window or the water to see what's below or behind the surface. Color saturation (and richness) of reflective objects—from berries to bathing beauties—is also increased, since the polarizer removes the shiny highlights that dilute or mask the true color of the subject (see photos, page 79). With an SLR or a view camera, you can see the striking results in your subject's appearance as you turn the polarizer.

Unfortunately, your best efforts to reduce or minimize reflections and/or flare won't always bear fruit. Polished bare metal won't be affected by a polarizer and neither will a body of rough-surfaced water. Even when the surfaces are good for polarization, the camera and polarizer must be at

Polarizers: How they do what they do



Vertical order out of chaos: Lined up minute crystals in polarizer only allow unpolarized light rays vibrating in one plane through the filter. (Most light, unless reflected from a shiny surface or in the sky on a sunny day, is unpolarized).

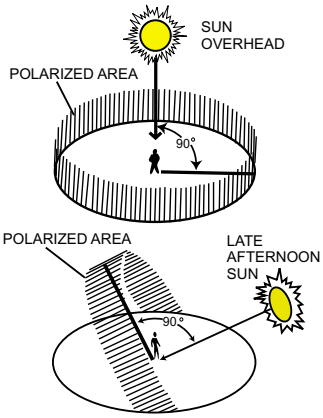
Turning the polarizer: The lined-up direction of the filter crystals always determines the plane of light ray vibration allowed through. Here we've turned the filter 90 degrees so only the horizontal vibrations of light rays enter.

Getting the polarization effect: If light is already polarized by being reflected from the right kind of shiny surface or coming from the correct type of sunlit sky, it is vibrating only in one plane to begin with (here horizontal). Therefore, you can cut it down or eliminate the light completely by turning your polarizer so its crystals don't line up in the same direction as the light ray vibrations coming in. The polarized sky becomes underexposed and so appears dark; reflections are eliminated.

Editor's Note: In 1985, Modern Photography *magazine published a 15-page landmark magnum opus on polarizers and how to use them. This cornucopia of essential polarizing information was among many treasures acquired by* Popular Photography *when it purchased* Modern Photography *in 1989. Unfortunately, the article's photographs were poor, and it was too long. Since the polarizer is far and away the most essential filter for amateurs and pros—albeit a tricky and idiosyncratic one—we decided to polish, shorten, tighten and update our polarizer prize, gracing it with completely new photographs. Let us know how you like it.* —H.K.

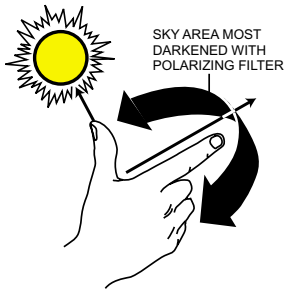
POLARIZER

To find band of maximum scenic sky effect, look 90 degrees from the sun



Noontime: Horizon's polarized. You need a bright, clear day for maximum polarization effect of the sky, but only part of the sky is polarized, namely a band 90 degrees from the sun. Polarization effect falls off gradually above and below band.

Low sun: Overhead's polarized. During the morning or afternoon, sun is closer to horizon. The polarization band tilts accordingly, giving you the possibility of using polarizer to maximize darkened sky overhead.



Use your finger: Point thumb at the sun. Your forefinger, when bent, will trace the band of maximum polarization effect.

an optimal angle to the surface, usually 30 to 40 degrees.

Smooth reflecting surfaces, like glass in a store window or the surface of a pond, react most dramatically with polarizing filters since they polarize light naturally. Most of the polarized light waves that reach the camera can be blocked by rotating your polarizer until you see just what you want. However, some surfaces polarize light more than others, so it's sometimes impossible to eliminate all reflections. Also, the angles of the camera, light and reflection are critical.

You can't eliminate reflections from light-diffusing surfaces—sand, powdery snow, rough rocks, or clouds—with a polarizing filter. These surfaces act to unpolarize light, scattering it in all directions; a polarizing filter barely affects them.

A mirror also does not polarize light; it merely reflects the light—polarized or not—that strikes it. Unless the light is already polarized when it reaches the mirror, your polarizing filter will do little or no good. An exception: A blue sky, for example, reflected in a mirror can be controlled with a polarizer; the reflected surface here merely acts to relay the light. Reflections from some metallic subjects (and even mirrors) can be controlled with the use of two polarizers—one over the light source and the other over the camera lens. We'll discuss this technique later.

Using a polarizing filter with a rangefinder or twin-lens reflex camera (or any other camera without through-the-picture-taking-lens viewing) is a little less precise since you can't view the scene through the polarizer and lens as the film will see it. Here's a way around the problem. First, set up the camera at approximately a 35-degree angle to an easily polarized subject, such as a window with a reflection. A tripod is useful. Then, hold the filter at the camera position and look through it. Rotate the filter until you see the glare or reflection diminish. Again, a change of angle might help. Once you have the filter in position for the result you want, put the filter on the camera lens, maintaining the same angle and degree of rotation. A dot or mark on the rim of the polarizer (indicating the axis of polarization of the filter) will help you maintain proper orientation. If this mark is pointed toward the sun when the camera is in shooting position, you will get the maximum amount of polarization for sky darkening (but not necessarily for eliminating reflections and glare). Even with SLR cameras, this is a fast way to shoot.

Occasionally, you will find a situation where two different surfaces are reflecting light in different planes in the same photograph, perhaps two store windows at an angle to each other. When this happens, you generally have to settle for minimizing the reflection in one surface—the one positioned at the correct polarizing angle to the filter. Depending on the various angles and surfaces involved, you may be able to partially reduce the reflection in both surfaces. Try different camera angles and degrees of polarizer rotation, carefully viewing the

Richer colors with polarizer


Slide film, no polarizer

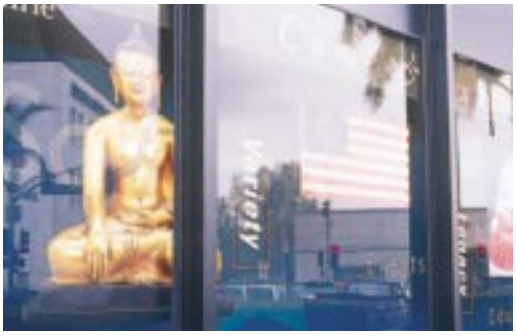

Slide film with polarizer

Polarizer always enriches color: Polarizer darkens sky, and increases color saturation with both slide and printfilm. However printfilm saturation also depends on photofinisher who made the print.


Print film, no polarizer


Print film with polarizer

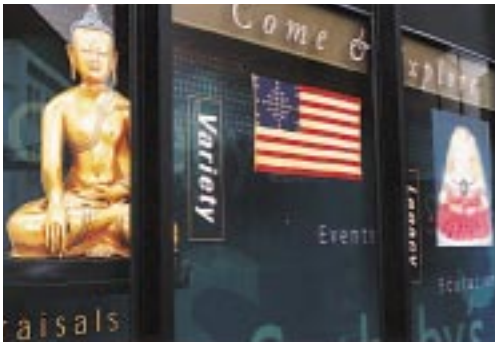
You can eliminate reflections



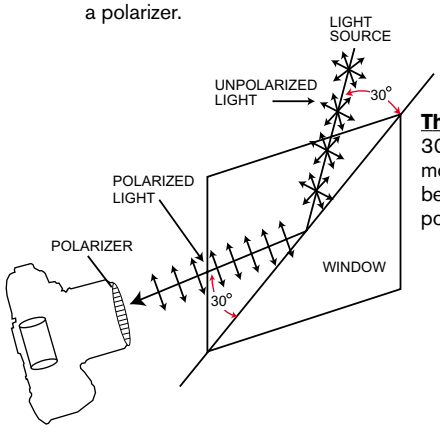
Wiping out reflections: Interior of store window is obscured by external reflections.

By using polarizer, external reflection is virtually wiped out. Why? Camera and light were at almost ideally efficient 30 degrees to store window (see drawing)

Will polarizer work with print film as well as slide film? Here are the same reflections shot on print film without a polarizer.



The polarizer eliminates reflections equally well if you're using print film.



The magic angle is 30 degrees: When light hits a reflecting surface at a 30-degree angle and camera is at same angle, maximum reflections are removed. Glass, water, and glossy paper polarize light well, allow reflections to be removed or minimized. Skin, clouds, sand, and most metal surfaces don't polarize, so highlights and reflections can't be removed from them.

effects of each on the subjects' surfaces.

How can you get proper exposure when using a polarizing filter? Use your SLR's TTL metering system. If you use a handheld meter, take a reading as you normally would, calculate the required change as described below, and make the adjustment manually.

Although they vary slightly, most brands of polarizers have a filter factor of 2X to 4X. Check the instructions for the type you're using to be sure. When using filter factors, remember that 2X means that the filter is reducing the light that reaches the film to half the original amount. To compensate for a factor of 2X, add the equivalent of a one-stop of exposure (open the lens one f-stop or use the next slowest shutter speed). A 3X factor polarizing filter, requires 1⅔ more stops of exposure. A 4X factor requires two more stops of exposure or a 4X increase in exposure time. If you're not sure what your polarizer's filter facto is, try 1½ or 2 stops as a starting point, and test.

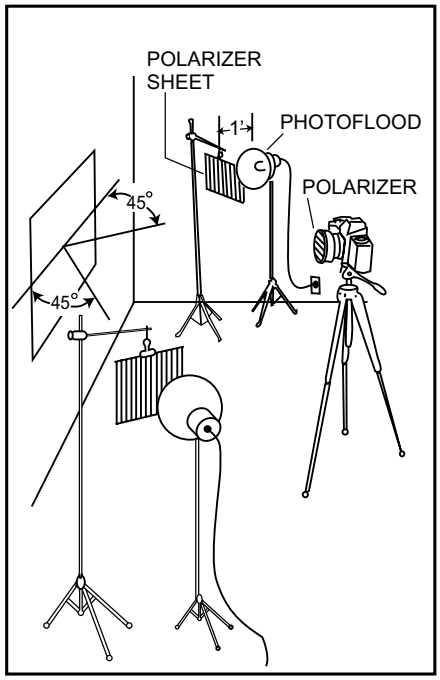
Is it really that simple? No. The filter factor given for a polarizer indicates the amount of light lost when the filter is used to photograph a subject consisting uniquely of unpolarized light (or one from which glare needs to be removed). It is the least possible amount of necessary exposure compensation. Depending on such factors as subject and light conditions—in other words, how much light is being polarized—you may need additional compensation.

For best copying, use cross-polarization

Usually, the extra exposure will be minimal, perhaps a fraction of an f-stop, but occasionally, if the subject contains a lot of polarized light, you'll need significantly more exposure.

Large areas in the subject that polarize light, like expanses of blue sky or still water, tend to affect the determination of proper exposure. Meters looking at the scene through a polarizing filter may indicate overexposure for the average areas of the scene.

While a through-the-lens meter reading with most cameras is usually accurate and a handheld meter may require some calculations, bracket polarized exposures if possible. Make an exposure according to your meter reading, then make an exposure of at least one-stop more (one-half stop for color slide film) and, for a full bracket, an additional exposure of at least one-stop less (again, one-half stop for color slide film). Bracketing increases the chances that one of the exposures will be what you need.



Why cross-polarize: When you try to copy art without a polarizer, you generally lose color, richness and contrast–while you may pick up various reflections from the room, surface of the painting, glass cover, or frame because of the lights. With cross-polarization (polarizer on camera plus polarizers over light sources) a vast improvement can be seen.

How to cross polarize: Place two lights at 45-degree angles from the art to be copied. Attach a polarizer over your lens. Place polarizing sheets (see text for source) in front of lights with polarizing axes vertical as shown in lines on polarizing material in drawing. Most sheets have axes marked. Turn polarizer on camera to create best possible effect through viewfinder or on ground glass.

If you want to copy artwork, such as drawings, paintings, or photographs, polarizers can help enormously by controlling reflections and glare while increasing color saturation. Set up your camera on a tripod or a vertical copy stand with a polarizer on the lens, and place the subject so it is parallel to the camera back. Often, the best lighting consists of two lights, (flood, quartz, or strobe—preferably with modeling lights to preview the effect) each positioned at the same angle on either side of the artwork.

To start, try a 45-degree angle, with light evenly covering the entire piece of art. Place your light carefully to eliminate or minimize any glare or reflection. If you can't eliminate glare by moving the lights, "cross-polarize" by putting a polarizing filter on your camera lens plus sheets of polarizing material, one each, over the two light sources. A single polarizing filter over the camera lens will have a slight effect, but since the camera will be aimed directly at the surface and not at an angle toward it, the effect will be minimal if the surface of your art is very smooth. If the surface is irregular, as in a painting, even a single polarizer on the camera can improve results significantly.

To get the most benefit from the polarization effect, use polarizers over lights and camera lens. Place polarizers on the lights so that their axes are pointing in the same direction. If there are no markings to indicate the axes, hold the two sheets (together) up to any light and rotate one sheet until the maximum amount of light shines through. At this point, the axes of the two polarizers will be facing in the same direction. Mark them with tape. Fasten them in front, of but at a safe distance, from the heat. (Use "barndoors" to avoid spillover of unpolarized light.) Aim the polarized lights at a 45-degree angle to the artwork on either side (see drawing on opposite page).

After you've put the polarizers in front of the lights, rotate the polarizer on the lens until the glare from the artwork diminishes or disappears. The polarization effect will be at its maximum when the axis of the filter on the lens is perpendicular to the axis of the filters on the light.

"Cross-polarization," as the setup is generally called, has some drawbacks. It is likely to add contrast, so you may need to overexpose and underdevelop the film to compensate. This is fine if you are shooting black-and-white film, but such adjustments may cause color shifts with color emulsions. Many professionals control the contrast of cross-polarized copies by "flashing." This technique consists of exposing the film (with whatever lighting equipment you're using—not just flash) to a white or gray card. Making a second exposure with this blank card lowers contrast and opens up shadows by effectively "fogging" the film.

After the basic exposure is complete, cover the painting being copied with a sheet of white paper or a card, and give an exposure that's two percent of the normal exposure. An easy way to determine this is by using neutral-density filters. There is no neutral density filter that gives two percent, but an ND filter of 0.7 passes 20 percent of the light, and an ND filter of 1.0 passes 10 percent of the light, so putting them together gives a density of 1.7, which transmits just two percent. The added "flash" exposure will cut down the contrast and put a little image in dead-black areas.

Furthermore, the specular highlights on the artwork, such as cracks on the surface of a painting, may pick up a blue or magenta cast if the polarizers aren't completely neutral. To avoid this, don't cross-polarize completely; stop rotating the filter just before it reaches the maximum extinction position.

Cross-polarization can reduce glare from artwork under glass also. First, cover the camera and stand with black fabric or paper that doesn't reflect light, such as construction paper with a hole cut out for the lens, so the light from the camera and stand (or other objects located behind the camera) does not reflect on the glass. Be careful to use a lens (or a filter on the lens) with a black rim facing the artwork to further reduce the chance of reflection. Use black tape to cover any lettering on the front of the lens.

Helpful hints and tips

Here are a few suggestions which can help you with your polarizer:

Using your polarizer as an ND filter: Your polarizer can act as a neutral-density filter. Since it doesn't affect color rendition appreciably (except to make it more saturated) but does cut down the amount of light reaching the lens, it may allow you, for example, to use fast film on a bright day—a situation that would ordinarily demand a faster shutter speed than you want to use. Furthermore, it can make it possible for you to create a blurred image.

Turn day into night: You can produce an exaggerated "day as night" effect by using both a polarizer and a deep red filter on your lens for black-and-white, or a polarizer and a deep blue filter for color film. You'll get extremely dark skies, simulating a night scene.

Be careful of rotating lenses: Many lenses have front elements that do not rotate when you focus; others, particularly zoom lenses, do rotate. With rotating front elements, focus first, then adjust the polarizer, and take your exposure reading. If you "polarize" first and focus later, you may not get the results you want.

Don't let sunglasses cross you up: Be sure not to wear polarizing sunglasses when photographing with polarizers!

Watch out for vignetting: When using polarizers alone or stacked with filters, you run the risk of vignetting at the edges of the picture frame. The rim of the outermost filter may block light from reaching the film, particularly with wide-angle lenses. Although the problem can occur when combining any filters, extra attention should be paid to polarizers, since their mounts tend to be thicker than others to accommodate the rotating mount. In fact, even without combining filters, some polarizers might block light from the edges of the film with a wide-angle lens because they are thicker than other filters. Some manufacturers sell specially designed polarizers in thin mounts to combat this problem. When in doubt, test at all apertures and examine the corners of the negatives or the unmounted slides for corner cutoff. If cutoff is slight or only at certain apertures, you may wish to use the filters anyway. Professional photographers tend to use oversized filters on wide-angle lenses (the filters screw onto the lens via a step-up ring). By using a filter large enough to cover the whole lensmount, the filter edge isn't in the way to vignette. In the last few years some filter makers have combined polarizers with a warming filter. Not only is this a combination often used by pros, but it also keeps the resulting filter ring thinner than a stacked pair to minimize the chances of vignetting.

Beware of overlong exposures: When using a polarizer, your exposure will, of course, increase. You must either use a larger aperture, decrease your shutter speed, or both to compensate for your polarizing filter. You can do this many times without difficulty, but sometimes you can't. Subjects in low light require a tripod (a good idea with or without a polarizing filter). A subject in motion may be blurred if the exposure time is too long.

Getting richer color

A bowl of cherries sparkles with surface reflection highlights without a polarizer.

With camera and light about 30 degrees from each other, the polarizer removes highlights. Cherries are richer, but is the picture better?

Caring for your polarizer: A polarizing filter should be cleaned and handled like any other filter. Use a soft cloth or lens tissue and lens cleaner to wipe the filter gently when cleaning. Avoid using too much lens cleaner and don't let any run over the edge of the filter. Polarizing filters are light stable and should last indefinitely with normal use. Under high temperatures, or if exposed to strong light for long periods, however, they may delaminate and acquire a color cast. Sheet-type polarizers can be deformed if placed to close to hot lights. Even the light from an electronic flash may affect these polarizers adversely if they are taped tightly onto the flash, especially if the flash is used often.

What polarizer do you need?

So much for using polarizers. What kind of polarizer should you get? You thought there was just one type of polarizer available in different brands? No, there are two: linear and circular. Knowing which is which and what polarizer you and your camera need can make the difference between polarizing success or failure, particularly as far as exposure is concerned.

Linear polarizers are relatively inexpensive and work with all cameras that do not have through-lens metering and/or autofocusing. However, if you own an SLR with through-lens metering and/or autofocusing, you'll probably need a circular polarizer which, alas, costs about three times as much as a linear polarizer. Linear polarizers can give the

wrong exposure or focus when used with through-lens metering and focusing systems that use beam splitters or split prisms in their metering or autofocusing systems.

The terms linear and circular refer to how each transmits light. Physically, the two types look very much the same. Their use and results are also the same.

(Check out the two illustrations below to see just what a linear polarizer doesn't do, but a circular polarizer does.)

Checking out polarizers

When selecting a polarizer, make sure it has no definite color; it should be a neutral gray. To check, look through the filter at a piece of white paper. If the paper appears to have color—brown, green, purple, yellow, or whatever—try another polarizer or a different brand. Theoretically, a polarizing filter should not allow any blue or purple light through when eliminating strongly polarized light, or when two polarizers are crossed. In reality, though, most polarizers do allow small amounts of these colors to pass through. This happens because photographic polarizers are most efficient in green and red regions, but tend to "leak" blue light—i.e., they're less efficient at polarizing blue light.

How does this affect your pictures? Although a slight blue color may be visible to your eye when two polarizers

Can you tell it's a circular polarizer by looking at it? Sure!

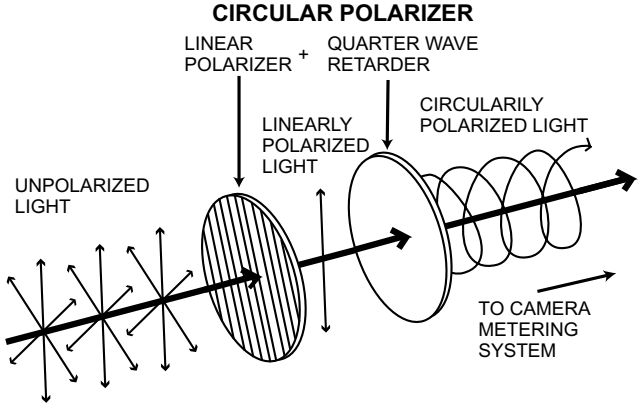
Clear both ways? It's a linear polarizer: Hold polarizer close to mirror so polarizer and reflection overlap slightly. If the overlap is clear, as here, and also when you reverse the polarizer, it's linear.

One side shows black overlap? It's a circular polarizer. If there is black overlap when you look through one side or reversed? It's circular.

You can, however, use linear polarization even with the cameras and hand-held meters mentioned above, as long as you don't try to use the lightmeter normally. To determine exposure, take a lightmeter reading without the polarizer. Then put the filter over the metering cell and manually adjust the reading by the equivalent of one to two stops, according to the filter factor. Or, keep the polarizing filter on the lens, but rotate it to its least effective position—the least change in exposure from that required with no filter. Take a meter reading and set the f-stop and shutter speed at that reading. Then rotate the filter to the position where it provides the pictorial results you want, and make the exposure. Again, you may need a little extra exposure, depending on the subject and the degree to which polarized light is diminished from the scene. Bracket wherever possible.

It should be obvious by now that it's advantageous to buy a circular polarizer, despite its high price. But if you already own a polarizer, how can you tell whether it's linear or circular? Usually it's marked "circular" or "circ" on the rim. No marking? Probably linear. Still not certain? Make a little test as suggested in the two photos above.

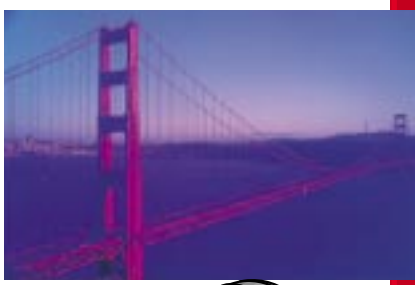
How and why circular polarizers work

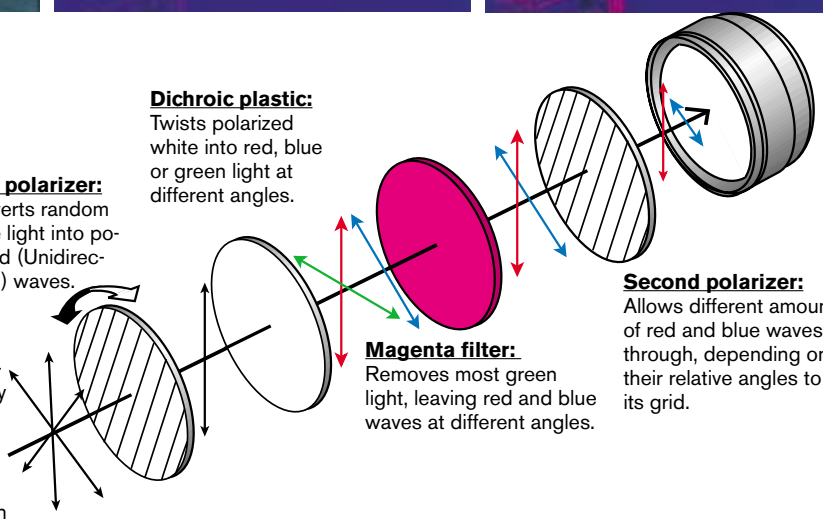


Scrambling Light: Circular polarizer consists of standard linear polarizer plus quarter wave retarder which scrambles the polarized light so it moves in a spiral or circular direction. To most already polarized camera metering systems, this light appears as "depolarized" so the systems operate manually.

Bicolor polarizer will give you two variable colors.

No polarizer





Red-blue bicolor polarizer–many hues with a twist of the wrist: These intriguing filters produce a variety of colors with a single lens attachment. By turning the front element, you can vary the color cast of your picture from one color to another with a range from deep to pale for each color, and you can obtain a mix of several colors in between. Here's a simplified explanation.

As you can see in the diagram above, random white light waves passing through the first polarizer emerge as unidirectional (polarized) white light. This enables the dichroic plastic to break up the light into primary colors and rotate their planes of polarization selectively according to those colors (wavelengths). In the red-blue filter used for the shots above, a magenta filter placed behind the dichroic disk removes the green light waves and the second polarizer analyzes or "reads out" the remaining red and blue components of the light waves differentially, depending on their respective angles to the second polarizing grid. So, as you turn the front polarizer, varying the angle at which the red and blue are transmitted, you can get all red and no blue (when the blue waves are at 90 degrees to the second polarizer), all blue and no red, or anything in between.

are crossed, is usually not visible in your photograph. It may appear as a slight coloration in strong specular highlights.

Testing polarizers by crossing them is highly subjective because your eye has such great sensitivity and ability to pick up slight color "leaks." The best test is to use the polarizer to shoot color slide pictures. If no color casts appear in areas from which strong glare is being removed by the filter, then the filter is OK.

Polarizers are available as screw-in filters and in drop-in series sizes. They also come in thin plastic sheets and can be laminated to thicker glass or plastic square sheets for use with various filter-holder systems.

Polarizing material in sheets is available at prices ranging from $15 for an unmounted 5x8½-inch model up to $111 for a 17x30-inch size unmounted from Edmund Industrial Optics, 101 E. Gloucester Pike, Barrington, NJ 08007; phone: 800-363-1992.

Besides linear, circular, and polarizer-warming filter combos, there's one more special-effects filter you should know about—the bicolor. A bicolor allows you to vary the overall color cast from one color to another, or anywhere in between. Once very popular and made by many manufacturers, we could find only one source today. Called Variocolor, Cokin makes them in red-green, red-blue, blue-yellow and pink- orange. How they work, plus examples of their use, appear above.

By this point, we hope most of your questions have been answered about polarization—why it works, when and how you can use it. Your best bet? Get yourself a polarizer and practice with it. You don't even have to put it on a camera. Just hold it to your eye, look at a likely subject, and start turning. Then, when you have a real need for a polarizer, you'll have a better chance at making it work.