# Fascinating Photos with a Simple Microscope

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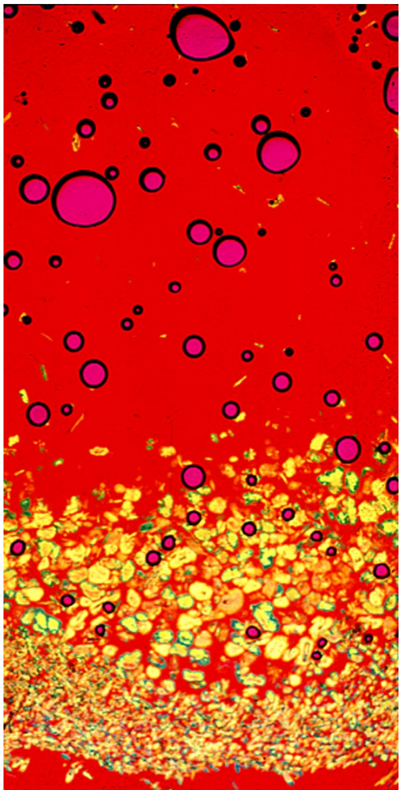
**"Nebraska" is a triple exposure of recrystallized ascorbic acid (the wheatlike plants in the foreground) stretched polyethylene (the morning sky), and the field-diaphragm image defocused and photographed through a yellow filter (the yellow sun).**

Photography through the microscope, or more commonly, photomicrography, has long been a useful tool for scientists. However, anyone who has access to a simple light microscope can produce highly color-saturated photographs, which display an exciting blend of art and science. Simple light microscopes with high-quality optics can be purchased for as little as $250, and adapters for most cameras are available for $25 to $75 (see the accompanying list of microscope manufacturers and distributors). Photographers who have access to state and government-surplus facilities may often find rather expensive surplus microscopes available at reasonable prices. Expensive high-powered microscope objectives (lenses) have a very narrow depth of field and are not really useful; therefore, a lower-cost 5x or 10x objective, which usually comes, as standard equipment on most microscopes, is all that is needed. All of the photomicrographs in this article were taken using a Nikon 4x or 10x objective. You can add polarizers to your microscope for just a few dollars, and the use of polarized light allows you to get beautiful photomicrographs of crystals made from common household chemicals.

**GETTING STARTED**

The first polarizer is inserted at the base of the substage condenser (shown in the microscope diagram on page 5) and can be held in place with tape. If the microscope has a built-in light source, the polarizer can be placed over the field lens. The second polarizer, commonly termed the analyzer, is placed inside the body of the microscope between the main-body tube and the eyepiece tube. There is usually a lens mount at the top of the body tube, and the analyzer can be placed directly on this mount. You will need a polarizer that is approximately 1-3cm in diameter because of the restricted area within the main body tube. This can be obtained by cutting a piece of polarized sheet plastic or buying a small polarizer from a science-supply distributor.

Next, rotate the polarizer until the viewfield becomes very dark.



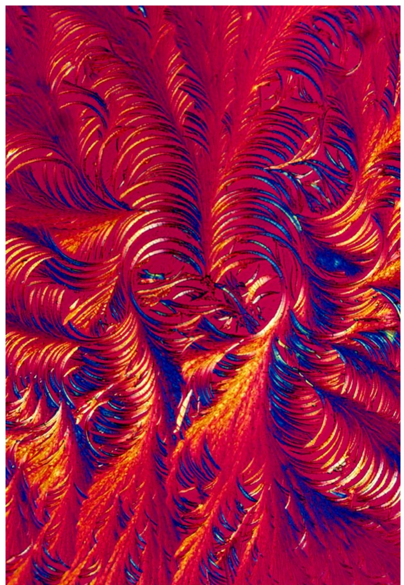
**A single exposure of thiamine (vitamin B1) crystallized from slowly evaporating solution in ethyl alcohol produced this "bubbling" image.**

At this point, the polarization direction is perpendicular between the polarizer and the analyzer, and you have what is termed crossed polarizers. When purchasing polarizers, remember to select polarizers that are very close to a neutral gray in color, such as the threaded polarizers made for the front of a camera lens. Avoid polarizing materials that are green or amber in color.

It is very important to ensure that your microscope is aligned to produce even illumination across the viewfield. Information in microscope alignment is available in owner's manuals or in text-books dealing with microscopy. An exceptionally good book, Photography Through the Micro-scope, is available from Kodak (Publication P-2), and can be purchased in many camera shops.

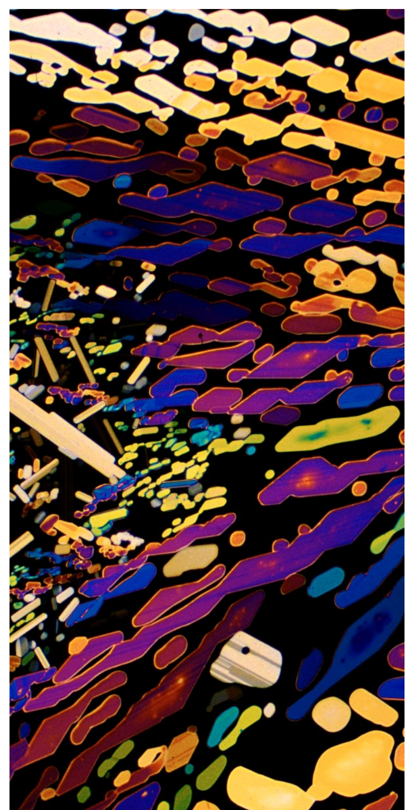
Most crystals are anisotropic and birefringment, which means that they will refract plane-polarized light emitted from the polarizer, and will bend it until it is visible through the analyzer when the polarizers are crossed.

To prepare crystals for examination in the microscope, you simply deposit a few granules of the crystal onto a microscope slide or a thin piece of 2 x 2-inch glass. Next, carefully place a microscope cover slip, easily obtained from a hobby shop or science-supply shop, over the crystals and heat slowly with a match or cigarette lighter until the crystals melt completely (a bunsen burner or alcohol lamp will do a very good job, if available). When melted, the crystals will flow underneath the cover slip and fill the entire volume between the cover slip and fill the entire volume between the cover slip and the microscope slide. Allow the slide to cool, and place it in a safe place for a few days to permit the melted chemical to slowly recrystallize. Very thick crystal samples will usually not transmit much light, and are not as colorful as thinner preparations. If you don't like the crystal formations after recrystallization, re-melt the sample and allow it to recrystallize a second time.



**A single exposure of sulfur recrystallized from the melt produced this pattern. This pattern is a single exposure of 3' -azido-thymidine (AZT) recrystal-lized from the melt. This drug is currently the most clinically effective treatment for HIV-infected AIDS patients.**

Another effective method of preparing crystals is to dissolve the chemical in a suitable solvent, like water, rubbing alcohol, or mineral spirits. This method is especially useful for chemicals in the salt family, like table salt, Epsom salts, Alka-Seltzer, and baking soda. Salts will usually decompose when heated, leaving a tarlike mess. However, when dissolved in water or alcohol, these salts will slowly recrystal-lize as the solvent evaporates to form colorful crystalline patterns. Many chemicals can form differ-ent types of crystals, depending



**A single exposure of aspartame recrystallized from the melt produced these unusual forms. This amino-acid derivative has been found to prossess great sweetening power, and is the active ingredient in Nutrasweet®.**

**This leaf is a single exposure of a liquid crystalline solution of DNA. As the solution slowly evaporates, the DNA concentration increases and the solution enters liquid crystalline states. This photomicrograph approximates the state of DNA found in nature.**

on whether they are melt-recrystallized or recrystallized from solution. Some chemicals recrystallize almost immediately, while some take hours, days, or even weeks. The chemicals listed in the accompanying table are easily obtained, and will recrystallize in a reasonable amount of time to yield beautiful photomicrographs. Several examples of photomicrographs of household chemicals are illustrated.

## CHOICE OF FILM

The majority of microscopes use a tungsten-halide bulb as a light source. These bulbs emit a very bright light with a wavelength spectrum centered in the 3200 K color-temperature range. There are a wide variety of films available that reproduce this color balance correctly. Kodak's Ektachrome 50 and 160 are good examples of transparency films that are tungsten-balanced; however, I prefer the good contrast and color saturation provided by Fujichrome 64T. Photomicrographs are notoriously low in contrast, so I usually underexpose one or two f-stops and push E-6 processing one f-stop. This increases the contrast and color saturation, without a significant loss in density. For Kodachrome lovers, Kodak makes a fine-grained ISO 40-speed, 3400 K-balanced Kodachrome, which can be corrected, for a tungsten-halide light source by the addition of a No. 82A filter between the light source and the first polarizer. If you are in a hurry, Polaroid's High Contrast Polachrome HCP (ISO 40) will produce very good results. With any film, it's wise to bracket the first roll to get a handle on exposure times.

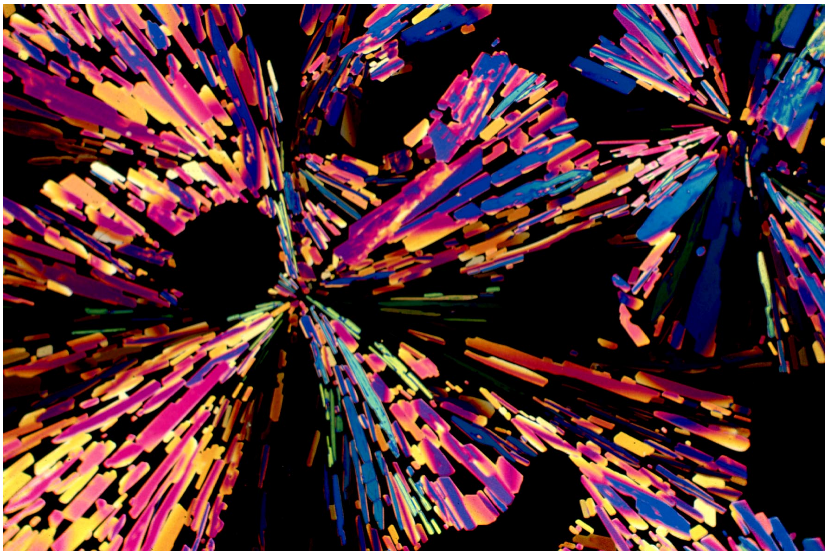
## CONSTUCTION OF "MICROSCAPES"

By taking advantage of multiple-exposure photography, you can construct images that bear an uncanny resemblance to alien landscapes. Several examples of these photomicrographs, which I call microscapes, are included here. You will need a camera that allows for multiple exposures, and a vivid imagination, to create these types of photomicrographs.

The first step in microscape construction is to expose a foreground. This can be any number of crystals, although I commonly use ascorbic acid (vitamin C) crystals, which in many cases resemble wheatlike plants or sea oats. The first exposure is made on the film, and then a mask is placed on the field lens (see the microscope diagram on page 5) to block any additional light from reaching that portion of the film.

The next exposure is a mountain (made from, again, a number of chemical crystal formations) or

**"Mexico Beach, Florida" is four exposures on a single frame of film: recrystallized ascorbic acid (the sandy, rocky foreground), stretched polyethylene with a blue filter (the ocean and morning sky), and the field diaphragm image defocused (two exposures-the rising sun, and its reflection photographed through a comb "diffraction grating").**



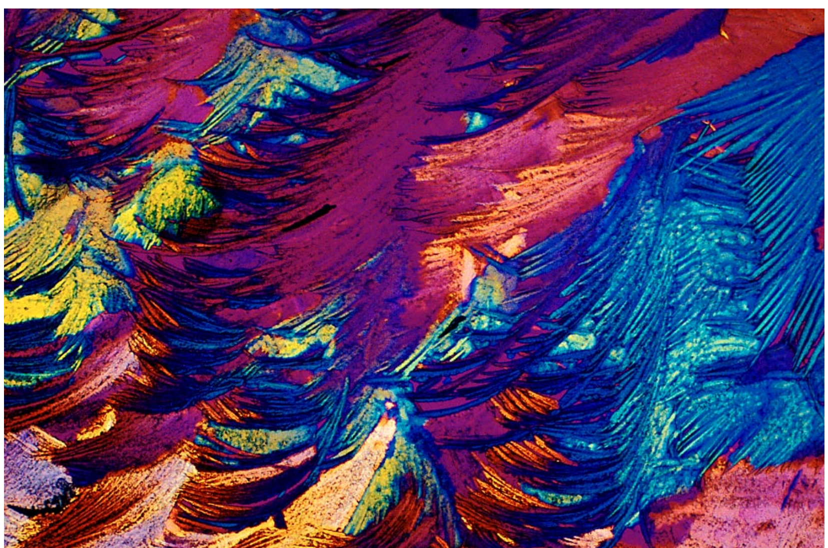
**How do you see relief? This kaleidoscopic image is a single single exposure of pain-reliever aspirin recrystallized from the melt.**

simply a blue or reddish morning sky. The blue sky is obtained by putting a blue filter in front of the field lens (remember to leave in place the mask that covers the previous exposures) and removing the polarizer. This places the microscope in the brightfield mode, which allows the blue light to reach the film. Alternatively, to create a morning sky, cut a 1x2-inch section from a sandwich baggie, and stretch the section before taping it onto a microscope slide. The stretched baggie is made of polyethylene molecules, which align when stretched to form a diffraction grating that acts as a prism, yielding the standard yellow-red-blue spectrum when viewed through crossed polarizers.

The next step in the sequence is an exposure for the sun or moon. This is done by defocusing the image of the field diaphragm (a leaf-type shutter diaphragm which allows light into the main tube of the microscope) until it appears as a circle. You can do this by closing the lever for the diaphragm until the individual leaves merge into a small circle. Then move the main focus knob until the individual leaves become blurred and a complete circle with a fuzzy circumference appears. Next, place a yellow, orange, or red, (depending on the desired effect) filter in the light path. At this point, the diaphragm image will be in the center of the field. You can move it to the upper right or left by moving the centering thumbscrews, which serve to position the substage condenser. Remember to recenter the condenser after the exposure.

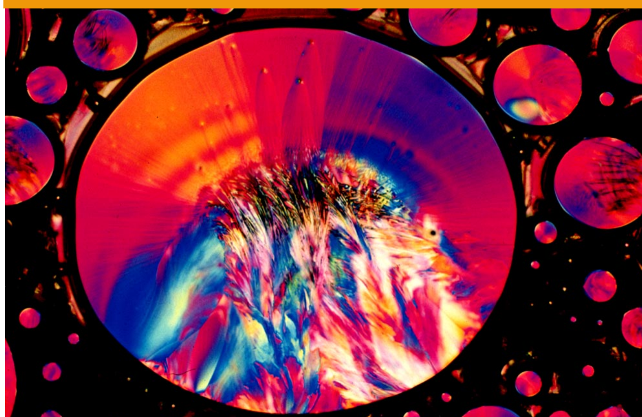
Stars are obtained by superimposing an image of very small crystallites over the previously exposed areas of the film. One of the most convenient ways of making "star" crystallites is to dissolve several vitamin-C tablets in an ounce of rubbing alcohol (isopropanol). Place a drop of solution onto a microscope slide and allow it to dry slowly. As the alcohol dries, small crystallites of vitamin C are formed, which can be used to simulate stars in your microscapes. Remember to mask all previous exposures before exposing the small crystallites.

By experimenting with a variety of recrystallized chemicals and filtering techniques, the amateur microscopist/photographer can generate a wide variety of unusual landscapes, as well as a collection of beautiful photomicrographs of crystals.



**"Feathers" was produced by a single exposure of the sugar arabinose recrystallized from the melt.**

"Lover's Leap" is another quadruple exposure: recrystallized sulfur (the canyon), a blue filter (the sky), tiny ascorbic acid crystallites (the stars), and the field diaphragm defocused with a yellow filter (the sun or moon).

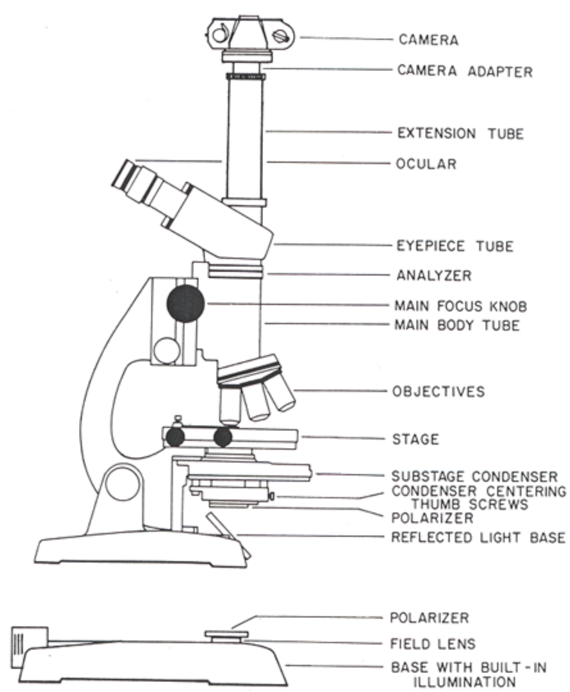


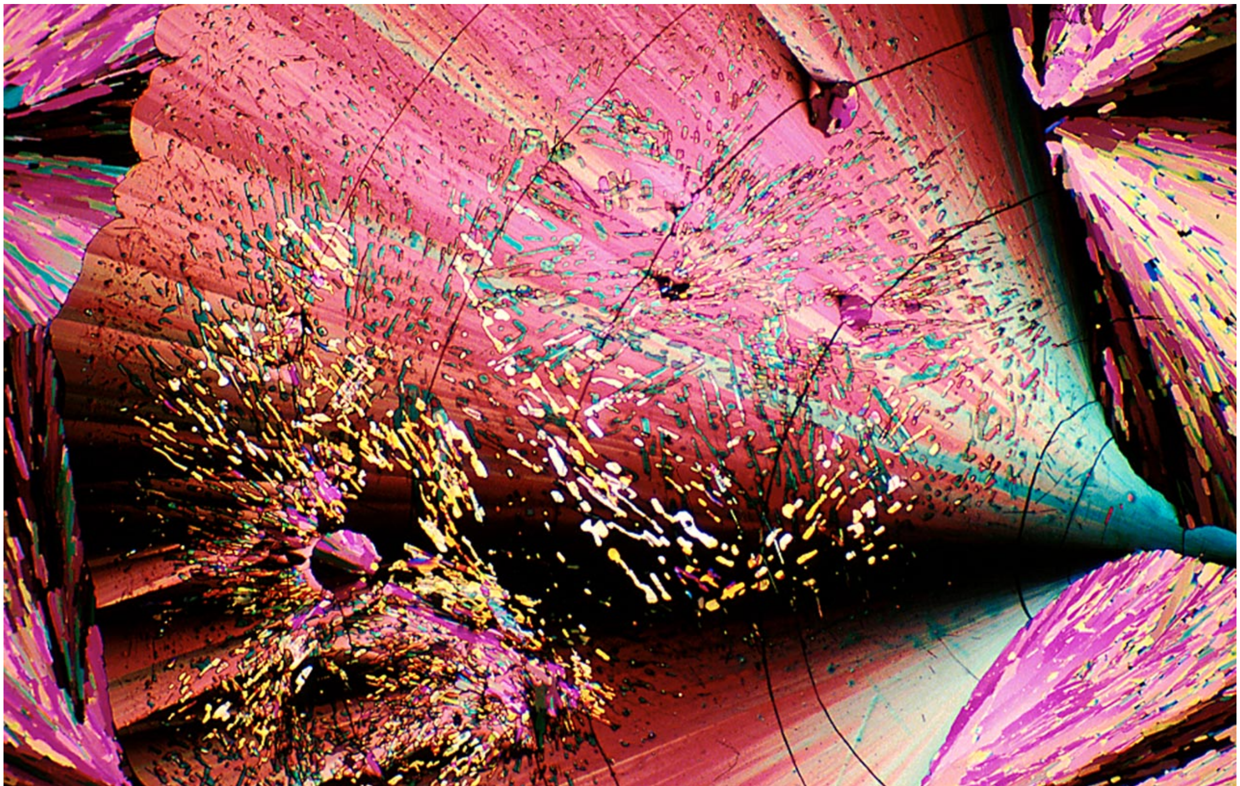
"Bizarre Windows" is a single exposure of absorbic acid (vitamin C) recrystallized from molten chemical.

"The Stand" consists of four exposures: recrystallized ascorbic acid (the plantlike structures found in the foreground), a blue filter (the sky), tiny ascorbic-acid crystallites (the stars), and the field diaphragm image defocused with a ballpoint pen inserted into the light path to resemble a new moon.

**Common chemicals suitable for recrystallization.**

| CHEMICAL | COMMENTS |
|---|---|
| Alka-Seltzer | Best crystals from aqueous solution. |
| Aspartame (Nutra-sweet) | Good crystals from melt-recrystallization or aqueous solution. |
| Aspirin (acetylsalicylic acid) | Equally good crystals from melt-recrystallization or aqueous or ethanol solutions. |
| Acetaminophen (Tylenol) | Equally good crystals from melt-recrystallization or aqueous solution. |
| Epsom salts | Recrystallize from aqueous solution only. |
| Glucose and sucrose (common sugars) | Crystals quickly obtained by evaporation of solution in water. Very beautiful crystals after melt-crystallization. |
| Kodak Dektol paper developer | Best crystals after evaporation of working stock solution. |
| Kodak D-76 film developer | Best crystals after evaporation of working stock solution. |





**A single exposure of sulfur recrystallized from the melt produced this pattern.**

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**Microscope and accessory manufactures and distributors**

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