No. 8

LECO MET-TIPS Ideas for Metallographic Procedures

Stereo-Pairs from Low Power Microscopes

The ability to view stereo-pairs of fractured faces in a three dimensional form need not be confined solely to a Scanning Electron Microscope (SEM) or Transmission Electron Microscope (TEM). Stereo-pairs can be obtained from lower power microscopes, either the type with fixed objectives that are rotated into position or the zoom type, and they will be true stereo, exhibiting the three dimensional effect. The limiting factor is the depth of focus which in turn limits the magnifications ranging from 4X to 40X depending on the fracture surface itself.

The technique is simple and does not require special skills or equipment. All that is required is normally found in the laboratory: two glass slides (1x3 inches), a small ball of plasticine (modeling clay), and a small spotlight or a single fiber optic for the light source. If the fracture is too tall, it should be sectioned to a convenient height to fit under the microscope and to allow maneuverability. Position the light source to one side of the microscope and focus the fracture to determine the magnification; rotate and tilt the sample until the desired orientation is obtained, then attach the sample to one of the glass slides with plasticine. Further adjustments can be made while the sample is on the glass slide; however, the long dimension of the glass slides should be from left-to-right. Position the light source to fully illuminate the place of interest, usually a low angle will give the best contrast. Too high an angle will tend to wipe out fracture facets or irregularities. Slip the short dimension of the remaining glass slide approximately 1/8-inch under one end of the slide holding the fracture; refocus and take a photomacrograph. Remove the glass slide shim and place under the opposite end of the glass slide holding the fracture, refocus and take another photo. The photos should be identified (on the back) as left or right in accordance to the position of the glass shim. For instance, if the shim were in the left side of the fracture that photo would be identified as "left". The light source remains in the same position for both photos. Care should be exercised when removing and repositioning the glass slide shim that the fracture remains in the same position. Noticing a particular feature and referencing it to the dial of a clock will aid in maintaining the correct position.

Viewing stereo-pairs can be done with the aid of a parallax bar or with the unaided eye. The latter is more difficult but can be done with practice. Parallax bars have lenses attached to a bar and the lenses can be adjusted to match the spacing between individual eyes. The photomacrographs marked left and right are placed beneath the viewer and one looks through the lenses to see stereo. Unfortunately, parallax bars are not always available and as a consequence, the ultimate solution is to train the unaided eye to see stereo.

It has been estimated that 80% of viewers can see stereo immediately, 10% with a little effort, and the remaining 10% probably will never be able to acquire the ability. The basis of stereo viewing is learning how to make each eye see a separate image.

Each pair of photos should be trimmed to the smallest size that will still contain all desired features and each photo should have the same orientation, i.e., a feature on one photo should be in the same location as on the other photo. Stereo-pairs trimmed to approximately 2.25x2.25 inches make viewing easier, however, as stereo viewing becomes easier, larger pairs can be used. Smaller size photos can be held by hand; larger photos may have to be propped up to obtain correct distance.

The trick is to relax the eyes. At first this sounds easier said than done, but in fact, one does it all the time—it is called daydreaming. When your eyes have been intently focused on something and then raised to look at some point far away, they become relaxed. If one were to bring stereo-pairs into the line of vision but slightly below the far away object, the photos will be out of focus. Lower the eyes to the photos but do not focus on them. The photos will appear to become three, with the middle one thinner than the two outside ones. As one relaxes the eyes more, the middle photo will grow thicker and some prominent features will appear to be four. At this point, pick out a prominent feature and concentrate on it. The two middle features will swim to and from each other; the closer they get, the closer one is to becoming able to view in stereo.

When the two middle features get to the place where they appear to be overlapping, but not coinciding, relax the eyes more, i.e., look farther beyond the photos. When two middle features coincide, the three dimensional effect will snap into position and one is viewing in stereo at the middle photo, which is now the same size as the two outside ones. The two outside photos will never be sharp or in focus but will appear fuzzy. Once stereo viewing is achieved, the eyes are free to move around the photo looking at different features.

If one does not achieve the knack of stereo viewing after several attempts, the following may be helpful. Take two sheets of regular size paper and roll in tubes 8.5-inches long and approximately 1-inch in diameter. Tape the tubes to prevent unrolling. Bring the tubes to the eyes as if looking through binoculars and focus on the stereo-pairs that have been propped up. Separate the two ends until each eye is viewing a separate photo. Relax the eyes and then concentrate on the same prominent feature in both photos. The features will swim toward each other then coincide for three-dimensional viewing. This method is perhaps easier to achieve than the former method but once this technique is acquired, try the first method again.

Spacing of the stereo-pairs is very important and should coincide with the individual eye spacing. However, since individual spacing varies, stereo-pairs spaced between 55 and 60 millimeters will be within the limits of most viewers. The spacing of 55 to 60 millimeters is from center-to-center of the two photos, not from edge-to-edge. All stereo-pairs, regardless of size, will be physically close to each other with only a very slight separation, but the larger the photos, the greater the spacing from center-to-center. Photos measuring 4x5 inches will have a spacing of approximately 110 millimeters and the viewer may have to prop the photos about 20 inches away before stereo viewing can be achieved.

The photos illustrated in Figure 1 are very easy to view in stereo because there is only one feature contained in them. The viewer is urged to master stereo-viewing with these before attempting to view the remaining stereo-pairs.

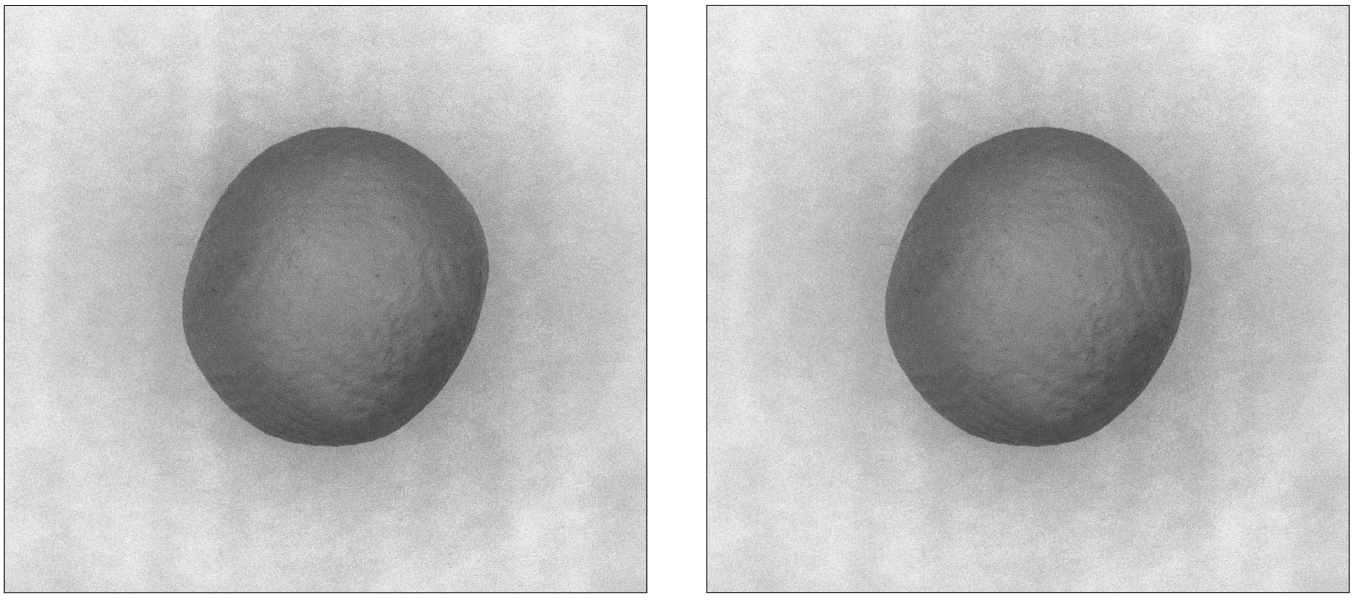

FIGURE 1. A small ball of plasticine rolled in the palm of the hand and placed onto a glass slide with a black background. When viewed in stereo, the ball appears to be floating in space and above the background. Magnification is 4 diameters.

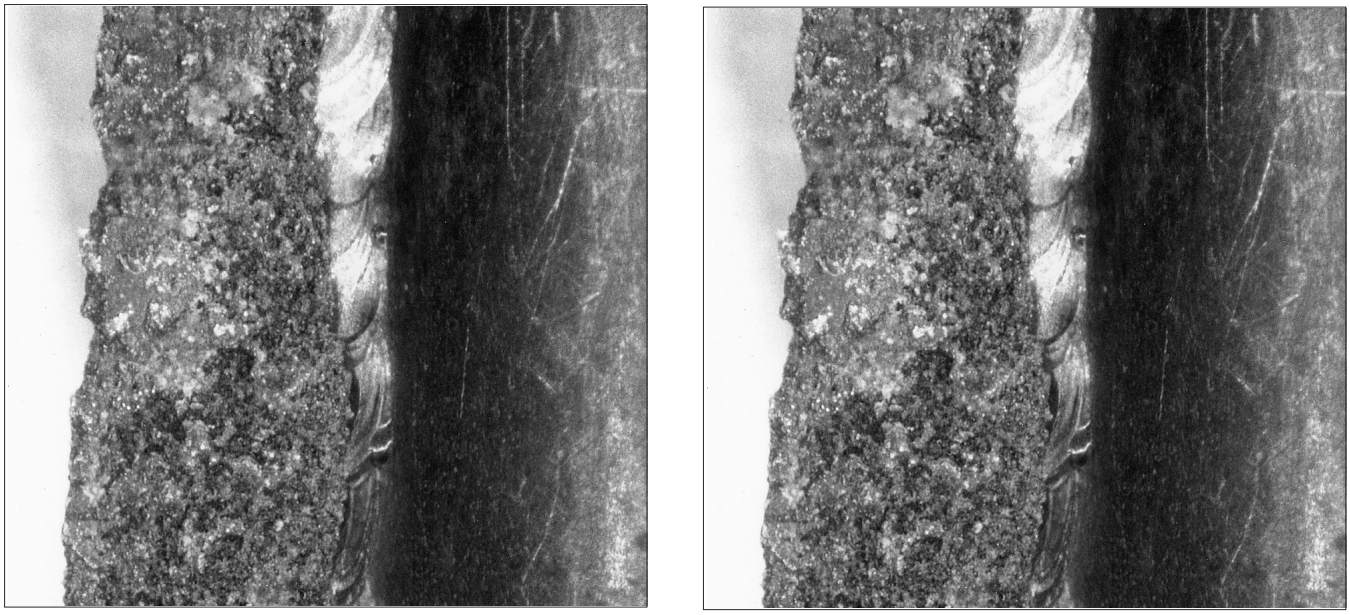

FIGURE 2. Stereo-pair of SAE 1045 tube failure, 4X.

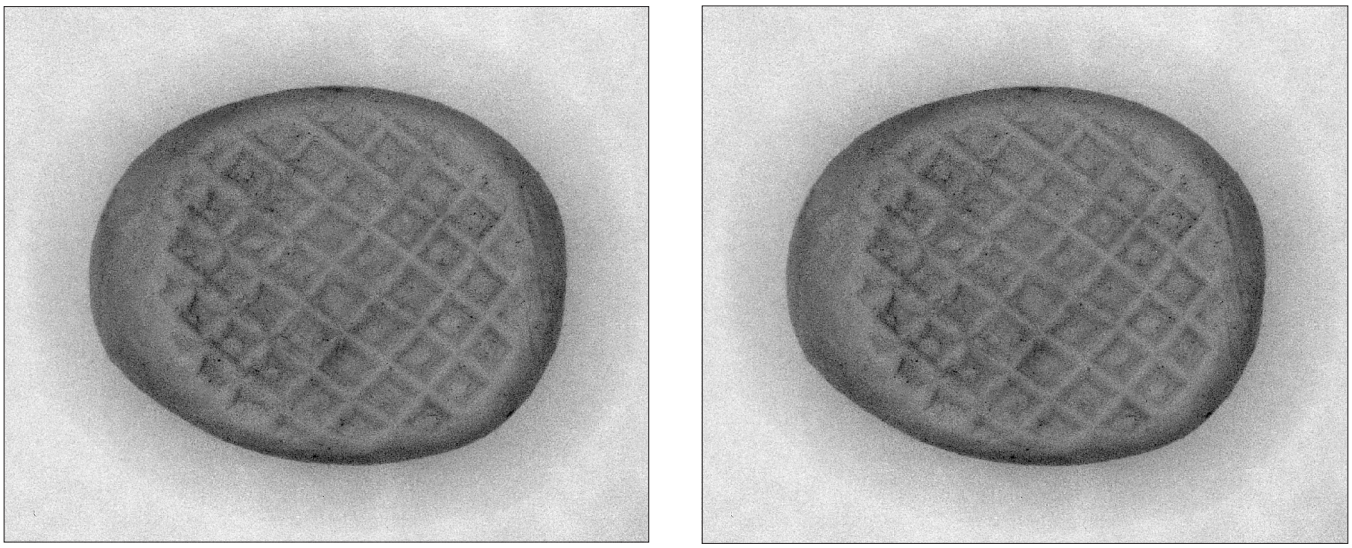

FIGURE 3. This stereo-pair is more difficult to view in stereo than those in Figures 1 and 2 because there are more features. It is a small piece of plasticine that has been flattened with the knurled end of a steel handle. Magnification is 4X.

The following stereo-pairs illustrated in Figure 4 are a little more difficult to view in stereo, but if the preceding stereo-pairs posed no problem than these should not either.

At first glance the photos appear to be the same; however, the difference is only apparent when viewed in stereo. The top pair was shimmed with only one glass slide and the bottom pair was shimmed with two glass slides. When viewed in stereo the top pair appears to be on the same focal plane as the page, but in the bottom pair the top portion of the fracture seems to leap out of the page.

Learning to view in stereo with the unaided eye (i.e. without parallax bars or viewers) is a very rewarding experience and once the ability is achieved, a whole new realm of viewing is available.

The stereo-pairs illustrated in this paper are relatively easy to view. When these are mastered, the reader is urged to view the SEM and TEM stereo-pairs illustrated in the ASM Metals Handbook. Start at the top of a page, and once the top pair is in stereo the eye can sweep down the page and view all the pairs in stereo without having to go through each set separately.

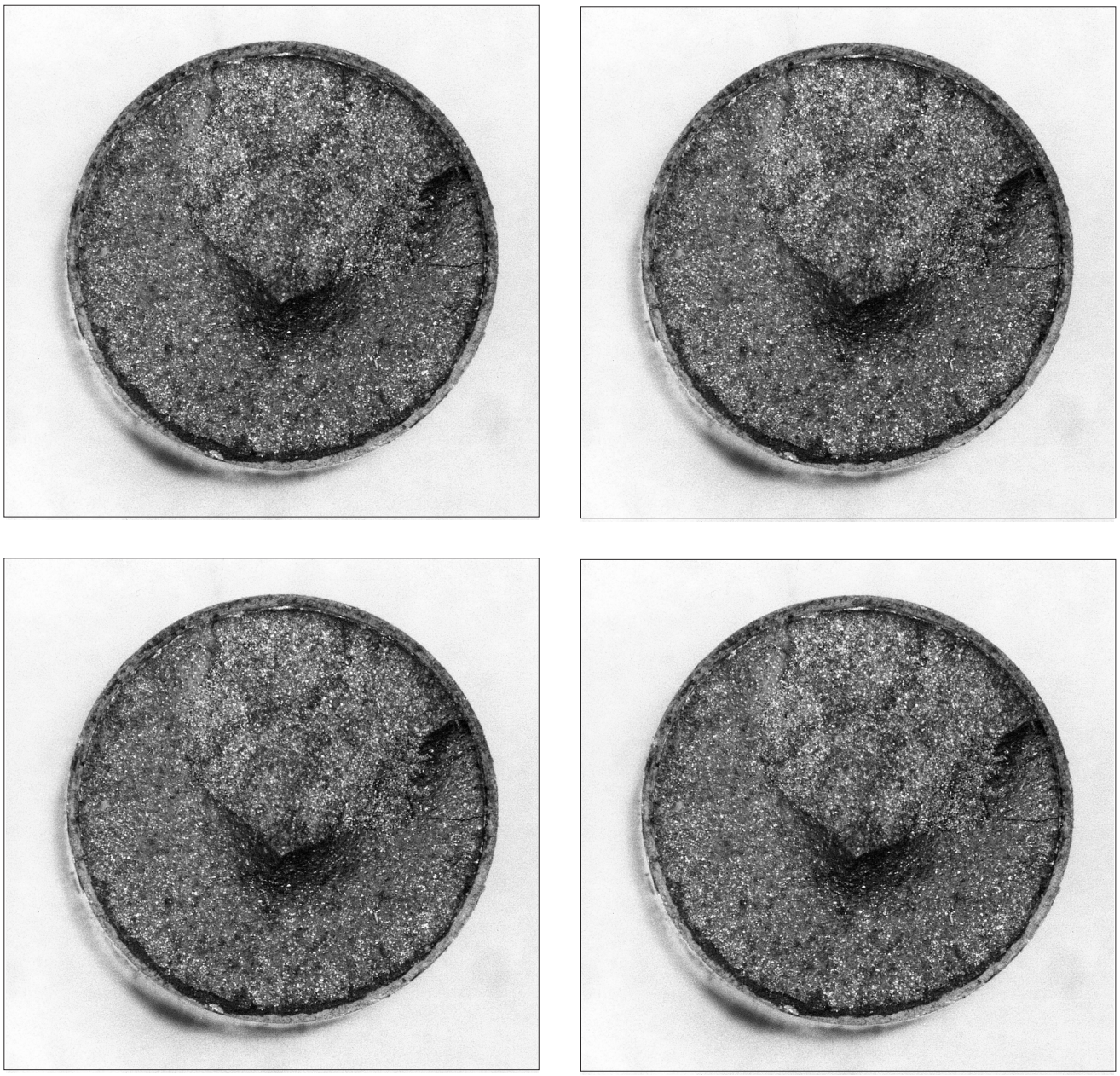

FIGURE 4. Fractured end of SAE 4140 steel rod, 6X.

LECO Corporation would like to thank Dr. Lee Dillinger for his contributions to this project.

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