Multimode Trans-Illuminator for the Stereomicroscope

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The stereomicroscope was the main tool I once used for metallurgical failure analysis. I have owned a Meiji EMT Greenough-type stereomicroscope since the late 1980's. I had not used transmitted light with the stereomicroscope until about a year ago when I completed a multimode transmitted light illuminator for my Meiji stereomicroscope. I thought this capability would be very useful for introducing the grandkids to the microscopic world, especially with live lake water organisms. My earlier article in *Microscopy Today*, "Rediscovery of Darkfield Dispersion Staining while Building a Universal Student Microscope," January/February 2003, demonstrated usefulness of a dual brightfield and darkfield capability in transmitted light for viewing living organisms. I have a ½" fiber-optic bundle light guide used in the illumination system for my modified Biolam microscope also shown in *Microscopy Today*, "Effects of Condenser Spherical Aberration on Image Quality," March 2005. I suspected I could obtain both darkfield and brightfield illumination for the stereomicroscope using this light guide and components I had or could fabricate.

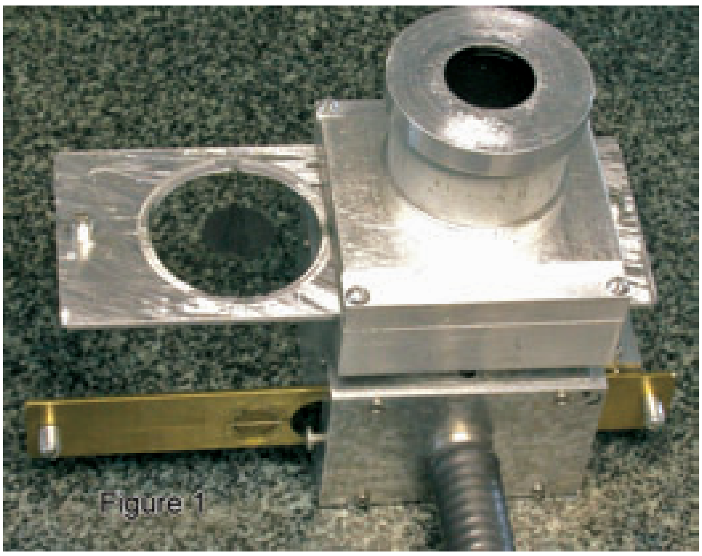
Figure 1

The final version of the illuminator is shown in Figure 1. The end of the ½" light guide is used as the light source. A slider is mounted right in front of the light guide end. The first slider (lower) is shown in Figure 2 along with the final version (upper). The darkfield stop size is 0.470" for both sliders. The first slider has openings for brightfield and darkfield along with a third opening containing a polarizer. The fabricated aluminum housing contains a 37 mm right angle prism to fold the light path ninety degrees. The condenser lens is composed of a pair of plano-convex lenses 50 mm in diameter with a 75 mm focal length. The lens pair is mounted with the convex surfaces almost

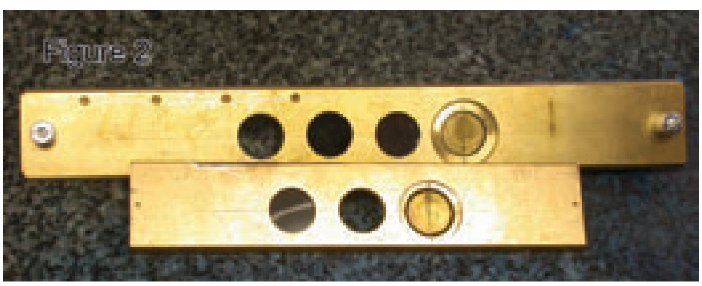
Figure 2

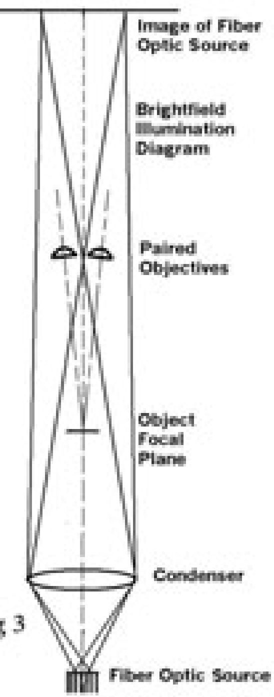

Fig 3

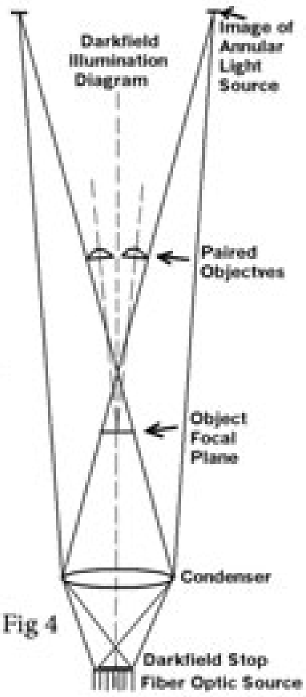

Fig 4

touching. The lenses were obtained from Edmund Optics and are antireflection coated. The gaps between the prism faces and the slider and condenser lens face are small to maximize the magnification of the light source. Schematic drawings of the illumination system are shown in Figures 3 & 4. The position of the sample stage at the top of the illuminator was determined experimentally using the Meiji stereomicroscope to provide the largest field of even illumination in both brightfield and darkfield illumination. This central zone of even illumination is about 12 mm. There is no diffuser in the system and the transition between the illumination modes is quickly and easily obtained by moving the slider to the next detent position.

The management of McCrone Microscopes and Accessories were very interested in the prototype illuminator when shown its brightfield performance with crossed polars and darkfield dispersion staining with a polarizer mounted on the nose of the Meiji microscope. They asked whether a first-order red compensator could be added to determine the sign of elongation and graciously loaned me an Olympus SZ60 trinocular stereomicroscope for further development of my illuminator. The solution to the need for a first-order red compensator was to add a fourth position to the slider. This added opening has a polymer film first-order red disk stacked with a polymer film polarizer on the light-guide side. The proper ori-


Figure 5

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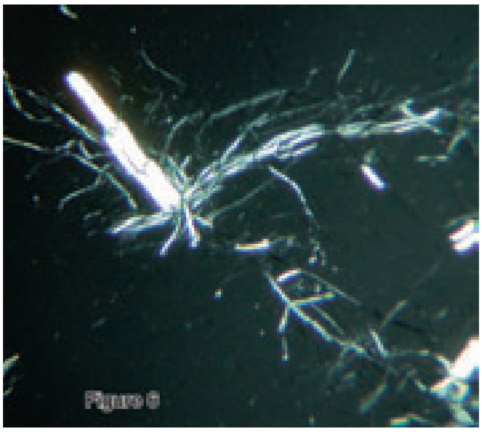

Figure 6

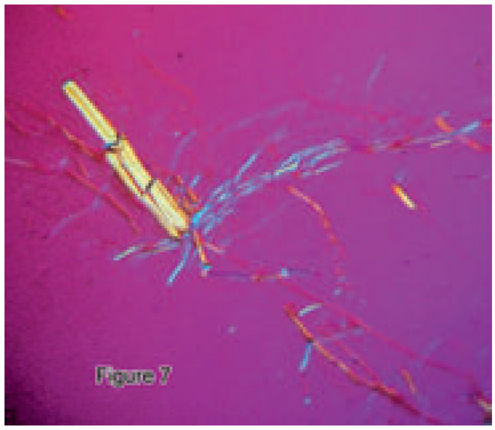

Figure 7

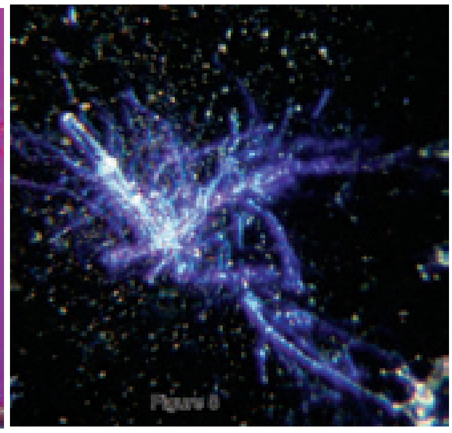

Figure 8

entation of the polarizer and red compensator disks was determined with the aid of my universal student microscope referenced at the start of this article. This four position slider is shown in Figure 2 (upper). I noted that the extinction between crossed polars was better with the SZ60 than with my Meiji EMT. I also detected a dim but bothersome reflection in darkfield with the SZ60. This reflection was blocked by adding a second slider containing a second stop just above the top of the condenser as shown in Figure 1.

A reference slide of Chrysotile asbestos in 1.550 mountant was provided by McCrone Microscopes and Accessories and used to document the performance of the multimode illuminator. Figure 5 shows the trinocular SZ60 stereomicroscope fitted with my new illuminator. A Nikon Coolpix 995 digital camera was attached to a high eye point

Figure 9

eyepiece in the photo tube for the asbestos photomicrographs taken at a zoom setting of 2.5. Figure 6 shows the fibers between crossed polars indicating they are birefringent. Figure 7 shows the fibers between crossed polars with the first-order red compensator indicating the fibers have a positive sign of elongation. The red background is not totally uniform and this was a problem with the sheets of first-order red compensator film formerly sold by McCrone Microscopes and Accessories and no longer available from them because of this problem. Figure 8 shows the fibers with plane polarized darkfield exhibiting the dispersion staining colors characteristic of Chrysotile asbestos in 1.550 mountant.

More recently I experimented with the new illuminator and my Meiji EMT. I found that I could obtain excellent extinction between crossed polars by placing the polarizer just below the test object. This indicates to me that the initially polarized light is being partially depolarized by passing through the prism and condenser. Since my Meiji does not need the added stop above the condenser lens, the slider opening for the stop was fitted with a polarizer made from polymer film obtained from Edmund Optics. I now can get good extinction between crossed polars, but not the excellent extinction I can get with much more costly polarizers obtained from Lomo America and also available from Edmund Optics. Figure 9 is a darkfield image of a housefly wing recorded with the 2X objective of the Meiji EMT using the new illuminator. This image was recorded with the Olympus E-330 DSLR camera shown in Figure 10. My web article in Micscape on using the Olympus E-330 DSLR camera with my binocular Meiji EMT contains a sequence of darkfield and brightfield images of the housefly wing and more information on using the E-330 with a binocular microscope: http://www.microscopy-uk.org.uk/mag/artfeb07/tc-meiji.html.

There are further improvements for the multimode illuminator that should be in any production version. The first improvement would be a ½" diameter light guide with a tight ninety degree bend at the output end. This would eliminate the need for a prism and associated depolarization. Since this would be a custom design light guide, it could also have an annulus of fibers at a greater diameter than ½" for improved darkfield capability with the higher NA CMO research stereomicroscopes. The costly pair of lenses for the condenser could be replaced by a single aspheric lens.

The inventor is always excited about the possible patenting and marketing of his invention. It took time for me to realize that the

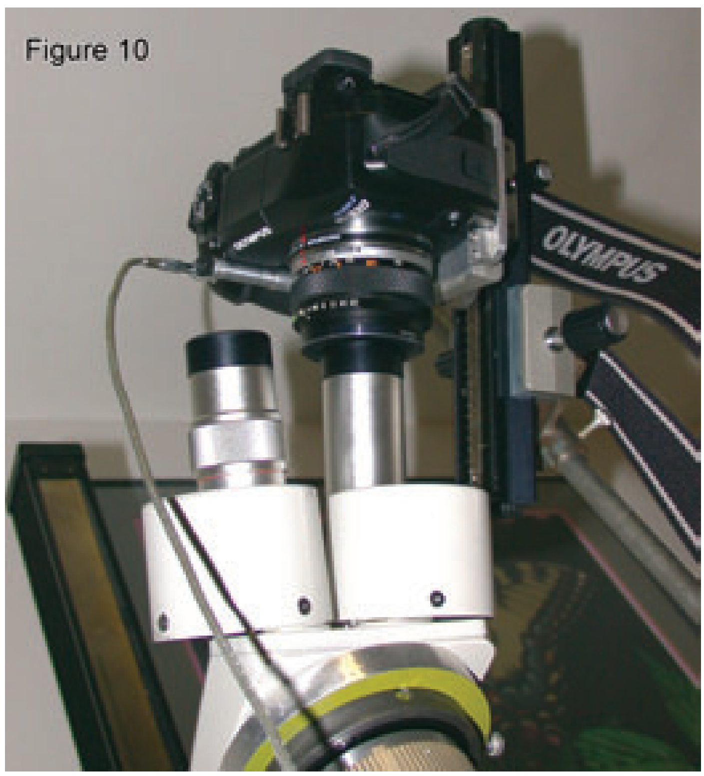

Figure 10

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multimode illuminator would be costly in initial production quantities and that the market for this product might never develop without the backing of a large manufacturer of microscopes. The details in this article should be sufficient for laboratories' instrument shops to make their own versions of my invention. The key element missing for my illuminator is that the potential customer base has not asked for such an invention. My earlier article on dispersion staining has not led to the adoption of high resolution dispersion staining in America. The situation is different in Japan where the environmental microscopists asked Nikon and Olympus for a method of high resolution dispersion staining as described in the Nikon web article:

http://www.nikon.co.jp/main/eng/portfolio/about/technology/field/2006/asbestos.htm.

Nikon developed a special 40X 0.75 NA objective with a totally opaque ring where a phase ring would normally be located. This objective works with the condenser phase annulus for the 40X phase contrast objective. Olympus chose the hollow cone darkfield method for the high resolution dispersion staining, also using a 40X 0.75 NA objective. Since the stop in the Olympus phase contrast condenser with a 1.10 NA optic is sized for a 0.65 NA objective, a special phase contrast condenser with a larger stop or the Olympus universal condenser with an available darkfield stop for a 0.75 NA objective would be needed.I learned that over 200 systems for high resolution dispersion staining have been sold by Olympus in Japan. Since the Japanese environmental scientists were receptive to high resolution dispersion staining, they might also be interested in identifying bulk asbestos in the field with my multimode stereomicroscope illuminator. I hope this article might lead to a market for my invention and a manufacturer wanting to pay for a patent application to protect his investment. ■