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MINIMIZING CEMENT STRAIN WHILE ASSEMBLING THIN LENSES USING ULTRA VIOLET LIGHT

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Optical Designers seem to enjoy designing doublet lenses with one lens much thicker or physically stronger than the other. For us manufacturers, that can cause distortion problems when the two dissimular materials are cemented. We measure this pull or distortion by using our Zygo interferometer. In other words we can detect the distortion in the elements by observing the fringe pattern on one of the outside sufaces. The usual element we choose to observe is the thinest element. We regard a thin optical element as anyone with a thickness to diameter ratio of over eight to one.

This is a discussion on how our company solved this problem of distortion when using an ultra violet lens cement and avoid pulling without reticulation. The goal is always to have less than 1/4 fringes or less distortion.

We cement with Norland NOA61, ultra violet sensitive adhesive. We put the concave element up in the lens centering fixture and add drops of cement into the small bowl formed by the element. Just like dropping milk into a cereal bowl. Then the mating convex element is placed on top pressing the cement uniformly or wetting both the surfaces. Some cement oozes over the side. A skilled operator allows just enough that reticulation won't occur when the cement shrinks. Usually the cements thickness is about .0002 inch on most lenses, when fully cured.

We're now ready to optically center. In our case, we pass a low power laser beam through the lens, rotate the lens holder while moving the top element until 180 degree rotation stills the image on a CRT screen.

We're now ready to stabilize the cement. We call this "tacking the lenses". This is where the trick occurs. We have a round UV light which is approximately 3 inch in diameter at about 4 inch above the lens surface. This was made for us by Aristo Grid Lamp Products and is their part M1457-3. It is approximately a 5 watt lamp. The energy is kept on the lens appoximately 60 seconds.

When distortion appears in a lens, this is where we have found the source of the distortion to begin. In other words an even illumination is what is needed to prevent distortion. Energy from a round source at tack time is the greatest deterrant in preventing cement distortion; curing seems to start slowly and evenly.

After the 60 second cure, we can remove the lenses from the centering fixture and transport them to a cabinet or box with an array of 6 ultra violet flourescent bulbs. The bulbs we use are Phillips F20T12/BLB. The distance of the bulb to the items cemented is 4 inches, the bulbs are 2 - 3 inches apart. The lenses almost touch one another when in curing. We have found that these cylindrical bulbs don't warp the fringes or cause distortion at this stage.

However, on thin lenses over three inches in diameter, we can still get some distortion from cement pulling. We solve this by placing the lenses on a rotating plate of 10-20 R.P.M. while keeping the light array in a fixed position. These lenses also take 16 hours to cure.

To keep the UV light in the box, we line the cabinet or box with aluminum foil. This causes the light to bounce around in the final cure keeping intensity uniform. The manufacturers of the cement say three weeks until full cure. Using our method we don't think this necessary. Other gimmicks we tried for slow even cure is to increase the UV light source to lens distance and to use a ground glass to diffuse the light. These were not as effective.

Here are some Zygo pictures of lens showing progression of distortion. First the original lens not cemented.

Next photo shows distortion to .305 fringes peak to valley.

Next photo shows distortion after overnight cure.
This distortion in our experiments doesn't seem to increase. The full cure meets the Military Standards MIL-A-3920. The lens has all the distortion after the overnight cure. Further illumination doesn't produce any better or worse results.

Tests can be performed for cold/hot 80°F to 160°F. This is a test where most separation or retriculation (cement starts) occurs. Other environmental tests of humidity and or salt fog have little effect on perfection.

To sum up: Prevention of thick/thin lens cement distortion

1. Use a ring shaped bulb to start the initial cure or tacking of the lenses for approximately one minute; a slower cure is usually helpful.
2. Shield the lens from stray UV light and put in a UV lamp array.
3. Cure for 16 hours under UV array.

Series of three interferograms shows how doublet lenses can be distorted by curing with straight or cylindrical ultra violet energy sources.

Figure 1

Interferometric readings before thin lens cementing exterior surface showing .184 fringes. Lens is shown without power removed.

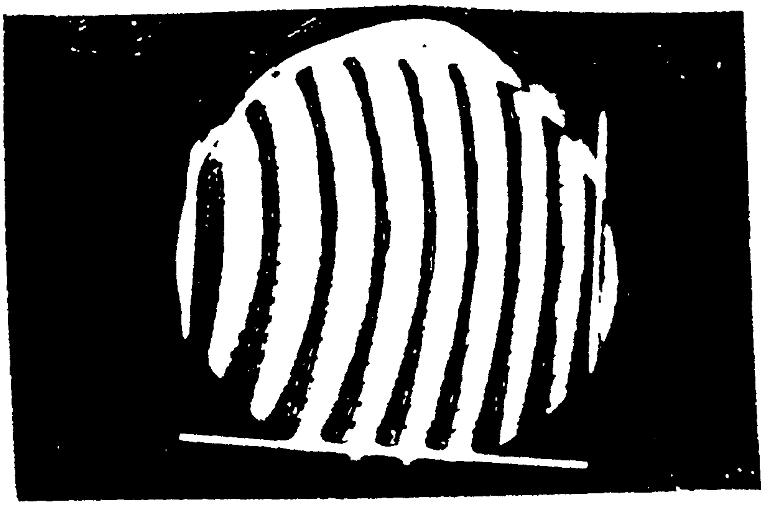

Figure 2

Same lens- initial cure after applying 60 second ultra violet energy showing .305 fringes or .125 fringe distortion.

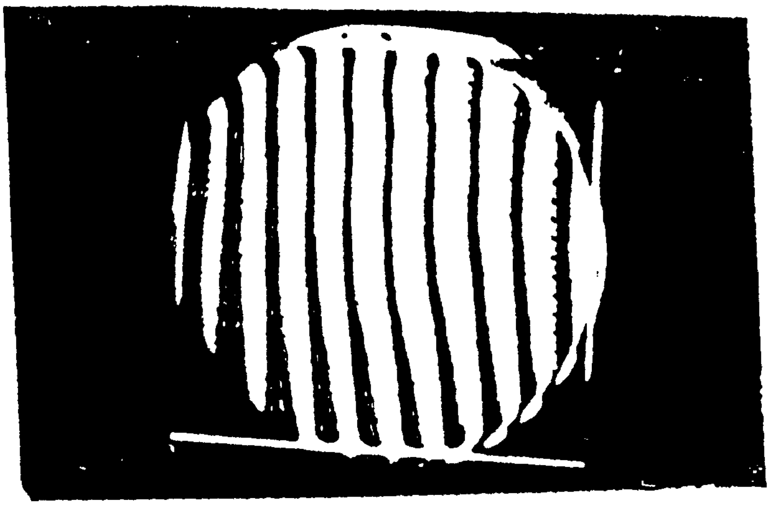

Figure 3

Same lens as above showing 16 hour full cure and cylindrically straight tube of UV energy - .517 fringes or .333 fringe distortion introduced by improper curing.