Hologram Research Oyster Bay Lab Notes

Denisyuk Tests on BB520 8x10" plates with John Wagner, 28 Feb.-Mar. 2, 2020

Laser: Lightwave 142 putting out about 420mw 532nm, horizontal optical axis 10.5".
Table: TMC 5x10x2 feet, table not floated due Denisyuk exposures & enclosed hood.
Exposure materials: Colour Holographic (TruLife Optics) BB520 8x10" glass plates.
Processing regime: 1% TEA pre-sensitization, Two-part Pyrogallol developer, FeEDTA bleach.

Feb. 28:
Ambient darkroom 20C

4:00pm: Mixed developer Part A, 1-liter distilled H_2O to 10 grams Pyrogallol Acid, $C_6H_3(OH)_3$, powder crystals, room temp.
5:00pm: Mixed developer Part B, 1-liter distilled H_2O to 60 grams Sodium Carbonate, Na_2CO_3, Monohydrate, room temp.
Started mixing FeEDTA bleach, 1-liter distilled H_2O to 30 grams EDTA, $(CH_2COOH)_2NCH_2CH_2N(CH_2COOH)_2$. Even hours after heating to 40C with stirring, it wouldn't dissolve & remained milky looking.

6:00pm: picked up John Wagner from LIRR Manhasset train station.

7-9ish pm:
Added in sequence to bleach solution:
30 gms Ferric Sulfate, $Fe_2(SO_4)_3$
30 gms Potassium Bromide, KBr
65 gms sodium bisulfate, $NaHSO_4$ (in lieu of sulfuric acid)

Bleach solution still wouldn't dissolve for a half hour or so. Reheated to about 35C & it finally all dissolved & clarified after about 1.5-2 hours. Turned a clear tobacco color. John said that's what it usually looks like.

10:30pm: We looked over available squeegees, trays for processing 8x10" plates & discussed methodology for processing. Minimum volume estimate in the 8X10" Patterson trays for an 8x10" plate is about 250-400ml. Discussed warming the 2 parts of the developer in an H_2O bath to about 30C before mixing & then using right away.

John says after post developer wash, ok to turn light on while bleaching even though it's not fixed!

John tested FeEDTA with ColorpHast pH strip (2.5-4.5) to make sure sufficiently acidic; yes, strip turned dark purple:

pH strip

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Feb. 29:

9:00am: Turned on Oasis 160 chiller. It started at about 15C and oscillated from about 15C to 21.xC and did two "pump failure" messages before settling in to 20C. Turned off after each "pump failure" & waited about 15 seconds each time & turned back on. This Oasis 160 is much quieter than previous two Oasis 150 chillers.

10:00am: Rinsed, dried & prepped processing trays and processing area.

10:20am: Oasis 160 @ 20C, ambient @ laser 20C

Started setting up Denisyuk overhead reference camera that John prefers and with which John is comfortable.

Borrowed one-inch collimating lens from H1 table to narrow Lightwave 142 slightly diverging beam so it would fit cleanly and unobstructed through spatial filter microscope objective rear aperture.

12:07pm: Laser turned on 19C, Oasis 20C
12:11pm: Laser lasing.
12:13pm: Laser 23C, Oasis 20C
12:27pm: Laser 23C, Oasis 20C
12:42pm: Laser 24C, Oasis 20.1C
12:56pm: Laser 25C, Oasis 20C
1:47pm: Laser 25C, Oasis 20C
2:06pm: Laser 26C, Oasis 20.1C
2:34pm: Laser 25C, Oasis 20C
3:06pm: Laser 25C, Oasis 20C
3:45pm: Laser 25C, Oasis 20C
4:00pm Laser 25C, Oasis 20C
4:26pm Laser 25C, Oasis 20C
4:36pm: Laser 25C, Oasis 20C
5:17pm: Laser 25C, Oasis 20C

Temporarily left lab with laser on…

Spatial filter has 60x objective with 5-micron pinhole.

6:15pm: Laser 24C, Oasis 20C, setup ready for plate.
Since this series of exposures is intended as a test of the BB520 8x10" plates and their processing on my system, the image was our least and last consideration but needed to be stable and reasonably reflective in the 532nm laser light. The object John selected was a porcelain rabbit kept by our living room fireplace, 8.5" tall by 6.25" wide.

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Feb. 29 (con't):

Porcelain rabbit object 8.5"h x 6.25"w

John Wagner with Denisyuk setup for BB520 8x10" plate

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Feb. 29 (con't):

A Newport model 270 lab jack was used to support the porcelain rabbit. Matte black foam core panels and black velvet were strategically placed to block and absorb stray laser light scatter. Matte black construction paper was secured to blocking cards and suspended from hood ceiling around spatial filter as needed to further block stray light scatter. Although the plateholder was secured to the table using screw down clamps, the lab jack was never secured to the table, an oversight that proved unimportant. The lab jack was placed up against the back of the plateholder and covered with black velvet on which the object was centered behind the plateholder.

Porcelain rabbit ready for immortality

10:00pmish: Light meter readings at plateholder with NRC 840-C with calibrated 818-ST wand light detector, with attenuator on, varied from about 450µw midplate to a low of about 200µw on edges. Assuming a 600µw/cm^2 exposure, we estimated a 2 second exposure. We set the Newport model 845 shutter controller (shutter 846HP) to 2 seconds and tested a couple of times.

10:22pm: Laser 24C, Oasis 20C. Ready to 1% TEA pre-sensitize first BB520 plate.

Darkroom ambient about 18.5C.

TEA mixed as follows: about 13ml was poured into 50ml glass graduate. John said, because of viscosity of TEA, it's always good to put a few milliliters more into graduate since some always stays in the graduate stuck to the sides & he was correct. 1 liter of distilled H_20 was poured into a glass beaker & a magnetic stirrer was used to mix the H_2O, 10ml of TEA and about 5-10 drops of photoflo and then poured into an 8x10 white Patterson tray.

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With red darkroom safelights (Kodak #1A, 1, & 2), soaked plate in the 1% TEA solution for 2'. John then removed the plate, gave it a 5-10" rinse with agitation in a tray of distilled H2O with a few drops of photoflo, let it drip back into tray a little, and rested the short edge of the wet plate on a blue shop paper towel and squeegeed the emulsion side three times with 12" window squeegee. He wiped the glass side and edges dry with the blue paper shop towels. He then used a small hair dryer to blow warm air across the plate while moving the hair dryer steadily back and forth across both sides of the plate.

Once we felt that the plate had cooled sufficiently from the hair dryer and was probably completely dry, the plate was placed in a light tight transfer box.

A 5 liter plastic beaker was filled with hot tap water at about 40C and 150ml each of Part A & B developer were poured into separate 250ml glass graduates which were then placed into the plastic beaker and left to warm up in the darkroom wetsink while we loaded and exposed the BB520 plate in the laser studio.

11:00pmish: Plate into plateholder, **Exposure #: 60-01-2020**, 8x10" BB520, emulsion facing the object. After loading the plate into the Data Optics plateholder, Type 235 ¼" black 3M photographers' tape was cut and applied along the top edge and two exposed side edges of the plate to eliminate internal reflections during exposure. (The technique John uses for determining the emulsion side (as opposed to the old "dampened lip" method) is to breath across the plate. The non-emulsion side will fog).

After plate was loaded, the table hood sides were closed, and we exited the laser studio. The plate settled for ten minutes. Returning to the laser studio, the plate was exposed for 2". After opening the hood, the type 235 tape was removed from the plate and the plate was unloaded into the light tight transfer box and taken into the darkroom.

Turning on a small darkroom worklight, a white Patterson tray was filled with filtered tap H_20 at about 22C for post-development pre-bleach rinse. The FeEDTA bleach was decanted into a white Patterson tray. The two 250ml glass graduates with Parts A & B of developer were removed from the heating beaker, &, with thermometer at the ready, combined into a white 8x10" Patterson tray. The developer immediately started darkening and was at 26C. Turning off the small worklight, John placed the plate emulsion up in the tray and within 20" the plate completely darkened. Total dev time from immersion to placing in the filled tray of still H_2O was 1'20". John estimated OD at about 2 and believed that the plate had been underexposed.
Total time with agitation in the tray of still H2O was 30" followed by a distilled H_2O spray to the plate emulsion and glass sides.
The plate was then immersed in FeEDTA bleach for total of 9'. Clearing time was 6' and the overhead lights were turned on.
The plate was then placed into a running filtered H_2O wash at 21C for 13' followed by a distilled H_2O spray to all sides of plate.
The plate was then rinsed in a tray of distilled H_2O with a few drops of photoflo.

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The plate was then squeegeed on the emulsion side only to remove excess water and wiped down and dried as mush as possible with blue shop paper towels to dry the glass side and plate edges.


John Wagner squeegeeing plate


JW drying plate with blue lint free shop towel

The plate was then completely dried using a small hairdryer.

Mar. 1:
12:05am: Laser 24C, Oasis 20.1/0C
12:08am: Laser turned to standby
12:28am: Laser off 22C, Oasis 20C

11:00am: New session: Ambient 18C. Oasis 160 on, started at 16.7C & oscillated to 22C & down to 18.5C & up to 20.5C & down to 19.5C & up to 20.1C and, after 3-4 minutes, stabilized at 20C.

Evaluation of 60-01-2020:
Besides the issue that there is a fringe in the upper right quadrant of the plate obscuring the image, the hologram is the brightest reflection hologram I've ever been involved in making.

As a side note, I hadn't made a reflection hologram in about 35 years. Of the thousands of holograms I made from the 1970s into the 1990s, almost all of them were some form of transmission hologram, either laser viewable or white light transmission of various types. Those holograms were almost all made on Agfa & Kodak silver halide plates and photo resist. I made about 50 small reflection holograms on 8E75 and 8E56 using D-19 and Mercuric Chloride bleach in the mid to late 1970s for General Mills Creative Products Group. In the early/mid 1980s, I experimented with the PBQ bleach regime on maybe ten plates of 8E56 which were reasonably good but not as bright or clear as this first image with John Wagner on BB520 plates.

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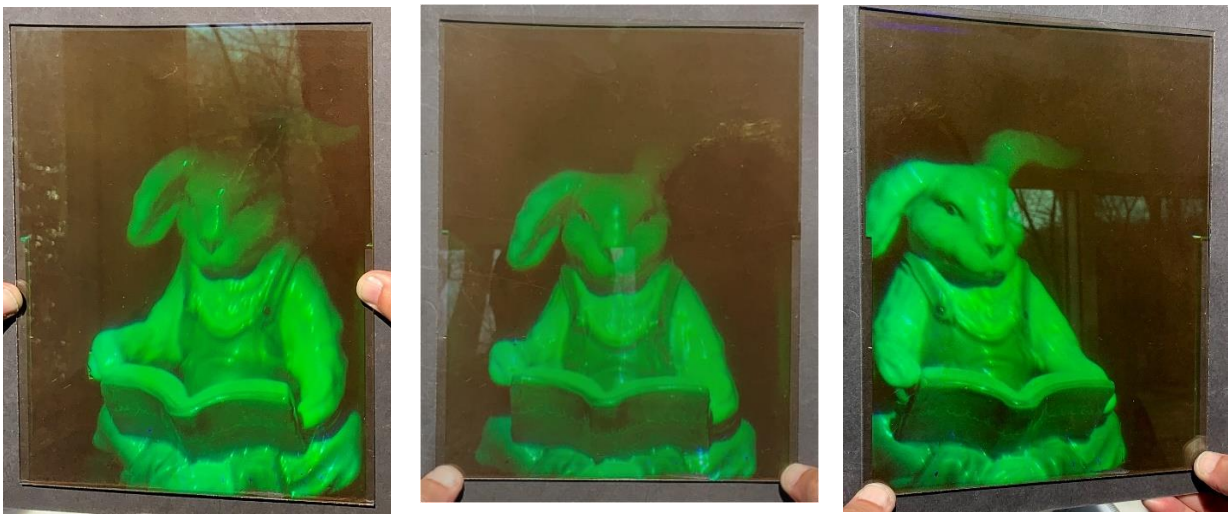
Mar. 1 (con't):



Note fringe in plate upper right quadrant by ear, exposure 60-01-2020

The fringe is clearly in the plate and not on the object otherwise we wouldn't be able to see the right ear of the rabbit when viewing the hologram from the left side.

Our analysis of the image and the setup led to five possible culprits in ascending order of difficulty to remedy. We decided to start with the easiest to fix. I had noted when putting the plate in, that it was a little loose in the plateholder. Additionally, only one of the three pieces of type 235 black tape were necessary to prevent internal edge scatter, the one along the top edge. So, we decided to tighten the plateholder and only use one piece of tape across the top of the plate to prevent the overhead reference from entering the edge of the glass plate.

Other possible sources of the fringe, in ascending order of difficulty to fix, were 1) incomplete drying or cooling of the plate from the 1% TEA pre-sensitization step, 2) incomplete tuning of the spatial filter pinhole and, 3) an interference fringe possibly generated by the first mirror in the setup.

A possibly detuned spatial filter pinhole would have been easy to fix without changing the setup although tedious since it involved using a step stool and leaning in awkwardly to the setup. A destructive interference fringe from the first mirror in the setup would have entailed realigning everything and taken a lot more time.

The evidence for a detuned pinhole appeared to be faint dark fringe fingers just outside the plate area. The evidence for a possible destructive fringe emanating from the first mirror was a fringe pattern on the anti-scatter iris just downstream from the mirror. When I traced the fringe back to the mirror, it seemed to converge inside the mirror which had a secondary spot at the back of the mirror. Since the mirror was a high quality first surface mirror coated for high power 457.9nm, it seemed possible that it was letting the 532nm light back out and mixing with the primary spot causing an interfering fringe in it.

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Mar. 1 (con't):

Fringe on downstream iris from first mirror

12:15pm: Oasis 20C.

2:59pm: Laser 25C, Oasis 160 20C. Light meter readings at plateholder plane: bottom 300-400µw, top 200-350µw, middle 350-500µw. Decided on 3" exposure for next plate since we felt that the first was underexposed. Set shutter time and tested.

3:15pmish: Unlike plate 60-01-2020, the 1% TEA solution was pre-heated to 30C since the darkroom ambient temp was about 18C. This was based on a note from Mike Medora that, below 18C, the TEA pre-sensitization might be ineffective. The 2' 1% TEA plate soak was followed by a bath in a tray of distilled H_2O with a few drops of photoflo to rinse out the TEA before using a more powerful hair dryer for drying the plate to ensure faster and more complete drying.

4:00pmish: Plate into plateholder, **Exposure #: 61-01-2020**, 8x10" BB520, emulsion facing the object. Only used one piece of type 235 ¼" black tape across the top of the plate. Ten minute settling time.

Prepared developer Part A & B as before except 200ml of each part; temp at 29C vs. previous 26C. Dev. time 1'10".
Still filtered tap H_2O 29C post dev. rinse for 30" followed by distilled H_2O spray 20C front & back.
FeEDTA bleach as before 20C, clear 6' total 9'. Overhead light on during bleaching.
Running filtered tap H_2O post bleach tray wash 24C for 15' followed by distilled H_2O spray 20C front & back. John estimated OD >2. Easy to see flashes of image while processing.
A distilled H_2O/photoflo tray rinse was the final step before drying with hair dryer.

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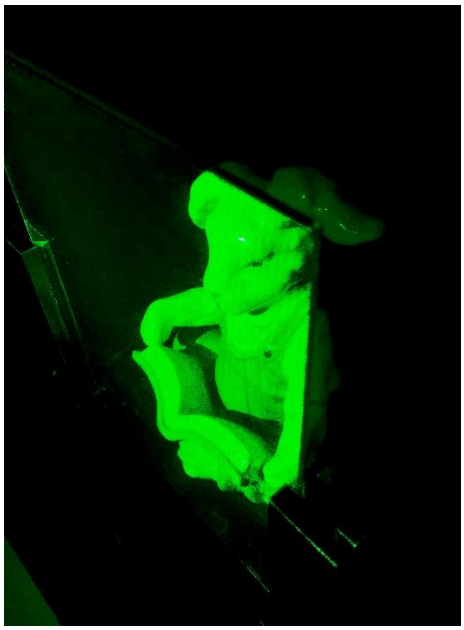
Mar. 1 (con't):
5:30pm: Laser 24C, Oasis 20C
6:14pm: Laser 24C, Oasis 20C

Evaluation of 61-01-2020:
Hologram is beautifully bright and clean, dramatically better than 60-01-2020.
When the hologram plate was placed back in the plateholder, a nice vertical fringe pattern was immediately visible across the object. Additionally, all velvet and light blocking cards were easily visible 35.5" deep in the virtual image (with plate blocked behind with an 8x10" black card flush to the back of the plate). More depth would probably have been visible if there had been no blocking cards in setup. The hologram is so efficient and so much of the laser light is going to the object that almost no light is passing through the plate to light the actual porcelain rabbit behind the plate. See photo just below right, upper right quadrant, to see dim "object ear" vs. bright hologram image.


Rabbit hologram making fringes with object


Rabbit image vs. object brightness (ear)

According to Ed Wesly, the ability of the Denisyuk hologram to make fringes in the hologram image when reconstructed with original object still in place behind it, indicates very minimal emulsion shrinkage during processing. In both holograms, we achieved very minimal emulsion shrinkage as demonstrated by this fringing, allowing the 532nm green laser light to make a bright green white light image.

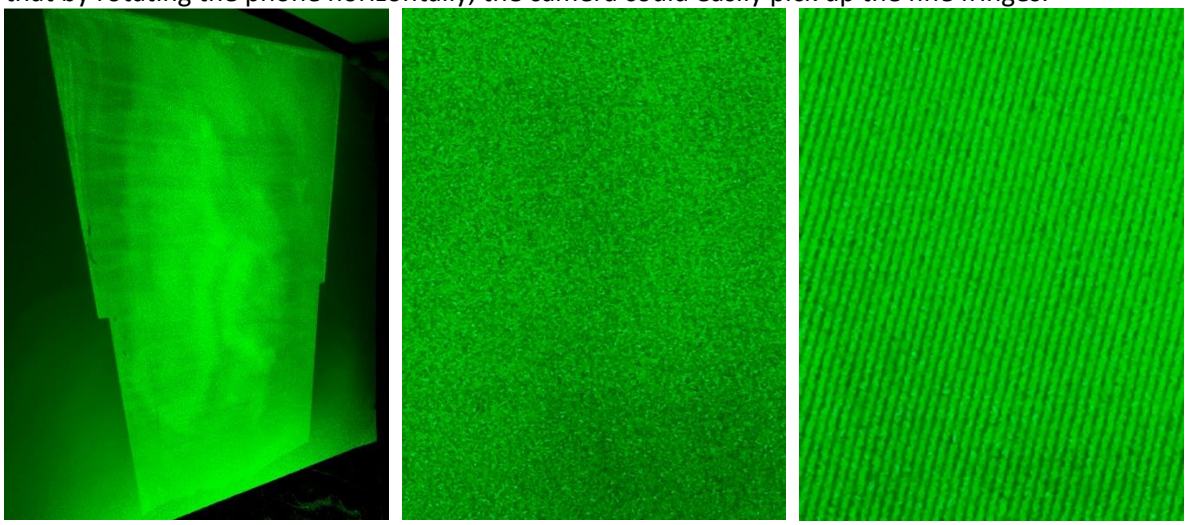
9:39pm: Laser 26C, Oasis "pump failure" message. Immediately turned laser to Standby and continued to let laser run. Luckily, must have caught it soon since the laser temp had only risen one 2C. It's possible that chiller pump was actually working but couldn't cope with additional heat in laser studio since I had turned up the studio heat about 8F after we stopped planned exposures. It was also possible that the chiller pump was working but had fallen below the minimum allowable threshold of 350ml per minute

of circulating coolant (max possible 450ml per minute. Also possible that the air temp inside the sound and vibration dampening chiller box got too warm.

9:42pm: Laser 25C
9:47pm: Laser 24C
9:49pm: Turned Oasis off
9:50pm: Turned Oasis back on and it cycled through it's temp oscillations to start up.
9:51pm: Oasis stabilized at 20C
9:53pm: Turned Laser on from Standby and it lased after two minutes.
9:54pm: Laser 23C, Oasis 20C
10:39pm: Laser 24C, Oasis 20C. Turned laser to Standby.
10:52pm: Laser 24C and turned it off, Oasis 20C.

Additional observations for this Denisyuk camera and BB520 plates:
We observed several interesting things not directly related to the hologram image.

First is that when laser light is reflected off the glass side of the hologram onto a horizontal white card, instead of the usual irregular and random woodgrain pattern reflected off the glass of most hologram plates, these BB520 plates have a very regular and closely spaced fine fringe pattern in addition to a fainter woodgrain pattern. That was true of both holograms. I speculated that the fringe pattern is a result of interference between the air/emulsion interface and, either the glass/air interface on the other side or the glass/emulsion interface. When I tried to photograph or video the fringes with my iphone in my usual portrait orientation, I was only able to get random pixilation of the image. John figured out that by rotating the phone horizontally, the camera could easily pick up the fine fringes.



Glass side reflected on white card Iphone pixelated portrait oriented & iphone same landscape oriented

Second, John observed and demonstrated a very interesting heat convection realtime visibility phenomenon. With the plate in the plateholder with the glass side facing the laser in it's recording position, a mirror virtual image is visible on the laser/glass side of the plate. When John placed his hand and iphone between the laser and the hologram, a clear realtime 2D shadowgram was visible on the surface of the plate. Recordability of heat convection patterns as shadowgrams has been known about

for decades but it was the first time I had observed realtime heat convection using the hologram as a "screen".

Related videos posted to YouTube:

Video of 60-01-2020 plate movement fringe in laser light: https://youtu.be/PxVQ93vla4I
Video of 60-01-2020 plate movement fringe in white light: https://youtu.be/TwtgrBoWndE
Video of 61-01-2020 with non-shrinkage fringes and object removal: https://youtu.be/uCrLeo-iZ_Y
Video of 61-01-2020 showing wide angle of Denisyuk view: https://youtu.be/YqrwY2o_Tro
Video of 61-01-2020 showing heat convection realtime visibility: https://youtu.be/g75l6scay5A
Video of 61-01-2020 showing white card reflected fringe pattern: https://youtu.be/KZyLGM-ZYgU