The Royal Photographic Society

# HOLOGRAPHY GROUP

## Newsletter August 1997

**Hologram kindly donated by Chris Levine/iC**

# Editorial

Once again the editorship of the Newsletter has changed. Changed back, really, as I was editor for the first two years of the Group's existence. There was a good deal more to write about in the early days, as the Royal College of Art's Holography MA course attracted many overseas artists, who were usually persuaded to address Group meetings on their work. Also, a lot of scientific work was going on at Imperial College and Loughborough University, and we caught some of the best overseas research workers such as Steve Benton and 'Hari' Hariharan. But over the years, as basic training facilities in universities and private studios became scarce, and purse strings tightened on research departments, the RCA's intake of qualified students dried up, and in 1996 its studios were finally closed. Visits by distinguished holographic artists and scientists are now rare, and Group meetings consequently fewer. However, the Group did recently have a visit from Mitch Henrion, a graduate of Steve Benton's Media Lab at MIT; a report on this appears in this issue. There has also been a successful exhibition of a large cross-section of the collection of Jonathan Ross, our long-suffering Treasurer, in the Members' Gallery at Bath. The permanent exhibition of holograms in the Octagon has proved a great success, with many visitors returning for a second and third viewing. These exhibits are due to be changed shortly, and there will be a new catalogue.

The heaviest blow yet to holography has been the decision by Agfa-Gevaert to cease production of holographic material. This has left most amateur holographers high and dry, and professionals with the choice of changing to polymers (which means bumping up laser power from milliwatts to watts and upgrading optical equipment to match) or going out of business. The rest of us will just have to be content with dichromated gelatin and very small holograms. However, all is not lost (see article in this issue).

After the success of last year's one-day symposium on creative imaging, a further meeting on similar lines is to be held at the University of Westminster's Regent Street premises. Details are given in the Newsletter and in the September issue of the Photographic Journal.

As the new editor, I would like to extend a hearty welcome to all our readers. Any letters, articles or other contributions will be very gratefully received. It is not unknown in other RPS Group newsletters for 95% of their content to be written by the editor. I don't want this to happen with ours. Apart from being undemocratic, it is hard work. I would much rather have my editorial task limited to adding commas, removing apostrophes and excising tautologies than be slaving away at a hot typewriter.

Graham Saxby

## Holographic exhibitions at the Octagon

Following the very successful exhibition of work by Holography Group members in 1995, another exhibition of holograms was mounted in the Members' Gallery in June, consisting of pieces from the collection of Jonathan Ross, the Group's treasurer. Nearly half of these were by RCA alumni such as Jeffrey Robb and Jon Mitton; others were by established artists such as Margaret Benyon and Harriet Casdin-Silver. The earliest piece in the display was Ruben Nunez's *Homage to Louis Comfort Tiffany*, a rainbow hologram of butterfly-like objects seeming to float in a glass bowl. This was made in 1976, and was one of the most inspiring exhibits in the great holography exhibition 'Light Dimensions' of 1983. Other notable images included a multiple self-portrait by Martin Richardson, a whimsical New York sequence made from a series of photographs by Patrick Boyd, a holographic stereogram by David Pizzanelli made from one of Eadweard Muybridge's 1890 *Studies in Human Locomotion*, one of John Kaufman's colour-manipulated studies of rocks, and a magnificent image of a bejewelled Russian egg in full natural colour by Hans Bjelkhagen. The comments book was unanimous in its approval, using adjectives such as 'fascinating', 'brilliant', 'amazing' and 'incredible'; also, many times: 'How are they made?' The exhibition has now closed, but anyone who was unable to get to Bath to see it, or would like to see more of this wonderful collection, should contact Jonathan on 0171-370 2239. The other exhibition is a permanent one, and is on the first floor of the Octagon in the oddly-shaped room which at one time housed the Leica Collection. It is staged by the Society and not by the Group, though we have, of course, had a hand in setting it up. At the time of writing it is due to be changed, and letters have been sent out to those people and companies we feel might be interested in exhibiting a piece or small panel. But if any of you out there would like to be represented but have not been contacted, please get in touch with Bob Gibson on 01703-252171. We are particularly short on industrial and medical holograms, but cannot show laser-read transmissions.

## Mitch Henrion addresses the Holography Group

On 28 April Michele (Mitch) Hendrion gave a talk to the Group about her research work in holography. She holds a Master's degree from MIT for research in display holography with the Media Laboratory, and now works for Northeast Photosciences Inc. in New Hampshire. She was also connected with the Holos Corporation.

Mitch began by talking about her research into edgelit holograms. These are recorded on glass plates with the reference beam entering the emulsion through the edge of the plate. There are several recording methods, including an optically-matched glass block, a prism or a tank of index-matched fluid, the optical principles in each case being somewhat different, but all producing Bragg interference planes of a type similar to those in a reflection hologram. The big advantage of such holograms is that they can be displayed with an integral white-light source in the base.

The second part of the talk was devoted to the Holos Corporation's work on full-colour silver halide holograms made using three lasers and a Russian panchromatic emulsion. Holos had, she told us, in fact ceased operations only the week before, but efforts were being made to form a new company with similar aims, Mitch showed a superb full-colour hologram made using this technique, as well as some excellent single-colour mass-produced photopolymer holograms.

Mitch concluded by describing the holography-based research at Northeast, including diffractive optical elements (DOEs) for solar power generation, architectural and greenhouse DOEs that track the sun and seasonally transmit (or reflect) IR radiation. More interesting to practising holographers is the development of spatial filters that do not require lenses or pinholes. These are basically ultrathick (1 mm or more) Bragg holograms which are direction-sensitive to less than a milliradian, and thus filter out any part of the beam diffracted by optical imperfections in the beam path.

Mitch would be happy to give any further information if you contact her by phone on 617-547-1818 or fax 617-547-1717, or write to Northeastern Photosciences Inc. at Flagg Road, Hollis, NH 03049, USA, phone 603-465-3361, fax 603-465-2859, e-mail 71053.3526@compuserve.com.

## After Agfa – What?

The withdrawal of Agfa-Gevaert holographic materials has been as much of a blow to holographers as it would be to photographers if all Western production of colour film were to cease simultaneously. Companies whose livelihoods depended on a steady supply of silver halide film have been forced out of business: professional holographic artists as well as amateur holographers have been left high and dry. Even Agfa's promised 'last run' seems to have been aborted. The company has been accused of behaving irresponsibly and even unethically. Agfa's (unofficial) response appears to be that holographic materials production has brought them nothing but grief. There are no small coating lanes left in operation, and to set up a large coating plant for a comparatively short run is uneconomical: moreover, the starting-up wastage represents a substantial proportion of the total batch output. In addition, triacetate base material is becoming increasingly scarce.

Now, you may believe (as I do) that by its action the company has probably done its worldwide reputation more harm than if it had kept up its production and explained to its shareholders that the prestige involved in supporting minority interests outweighed any small financial loss. The most likely picture, it seems to me, is that holographic emulsion production was an irritation, a small tick bothering a very large animal.

All is not lost. Some optimists feel this may be the beginning of a new era for holography. There are other materials available, and without exception they produce brighter and less noisy images than Agfa material. The less good news is that they are anything from one to three magnitudes less sensitive to light, so you may find yourself having to upgrade your laser. SPIE's Holography Working Group publishes a twice-yearly newsletter, and has devoted its latest issue entirely to the subject of alternative materials, with articles by representatives of all the main manufacturers. The information is summarised below.

The Slavich Company of Moscow manufactures four emulsions, PFG-01 (HeNe and ruby), -02 (HeNe, DPSS and Ar), -03 (HeNe only) and -03c (RGB, for colour). PFG-01 is almost as fast as Agfa; the others are 15-20 times less sensitive (about 3 $mJ/cm^2$), but the resolving powers and signal-to-noise ratios are very high. You can use standard rehalogenating processing methods (after prehardening) but the Russian colloidal-silver system is better, albeit with a colour shift towards blue. The address of the parent company is Slavich Joint Stock Co., Micron Branch Co., 2 pl. Mendeleeva,152140 Pereslavl-Zalessky, Russia. Tel 7-085 352-24-65. Fax 7-085 352-25-60. e-mail ivc@slavich.botik.ru. The European agent is Holography Center Austria, Kalenbergstrasse 6, A-3042 Wuermla, Austria. Tel 43-(0)2275 8210. Fax 43-

(0)2275 8210-5. The material is available only as plates, sizes 4 X 5 and 8 X 10 in, and 28.8 X 40.6 and 60.9 X 81.2 cm.

The Royal Holographic Art Gallery of Victoria, British Columbia, is proposing to distribute a new silver halide material called Red Star. This will be coated on triacetate film base and will initially be suitable for HeNe, Kr and ruby lasers. The sensitivity is around 3 mJ/cm$^2$, about 30 times less sensitive than Agfa, though it is hoped to raise the sensitivity for the production runs. The material is suitable for colloidal-silver development, and it is claimed that there is no colour shift with this method. The address is The Manager, Royal Holographic Art Gallery, 122-560 Johnson Street,. Victoria, BC, Canada V8W 3C6. Tel/fax 250/384-0123.
e-mail royal@islandnet.com. http //www.islandnet.com/-royal/film.htm.

Richard Birenheide of HRT Holographic Recording Technologies GmbH of Steinau, Germany, has developed a silver halide emulsion in collaboration with Jeff Blyth. There are four types: BB-640, -520, -450 and -PAN, with respective maximum sensitivities to red, green, blue and RGB. The sensitivities are 0.1 – 0.15 mJ/cm$^2$, a little less than Agfa material. At present the emulsion is available only on plates. Birenheide is trying to find a company prepared to coat the emulsions on film, but this will probably have to be polyester base. The address is: HRT Holographic Recording Techniques GmbH, Am Steinaubach 19, 36396 Steinau, Germany. Tel 49 6663-7668. Fax 49 6663-7463. e-mail hrt.birenheide@t-online.de. URL http: //home.t-online.de/home/hrt.birenheide.

Richard Rallison of Paradise, Utah, makes HOEs to special order, using DCG, (dichromated gelatin) and makes out a strong case for its use in holography. In its basic form it uses only purified gelatin and ammonium dichromate. In this form it is sensitive only to blue light, but Jeff Blyth has developed a method which not only sensitises it to red, but increases its sensitivity to around 5 mJ/cm$^2$ (Jeff’s mnemonic: 5 min for a 5 cm disc with a 5 mW laser ). Details of making, exposing and processing the emulsion are too long to give here, but you can find full instructions in my books ‘Manual of Practical Holography’ (Focal Press) or ‘Practical Holography’ (Prentice-Hall), the latter giving greater detail. The main snag about DCG is that the finished hologram must be totally protected from moisture, usually by sealing it with a cover glass and UV-curing cement.

Holography companies remaining in business have mostly turned to Dupont photopolymer material. Its advantage, apart from its very bright images, is that there is no wet processing, merely an exposure to UV light to fix the image. All four available film types are sensitive to blue and green, but Omnidex HRF-800X 001-15 is also sensitive to red (5 mJ/cm$^2$ at 647 nm). Colour changes are made by laminating the exposed emulsion to a 'color tuning' film and baking.

This swells the hologram, shifting the image towards red in a controllable manner. Diffraction efficiency is close to 100 per cent in photopolymer holograms. The main disadvantages are slow speed (200 times lower than Agfa), high reciprocity failure (10 mW lasers are useless), and the polyester base, which, being optically active plays havoc with the polarisation of the beams. However, you can avoid blotchy reflection images in three ways: (1) set up the film in a diamond format, (2) use a quarter-wave plate in the reference beam, or (3) strip the emulsion on to a glass plate (not too difficult with this material), One big advantage of Omnidex material it that its surface is very tacky, and you can squeegee it directly on to glass without using index-matching fluid. Richard Rallison notes that waste films make excellent flypaper.

Film is available in commercial quantities direct from Dupont in A4 size sheets or 12.5 in X 500 ft rolls. Smaller quantities of Omnidex 706 (blue and green sensitive) are obtainable in Europe from the following address: Holographic Systems Munchen GmbH, Wiegenfeldring 2a, D-85570, Markt Schwaben, Germany. Tel 49 8121 93000. Fax 49 8121 930099. Further information can be obtained from Paula Bobeck, Dupont Holographic Materials, Building 352, Dupont Experimental Station, Wilmington, DE 19880-0352 USA. Tel 302-695 4983.

Well, there you have it. My guess is that in future holographers will be buying DPSS (diode-pumped solid-state) frequency-doubled lasers in future. These emit green light at 532 nm. They run off an ordinary wall socket, run cool, have a coherence length of tens of metres and last for ever. The best ones for holography are made by Coherent. They still cost over £10000 for 75 plus milliwatts, but are already competitive in price with argon, and are getting cheaper. It is worth looking for secondhand Adlas DPSS lasers (Adlas was absorbed by Coherent). The maximum power available at present is some 5 watts. There are DPSS pulse lasers of about 3 joules, and they can also be strobed.

Finally, I understand that Agfa-Gevaert is continuing production of their Millimask material. What is Millimask? It is a high-resolution green-sensitive plate designed for microlithography (masks for making microchips). The emulsion type? Yes, it's 8E56.

Graham Saxby

## Department of partly-baked ideas

For several years I was a corresponding editor for *holosphere*, the much-mourned newsletter of the New York Museum of Holography. I wrote a regular column of British holographic news 'Jottings from the UK', finishing with a report from the fictional Department of Partly-Baked Ideas (DPBI). These tended to be whimsical ideas for hypothetical inventions, but they generally had a fairly sound theoretical basis. On re-reading these articles recently I was struck by the number that had proved to be prophetic in some way. So I thought it would be worth while to repeat a few of them in our newsletters, with comments and updates. Here is the first of them, from the Summer 1983 *holosphere*, slightly abridged.

One is often struck by the exaggerated perspective in transfer holograms, particularly in large real-image rainbows. Nobody seems to have looked into the reasons for this. [In fact, Stephen Benton had outlined some of the geometry concerned in an early paper on rainbow holograms, but for a different purpose.] The central clue is that a hologram of a single point is a zone plate, which behaves exactly like a lens or a focusing mirror. Now, an extended object is simply the sum of a very large number of points in various positions in space, so each point is at the focus of its zone plate, and the fundamental lens (or mirror) law $1/u + 1/v = 1/f$, where $u$ and $v$ are the object-point and reference source distances respectively (the latter is infinite for collimated reference beams), $f$ is the focal length of the zone plate. When the hologram is illuminated from a finite distance the image of the point changes its distance from the hologram in accordance with the lens law. If the hologram is real-image, the image is magnified laterally in the proportion $v/u$, and 1ongitudinally in the proportion $v^2/u^2$. [Proof omitted].

Now, it is common practice to illuminate a master hologram with a collimated reference beam, but to use a divergent reference beam for the transfer hologram. The reference source distance is the $v$-value and the points on the projected master image are the various $u$-values. This hologram is now flipped for display under a beam which is also diverging (it should be converging, for a correct reconstruction). If the same source distance $v$ is used, $v$ becomes minus-$v$ in the lens equation. With the usual kind of subject depth there is an exaggeration of perspective of some 30 per cent [calculation omitted], resulting in noticeable image distortion. Portraits, in particular, look like photographs taken close up with a wide-angle lens...

Not long after I wrote this the quality of display holography had improved to the point where these distortions had become intolerable, at least in representational imagery, and serious holographers were beginning to collimate their transfer

reference beams, or at least use a long throw. Full correction, however, demands a *converging* transfer reference beam, the conjugate of the display beam.
The problem was the requirement for a very large short-focus reference mirror. I took up this problem in my own lab, and eventually presented a paper on the subject at the Fourth Lake Forest Symposium showing a number of possible solutions. At the same session Peter Waddell caused something of a sensation when he demonstrated his prototype vacuum- operated flexible zoom mirror (the ideal solution). This mirror is undergoing further developmental research. If you would like a copy of the paper, contact me on 01902-341291.

Graham Saxby



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The Creative Displays conference that was to have been held on October 18th has been postponed, and will now take place on a date to be announced in the Spring of 1998.

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