A NOVEL APPROACH TO COLOUR PROCESSING

by Jeff Blythe

The process described below allows one to change the color of a reflection hologram by exposing it to white light, followed by a development and bleach step.

This method produces remarkably noise-free and bright holograms replaying in yellow. It also offers artists an interesting way of using photography to modulate the color of a hologram by using negative masks or projected images.

Since the idea has potential in the security field to create unforgable holograms by mass production methods, worldwide patent applications are pending. Those interested in the science of processing holograms will be intrigued by some unexpected subtleties that this method offers.

The essence of the process is as follows:

1. Produce a red reflection hologram using a special rehalogenating bleach, while maintaining safe-light conditions.

2. Expose this hologram to white light (eg. Wotan spot lamp) for under half a minute.

3. Re-develop hologram in standard holographic developer.

4. Bleach in standard solvent dichromate bleach.

The first bleach leaves the emulsion still remarkably light sensitive (about one hundredth that of the virgin emulsion); the white light exposure makes the silver-halide partially redevelopable. The silver produced by this second development is then totally removed by solvent bleach. Thus, with some of the silver halide removed, the original fringe spacing of the red hologram has contracted, and the replay color shifts to a shorter wavelength.

The subtlety lies in the question: which silver halide has been removed? Is it the remaining virgin silver halide put in originally by the emulsion manufacturer and not developed when the hologram was first made? Or is it the "secondary" silver halide produced when the rehalogenating bleach was used?

These are not academic questions, because once you start playing around with this process you will find that a mild amount of second development and hence final contraction can produce an impressively clean and noise-free hologram replaying in the yellow or yellow-green region.

If, however, the second development is considerable, then the final hologram is a dull, dark green. There is no doubt in my mind that in the second case one has eaten into the essential halogenated material in the fringes. The noise reduction in the first case may either be due to virgin silver halide lying untidily outside the rehalogenated fringes that has been removed preferentially, or the result of any filamentary growth on the fringes being neatly etched away. (Fringes having their whiskers shaved off!?)

The formulation details are:

Developer

Stir into roughly 700 ml water:
70g Anhydrous sodium carbonate (or 160 g of the decahydrate)
20g Sodium Hydroxide
5g Metol
40g Ascorbic Acid
Top up to 1 litre

1st Bleach (Rehalogenating)

Stir into about 700 ml (tap) water:
10 ml Acetic Acid
35g Copper sulphate crystals (pentahydrate)
110g Potassium bromide
Top up to 1 litre. (Store above 17deg.C)

This combination should give red reflection holograms, but may tend toward orange if the exposure is made at high humidity or with a soft emulsion. However, after a test piece is done, other tests have to be kept in safelight right through the bleaching step (although this light can be brighter than usual since the bleached emulsion seems to have about a hundredth of the sensitivity of the virgin emulsion).

After being gently dried, the hologram is given its white light exposure through a negative mask by exposing, for example, for 10 seconds one foot away from a 20-watt Wotan spot lamp or for about 20 seconds from an ordinary 100W bulb. This is assuming that the negative mask is not of a variable tone (discussed later). I recommend tests first be made with simple shapes covering large areas of the hologram.

The hologram is then put back in the developer. The amount of development then needed can be easily monitored under safelight, preferably with a Kodak density strip held up at the same time. Development needs some trial and error testing. For example a density of 0.5 can change a once-red area to an interesting bright lime green in the final result. Densities of the order of 1.5 are definitely "over the top".

The final step is to simply use ordinary solvent bleach (distilled water rinsing immediately before and after solvent bleaching).

Solvent Bleach

5g potassium (or ammonium) dichromate
35g sodium hydrogen sulphate
Made up to 1 litre.
(Any other pet solvent bleach system will do.)

Tone Range

One seems to be restricted to a range of wavelengths between red and mid-green, or its equivalent spread higher up the scale. I have not managed to get to the blue (starting with a red hologram). A turquoise-green originating from a fringe spacing once replaying in red has poor diffraction efficiency because the fringes are perhaps too eaten away. This does limit the effect of using continuous tone masks. The best tone range seems to be helped by not taking the density up to its maximum when the hologram is first made.

The fact that the system works best in terms of range if the original development is subdued somewhat supports the idea that the remaining virgin silver bromide develops first during the second development step. However, a hologram thoroughly developed in its first stage can still benefit in quality from an overall second exposure and very mild development to a density of, say, 0.2.

Footnotes

1. British Patent Application No. 8422393

2. Proc. International Symposium on Display Holography Vol.2, p. 326