AGFA-GEVAERT

PHOTOGRAPHIC MATERIALS FOR HOLOGRAPHY

Agfa-Gevaert's Scientia range of materials is a long list of scientific recording films and plates rather on the line of Kodak special order materials, some of these cease production because their function is superseded by other recording methods, either direct imaging systems such as television or computer compatible digital systems. Some gain the "respectability" of having their name changed and start up a whole new generation of materials such as the Datarex range for COM recording.

Some Scientia emulsions are produced for one single use such as the Bubble Chamber films, for high energy research, others for transmission Electron Microscopy and for the Spectroscopic analysis of impurities in metal refining, fulfill an every day function in industry and research. There have been Scientia materials for Ultra Violet and for Infra-red photography, for Auto-Radiography and Astronomy, for stress analysis, mass spectrometry.

The systems of coding these materials sometime confuses people but is very simple. The first part is the speed, (originally 2.2 x the log DIN speed, but now only indicating which materials are faster or slower than others in the range).

The letter in the centre of the code refers to contrast. 'A' being the lowest contrast and 'E' the highest contrast.

And the last two digits refers to the longest wave-length to which each emulsion is sensitive: 50 being 500nm, 56 up to 560nm, 75 up to 750nm and so on, thus 67A 50 would be a fast low contrast emulsion only sensitive to blue: 45C 62, not quite so fast, but with higher contrast and sensitive to blue. green and red. While 10 E 75 now called Holotest 10 E 75, but originally part of the Scientia range, is by normal photographic standards a slow very high contrast materials with spectral sensitivity extending even slightly beyond the upper red limit of the human eye.

The originals of the Holotest range of materials is interesting in itself. The 10E materials were developed from an emulsion used for high resolution optical Microscopy and Spectography and the very much higher resolution 8E films and plates were developed along with a parallel range of materials for the Micro Electronics industry for the production of integrated circuits. These early materials were only sensitive to the blue and green area of the spectrum up to approximately 560nm, but through the work of two brilliant chemists specialising on dye materials, special senstitising dyes were incorporated in these materials which not only extended their sensitivity into the far red end of the spectrum to cover the line the He Ne. lasers and later for Ruby, but did it without deterimental effect on the image quality or more important scatter of the light within the emulsion, this is an extremely difficult result to achieve and many attempts to do this on other materials have achieved far less satisfactory results. These new emulsions were called 8 E 70 and 10 E 70. One other material 14 C 70 was also produced as a high speed Holographic recording film for Non-Destructive Testing, but this proved to be un-necessary when improvements to 10 E 75 with its superior contrast and grain size proved to be much more suitable for this field of work, and so the 14 C 70 was discontinued. Then with the increasing potential of Ruby lasers for Holography new materials 8 E 75 and 10 E 75 were brought out in parallel with the 8 E 70 and 10 E 70 materials. Later they superseded these earlier materials when the dyes were modified to make them equally suitable for both 633 and 694nm.

In 1973, to stress Agfa-Gevaert's confidence in the future of Holography as a recording technique it was decided that the materials for Holography could stand on their own, apart from the Scientia range and the name Holotest came into being. A year later 8 E 56 was added to the range because of the increasing use of Argon Ion Lasers. More recently the grain size of 8 E 75 and 8 E 56 materials was further reduced from 50nm to 35nm and the suffix HD was added indicating the improved high definition characteristics, this considerably increased the maximum defraction efficiency attainable with these materials.

In the early days of Holography all development work was based upon Laser Lit Transmission Amplitude Holograms as this was the type most frequently used, and indeed still is in Non-Destructive Testing, which is by far the largest market for Holographic materials. It was in this area that most research was conducted. Theoretical calculations at about this time concluded that to produce White Light reflection Holograms would require emulsion of at least 15 microns thickness to record sufficient Bragg planes, and so a range of materials satisfying these conditions was produced, these were given the letter 'B' for Bragg as a suffix, but the compromise between producing an emulsion which was hard enough to maintain its mechanical integrity at this thickness, while not being so hard that it was impossible to develop the multiple Bragg Plane images evenly through the thickness of the emulsion, proved to be unatainable. However, as we now know practical work has tended to modify theoretical considerations and as processing techniques improved, so the quality of Holograms obtainable with a conventional thin emulsion of about 6 or 7 microns thickness improved to the standard which we see displayed here this week.

Without any doubt, more Holograms are produced with Helium Neon lasers than any other type, and I am finding in the U.K. that although $^1/_2$ to 1 milliwatt lasers are still the most common, and are used in a great many schools to introduce students to Holography. There is a move towards 10-25 milliwatt Helium-Neon lasers with which an increasingly high standard of Holograms even up to 30x40cm is being produced. Most notably multiple image and Denisyuk Holograms displaying a high standard of originality and technical excellence.

However we now have a situation where many different types of lasers are being used for Holography. Helium-Cagmium, Krypton and Argon Ion, Ring dye lasers, Pulsed Ruby and even Frequency doubled Neodynium YAG which falls nicely in the green.

This leads us to the present range of Holotest emulsions which consist of the two fast emulsions, 10 E 56 and 10 E 75 which are ideal for any applications where amplitude Holograms are required, and the 8 E 56 HD and 8 E 75 HD emulsions which, because of their very much smaller grain size, are much more suitable for the production of phase Holograms, where the bleaching process is likely to change the physical size or characteristics of the silver halide.

Many types of photographic emulsion particularly in the graphic arts and X-Ray fields are produced in such large quantities that coating machines up to 2m. wide may be running 24 hours a day coating nothing else.

As you have probably realised this does not apply to Holographic materials which are produced in very much smaller batches as and when needed rather than on a continuous basis. With film these are then stocked as master rolls, so that they can be cut to sizes required with as little delay as possible.

But of course plates cannot be coated in any continuous line in the way film is. Agfa-Gevaert coats Holotest plates on two coating lines to twelve different specifications, each of which requires time consuming adjustment to the coating plant between batches. Although there are only four different emulsions, each is coated on three different glass thickness depending on the size to which they will be cut.

So you can perhaps begin to understand why it is only possible to stock the most commonly used films and plates in a limited range of sizes. The factory in Antwerp lists no less than thirty separate items in their assortment which they are prepared to supply without making special coatings, but no one country, let alone one stockist can justify keeping all thirty combinations on the shelf, and the problems of supply then becomes the classic 'Chicken and Egg' situation. No stock therefore no sales. No sales therefore no stock.

Perhaps a range of ten items, always in stock would help to solve this problem. I hope you will give me your own ideas on this.

There have of course been no standards laid down for the sizes of films and plates for Holography and so the sizes used in other industries have tended to be accepted. Outside the United States this has tended to mean a move towards metric sizes, but because of the enormous size of the U.S. market in the closely allied fields of Micro Electronics and conventional photography the inch sizes have tended to remain in existance, at least on the small sizes up to 8" x 10". For the larger sizes Agfa-Gevaert have tended to use metric measurements simply because the proportions of 30x40cm and 50x60cm seemed most convenient. I know that $11^{3}/_{4}$" x $15^{3}/_{4}$" seems a little odd but I don't think that 11" x 14" has any historic justification either and we are looking at the possibility of increasing the standard size at least of glass plates to $12^{1}/2$"x$16^{1}/2$" that is 32x42cm but dropping any larger sizes as there has been diminishing demands for these since other users of large glass plates notably the Cartographic industry, have moved over exclusively to film. Agfa-Gevaert are at present in the process of rebuilding the plate coating facility at their Antwerp factory to increase the capacity of this plant and this should then be able to cope with the growth in the requirement for Holographic plates for the foreseeable future, however it will not then be possible to justify coating plates on two separate plants and so it is intended in June, 1983, to close down the large plate coating plant which at the moment is producing materials 50x60cm and larger. We would anticipate that stocks of these sizes would remain available for two or three years after this plant is closed and feel that by then the present developments there are on the production of Holograms using pulsed lasers, that the use of film for these large sizes, which is so much more economical for everyone concerned, would probably make the continued use of plates in these large sizes very un-likely. All four of the Holotest emulsions have been produced on film although of course the red sensitive emulsions, because of the far greater demand for them, are the ones most readily available.

Looking to the future, tests have already been conducted on Holographic materials with a grain size of approximately half the present minimum grain size, and also materials sensitive to red, green and blue wave lengths so that true three colour Holograms will be able to be produced at some time in the future, when the technical problems of doing this have been over come, notably the problems associated with ring dye lasers.

Also, if the problem of the bi-refringency of polyester affecting polarisation were to prove insuperable then the option of an alternative film base is not outside the realm of possibility. The thickness of the emulsion and the silver gelatine ratio are those found to be most suitable for present day techniques, but these too could be modified if future developments so dictated. But any of these changes would only be made if my colleagues in the Marketing Department are convinced that there is a valid commercial market for these products. Over the past fifteen years Agfa-Gevaert have spent a lot of time and money on research into Holographic recording materials, and I can assure you that if the market justifies it, then this research will continue to produce new materials which will keep pace with the development of new techniques and technology for the production of better and better Holograms.

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