United States Patent

De Belder et al.

[15] **3,652,280**

[45] **Mar. 28, 1972**

[54] LIGHT-SENSITIVE SILVER HALIDE EMULSION WITH HIGH RESOLVING POWER

[72] Inventors: **Maurice Hector De Belder**, Mechelen; **Rene Omer Duville**, Edegem; **Herman Adelbert Philippaerts**, Mortsel; **Theofiel Hubert Ghys**, Kontich; **Henri Depoorter**, Mortsel, all of Belgium

[73] Assignee: **Gevaert-AGFA N.V.**, Mortsel, Belgium

[22] Filed: **Dec. 8, 1969**

[21] Appl. No.: **883,235**

[30] **Foreign Application Priority Data**

Dec. 11, 1968 Great Britain 58,844/68

[52] **U.S. Cl.** **96/64**, 96/94, 96/2

[51] **Int. Cl.** **G03c 5/24**, G03c 1/02

[58] **Field of Search** 96/2, 64, 94, 102, 84

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

699,375 1/1967 Belgium 96/2

Primary Examiner—Norman G. Torchin
Assistant Examiner—Richard E. Fichter
Attorney—Brufsky, Staas, Breiner & Halsey

[57] **ABSTRACT**

Lippmann silver halide emulsions comprising a hydrophilic colloid are provided which contain at least one light-absorbing dye that absorbs light of the wavelength used for the exposure of the said emulsions and that is decolorized and/or removed in at least one of the photographic processing liquids, characterized in that the said absorbing dye is present in such an amount that per micron of emulsion layer thickness a density of at least 0.05 and at most 0.14, preferably comprising between 0.08 and 0.12, measured in the spectral region of the exposure light, is obtained. The emulsions have high resolving power and acutance, and are suitable for both reversal processing and negative processing.

17 Claims, No Drawings

LIGHT-SENSITIVE SILVER HALIDE EMULSION WITH HIGH RESOLVING POWER

The present invention relates to novel photographic materials comprising silver halide emulsions, more particularly Lippmann emulsions.

Lippmann emulsions are of particular importance for the preparation of photographic plates or films used as masks in the production of microelectronic integrated circuits. For this purpose drawings are made on highly enlarged scale of the various successive masks necessary to produce one integrated circuit (IC) whereupon the drawings are reduced, if necessary in successive steps, and reproduced on a photographic plate or film material forming thereby the mask ready for use. By various photographic and chemical steps (photo-etching of lacquered plates) the images of the masks thus produced are transferred to the surface on which the integrated circuit is to be made, in order to produce the required circuit elements. The photographic materials for use in this process should have a high resolving power and acutance, and allow a correct reproduction of the dimensions of the image.

It is well known that the quality of reproduction depends on the scattering and reflection of light within the photographic material.

In the manufacture of photographic materials for use in silver halide emulsion systems it is common practice to apply to the support an antihalation backing comprising a light-absorbing dye by means of which the influence of reflection is reduced.

The presence of an antihalation backing in light-sensitive materials often poses a number of difficulties. Indeed, the application of an antihalation layer requires an additional coating step and in addition thereto, such an antihalation backing is highly subject to mechanical damage and scratching, particularly in the case of glass supports.

In order to avoid the use of an antihalation backing in photographic materials with Lippmann emulsions and to retain good detail reproduction it has been proposed in Belgian specification Pat. No. 699,375 to incorporate into said emulsions at least one light-absorbing dye known for use in ordinary photographic emulsions, said dyes being chosen so as to absorb light of the wavelength to which the material is exposed, and in such amounts that per micron of layer thickness a density of at least 0.15 measured in the spectral region of the exposure light, is obtained.

Materials of the kind described in the above Belgian patent specification give satisfactory results on negative processing. It is however highly desirable that said materials also show a high acutance on reversal processing. Indeed, it is often difficult to position a mask produced by negative processing into register with integrated circuits, to which the images of previous masks have already been transferred, when image-details of the latter masks are smaller in size than the black image-details of the negative mask and thus are entirely hidden by the said black image-details. Proper registering can be achieved in these instances by the use of masks produced by reversal processing because the black image areas of the mask obtained on negative processing are fully transparent on reversal processing.

The materials described in the above Belgian patent specification were found to be unsuitable for reversal processing in that the acutance of the direct positive images obtained is rather poor as compared to the acutance of the negative images obtained on negative processing; the width of the image-lines is no longer truly reproduced but enlarged by lateral diffusion.

This is rather surprising since it is generally accepted that the reduction of the lateral light-diffusion, resulting from the presence of light-absorbing dyes, has the same beneficial effect on the sharpness of photographic layers on reversal processing as on negative processing.

It has been discovered that, in the particular case where high-resolution materials are used for reproducing details whose dimensions are comparable to, or smaller than, the emulsion layer thickness, the presence of light-absorbing dyes in concentrations as described in the above Belgian patent specification has an unfavourable effect on the reproduction quality of said details when reversal processing is applied, in that a considerable line-broadening is noticed.

Measures taken to adapt the emulsion characteristics or varying the bath compositions in order to influence the sensitometric properties of light-sensitive materials of the kind described did not give satisfactory results as regards the broadening of image details with the above dimensions on reversal processing.

It has now been found that high-resolution materials comprising Lippmann emulsions, i.e., silver halide emulsions the average grain size of which is at most 0.1 μ, give satisfactory results upon reversal processing, even when image-details are involved having dimensions comparable to or smaller than the emulsion layer thickness, provided the amount of light-absorbing dye is markedly reduced.

In accordance with the present invention Lippmann silver halide emulsions comprising a hydrophilic colloid are provided which contain at least one light-absorbing dye that absorbs light of the wavelength used for the exposure of the said emulsions and that is decolourized and/or removed in at least one of the photographic processing liquids, characterized in that the said absorbing dye(s) is (are) present in such (an) amount(s) that per micron of emulsion layer thickness a density of at least 0.05 and at most 0.14, preferably comprised between 0.08 and 0.12, measured in the spectral region of the exposure light, is obtained.

Upon coating of the Lippmann emulsions according to the invention on a suitable support, e.g., a glass plate, a photographic material is obtained with high resolving power and high acutance with which a true reproduction of image details can be obtained on reversal processing, even when the image details have dimensions comparable to or smaller than the emulsion layer thickness.

Though the emulsions according to the present invention are particularly suitable for reversal processing, the loss of acutance when subjecting the said emulsions having such low content of light-absorbing dye to negative processing is immaterial, so that they can also be used for negative processing. Therefore, in accordance with the present invention Lippmann emulsions with high resolving power and acutance are provided that are suitable for both reversal processing and negative processing.

The thickness of the emulsion layer of a photographic material according to the present invention is generally comprised between about 3 μ and about 8 μ and the average grain size of the silver halide grains is generally less than 0.08 μ. The ratio of silver halide to hydrophilic colloid binder in the Lippmann emulsions according to the present invention is preferably at least 1:2 and at most 4:1.

The hydrophilic colloid used as the vehicle for the silver halide may be any of the common hydrophilic colloids employed in photographic light-sensitive emulsions for example, gelatin, albumin, zein, casein, alginic acid, collodion, a cellulose derivative such as carboxy methyl cellulose, a synthetic hydrophilic colloid such as polyvinyl alcohol and poly-N-vinyl pyrrolidone, etc. If desired compatible mixtures of two or more colloids may be employed for dispersing the silver halide.

Various silver salts may be used as the light-sensitive salt such as silver bromide, silver iodide, silver chloride, or mixed silver halides such as silver chlorobromide, silver bromoiodide and silver chlorobromoiodide. Silver bromoiodide emulsions having a iodide content of at most 8 mole percent and a grain-size of at most 0.08 μ are favoured.

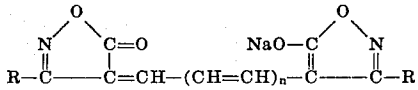
The light-absorbing dyes of use according to the present invention should meet the demands that are normally required for such dyes. They should have practically no fogging action and their effect on the inherent sensitivity of the light-sensitive emulsion should be as low as possible. They should have good absorption characteristics with regard to the exposure light chosen. Further, they should readily be rendered ineffective,

i.e., decolorized or destroyed and removed in at least one of the photographic processing liquids.

The light-absorbing dyes for use according to the present invention may be any of the light-absorbing or filter dyes customarily employed in photographic light-sensitive materials. These dyes may belong to the most varying classes of dyes such as the class of the oxonol dyes, the class of the arylidene dyes, the class of the styryl dyes, the class of the triarylmethane dyes and the class of the azo dyes.

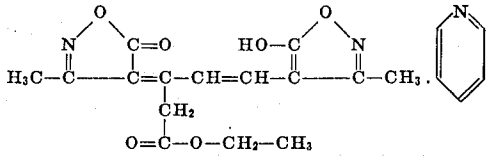
Suitable oxonol dyes are those described in United Kingdom Pat. specification Nos. 506,385 - 515,998 - 646,123 - 646,125 - 619,544 - 933,466 - 1,112,417 - 1,133,986 and 1,138,061, in Belgian Pat. specification No. 733,125 and Japanese Publication No. 64/22,069. Representative examples of this series of dyes are those having the following structural formulae :

1.

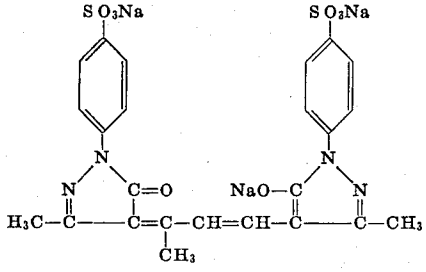


wherein:
R=t.butyl and n=1,
R=methyl and n=1 or 2,
R=t.butyl and n=2

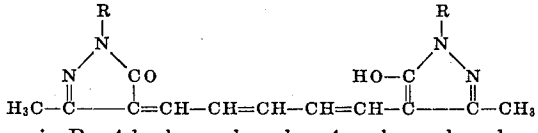
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3.

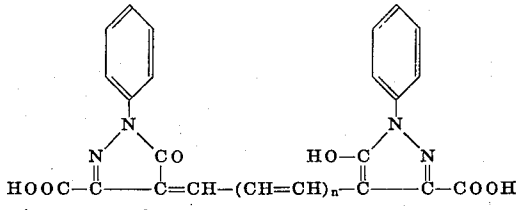


4.



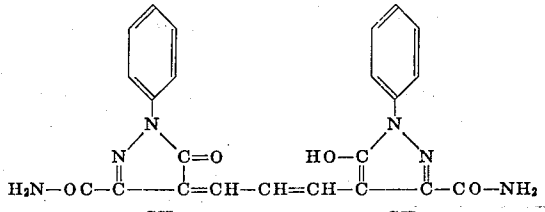
wherein R=4-hydroxyphenyl or 4-carboxyphenyl

5.

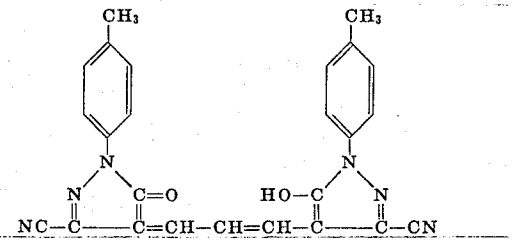


wherein n=1 or 2

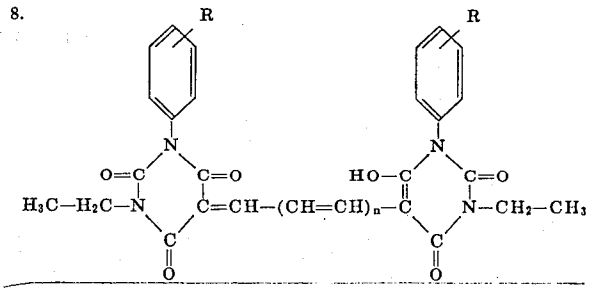
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7.

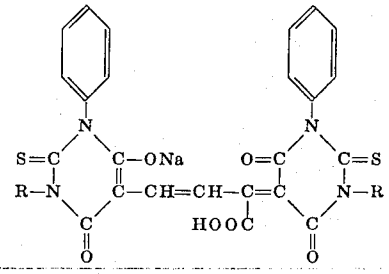


8.



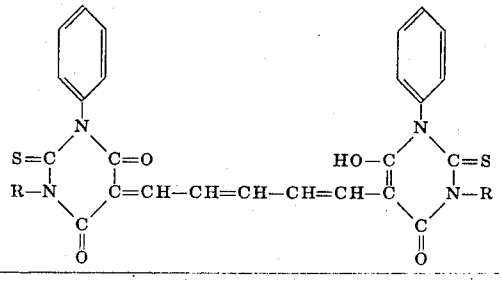
wherein n=1 or 2 and R=p-SO_3H, p-COOH or CN

9.



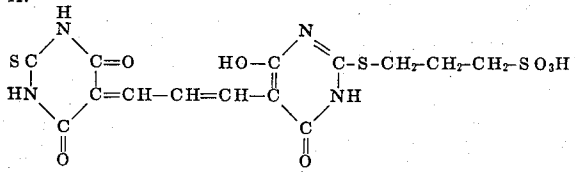
wherein R=4-hydroxyphenyl or 3-carboxyphenyl

10.

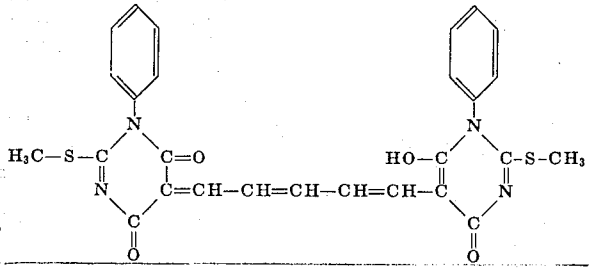


wherein R=4-hydroxyphenyl or 3-carboxyphenyl

11.



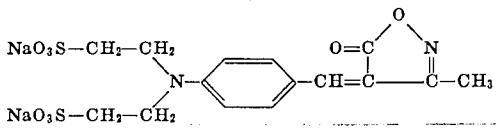
12.



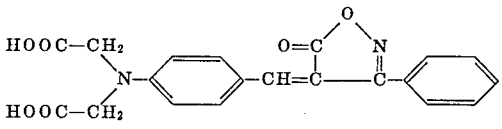
The azaderivatives of oxonol dyes, known as "Murexide," such as those described in published Dutch Pat. application No. 6,608,185 are also suitable light-absorbing dyes for use according to the present invention.

Suitable arylidene dyes are those described in United Kingdom Pat. specification No. 396,646, in Japanese Pat. specification No. 201,903 and the Patents of Addition thereto, in French Pat. specification No. 1,570,870, in Belgian Pat. specification No. 716,661, in U.S. patent application Ser. No. 824,079 and in British Pat. application No. 52,876/68 and those having the following structural formulae :

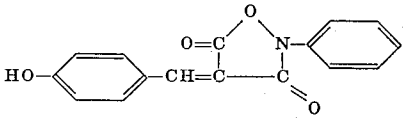
1.



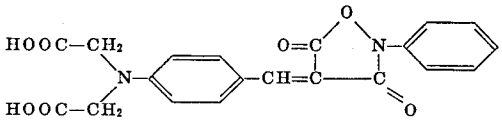
2.



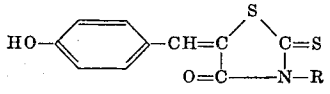
3.



4.

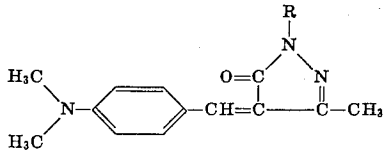


5.



wherein R=2-carboxyethyl or 4-carboxyphenyl

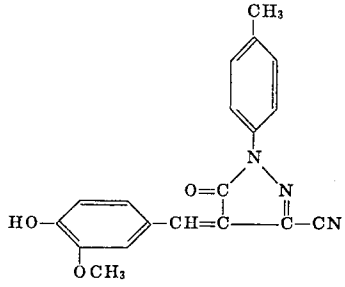
6.



wherein:

R=2-chloro-5-sulphophenyl,
3-sulpho-4-chlorophenyl,
2-sulpho-4-chlorophenyl,
2,5-dichloro-4-sulphophenyl,
2-chloro-4-sulpho-6-methylphenyl

7.

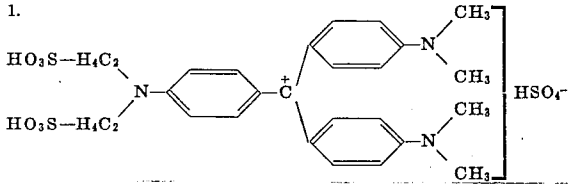


Styryl dyes suitable for use as light-absorbing dyes in accordance with the present invention are for example those described in Belgian Pat. No. specification 669,003.

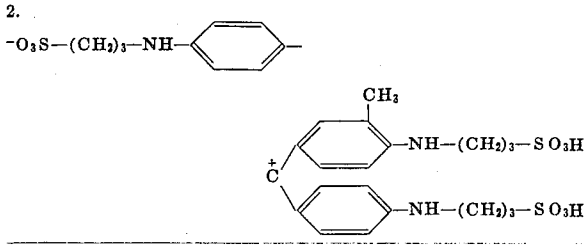
Suitable triarylmethane dyes are for instance those described in United Kingdom Pat. specifications Nos. 446,583 and 790,023. Typical dyes that are particularly suitable for use in accordance with the present invention are the triarylmethane dyes:

C.I. Acid Blue 1 (C.I. 42,045),
C.I. Acid Blue 147 (C.I. 42,135),
C.I. Acid Green 3 (C.I. 42,085),
C.I. Acid Green 5 (C.I. 42,095),
C.I. Acid Green 7 (=C.I. Solvent Green 15, C.I. 42,055),
the triarylmethane dyes having the following structural formulae:

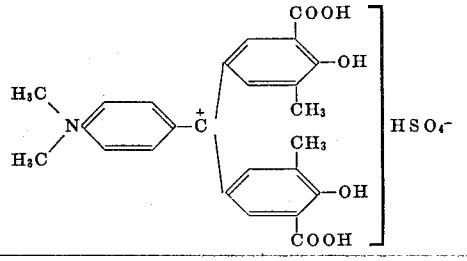
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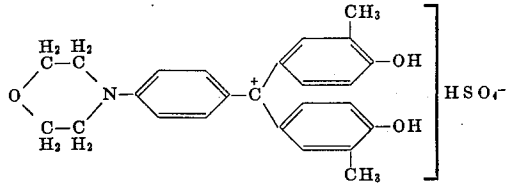
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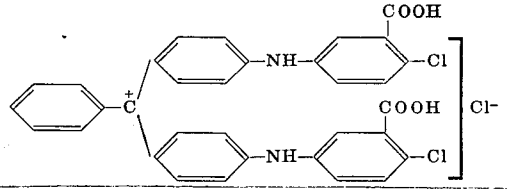
3.



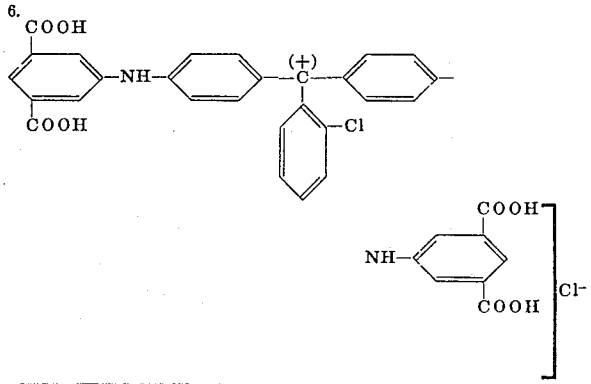
4.



5.

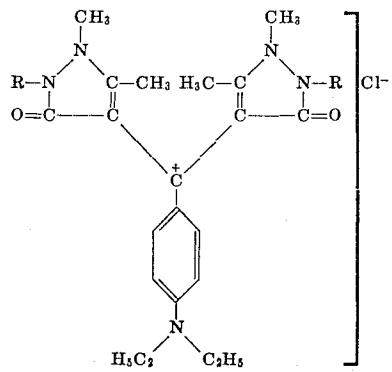


6.



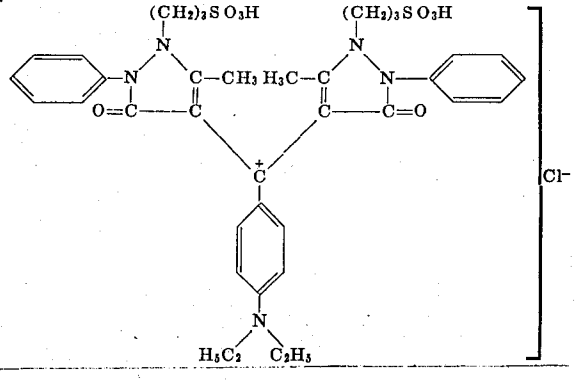
and the related dyes having the following structural formulae:

1.



wherein R=4-sulphophenyl or 4-carboxyphenyl

2.



In the class of the azodyes, the tartrazines such as C.I. Acid Yellow 23 (C.I. 19,140), C.I. Acid Yellow 27 (C.I. 19,130) as well as the organic salts of these dyes such as Lampronol J. Yellow (C.I. Solvent Yellow 57) which is the guanidine salt of C.I. Acid Yellow 23, can be particularly mentioned as well as the dyestuffs described in U.S. Pat. No. 2,956,879 and German Pat. Specification No. 1,182,067.

Other dyestuffs that do not belong to the above classes of dyestuffs and that are suitable for use as light-absorbing dyes in accordance with the present invention, are for example Naphthol Green (C.I. Acid Green 1, C.I. 10,020), Prussian Blue and derivatives thereof such as C.I. Pigment Blue 27 (C.I. 77,510 and 77,520) and C.I. Pigment Green 16 (C.I. 77,525, 77,530 and 77,533), Naphthol Yellow (C.I. Acid Yellow 1, C.I. 10,136), sulphonated Indigos such as Indigo disulphonic acid (C.I. Acid Blue 74, C.I. 73,015) and Indigo tetrasulphonic acid (C.I. 73,020), the formazanes described and claimed in United Kingdom Pat. specification No. 88,494, the 8-oxy-quinoline vanadium complexes described and claimed in United Kingdom Pat. specification No. 1,114,404, the merocyanines described and claimed in United Kingdom Pat. specification No. 1,034,044, the dyes described and claimed in German Pat. specification No. 1,152,609 and those described in theses by Charabin Singh Chadha (Dresden 1965) and Jauer (Dresden 1966).

The light-absorbing dyes for use in accordance with the present invention can be incorporated into the emulsions according to any technique known by those skilled in the art, e.g., from aqueous solutions or solutions in water-miscible solvents. Many of the above dyes are insoluble in water at a pH-value of 4 to 6. These dyes can be dispersed by known methods in aqueous gelatin medium whereupon the said dispersions are incorporated into the emulsion where they are accessible in the normal way for being decolorized during photographic processing.

The emulsions may be coated on a wide variety of photographic emulsion supports. Typical supports include cellulose ester film, polyvinyl acetal film, polystyrene film, polyethylene terephthalate film and related films of resinous materials as well as paper and glass. In the manufacture of high-resilution plate materials for the preparation of masks for use in the electronic industry glass supports are most advantageously used in view of their high dimensional stability.

The light-sensitive silver halide emulsions of use in the preparation of a photographic material according to the present invention may be chemically as well as spectrally sensitized.

They may be spectrally sensitized by any of the known spectral sensitizers such as cyanines and merocyanine dyes for photographic light-sensitive silver halide materials. The silver halide emulsions according to the present invention are most advantageously sensitized for the green region of the spectrum. The exposure light is preferably chosen so that it radiates light of a wavelength to which the emulsion has been spectrally sensitized.

They may be chemically sensitized by effecting the ripening in the presence of small amounts of sulphur containing compounds such as allyl thiocyanate, allyl thiourea, sodium thiosulphate, etc. The emulsions may also be sensitized by means of reductors for instance tin compounds as described in French Pat. Specification No. 1,146,955 and in Belgian Pat. Specification No. 568,687, imino-amino methane sulphinic acid compounds as described in United Kingdom Pat. specification No. 789,823 and small amounts of noble metal compounds such as gold, platinum, palladium, iridium, ruthenium and rhodium.

The said emulsions may also comprise compounds which sensitize the emulsion by development acceleration for example compounds of the polyoxyalkylene type such as alkylene oxide condensation products as described among others in U.S. Pat. Nos. 2,531,832 and 2,533,990, in United Kingdom Pat. specifications Nos. 920,637, 940,051 945,340 and 991,608 and in Belgian Pat. specification No. 648,710 and onium derivatives of amino-N-oxides as described in United Kingdom Pat. specification No. 1,121,696.

Further the emulsions may comprise stabilizers, e.g., heterocyclic nitrogen-containing thioxo compounds such as benzothiazoline-2-thione and 1-phenyl-2-tetrazoline-5-thione and compounds of the hydroxytriazolopyrimidine type. They can also be stabilized with mercury compounds such as the mercury compounds described in Belgian Pat. specifications Nos. 524,121 and 677,337, United Kingdom Pat. specification No. 1,173,609 and in U.S. Pat. No. 3,179,520.

Any of the hardening agents for hydrophilic colloids may be used in the emulsions according to the present invention such as chromium, aluminum and zirconium salts, formaldehyde, dialdehydes, hydroxy aldehydes, acrolein, glyoxal, halogen substituted aldehyde acids such as mucochloric acid and muobromid acid, diketones such as divinyl ketone, compounds carrying one or more vinylsulphonyl groups such as divinyl sulphone, 1,3,5-trivinylsulphonyl benzene, hexahydro-s-triazines carrying vinylcarbonyl, halogenoacetyl and/or acyl groups such as 1,3,5-triacryloylhexahydro-1,3,5-triazine, 1,3-diacryloyl-5-acetyl-hexahydro-1,3,5-triazine, 1,3,5-trichloroacetyle-hexahydro-1,3,5-triazine, etc.

In order to promote adhesion of the emulsion to glass supports in the preparation of high resolution plate materials, the silicon compounds described in co-pending application Ser. No. 54,678/68 can be incorporated into the emulsion.

The light-sensitive emulsions may also comprise all other kinds of ingredients such as plasticizers, coating aids, etc.

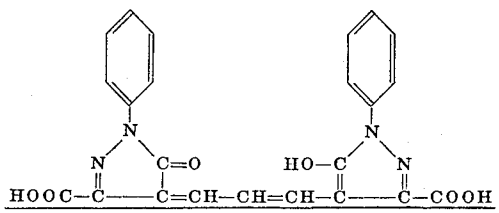
The following examples will illustrate the present invention.

EXAMPLE 1

A silver bromide emulsion comprising per kg. 72 g. of silver bromide and 93 g. of gelatin was prepared by simultaneous addition of a silver nitrate solution and a potassium bromide solution to a 3 percent aqueous solution of gelatin. The conditions of precipitation were adjusted so that a Lippmann emulsion with an average grain size of 0.07 μ was obtained. Details as to the preparation of Lippmann emulsions can be found amongst others in P.Glafkides "Photographic Chemistry" Vol. I, 1958, Fountain Press, London.

The emulsion was sensitized by addition of 150 mg. per 100 g. of silver halide of a merocyanine dye by means of which a strong spectral sensitization in the region of 520–550 mμ was obtained.

The emulsion was divided into 4 portions A, B, C and D and to each portion was added an amount of the light-absorbing dye having the following structural formula :



so as to obtain, after the emulsion portions were coated, a den-

sity of 0.17, 0.14, 0.10 and 0.05 respectively per micron of emulsion layer thickness, measured at 550 mμ (absorption maximum of the light-absorbing dye used).

The 4 emulsion portions were coated on glass plates pro rata of 230 ml. per sq.m so as to obtain after drying a layer thickness of 6 μ. The 4 plate materials A, B, C and D were then exposed under identical circumstances by means of monochromatic light, the spectral composition of which corresponds with the absorption region of the light-absorbing dye used, through a test pattern, as normally used for the quantitative evaluation of materials for use in microelectronics mask-making, consisting of lines which are separated by spaces of the same width as the lines themselves and with a width varying from 1 to 20 μ. The exposure was of such an intensity so as to limit the density in the transparent areas of the images produced, which correspond with the white lines of the test pattern, to the fog value.

After the exposure the 4 plate materials were reversal processed at 20° C., under completely identical circumstances.

For that purpose the exposed materials were first developed for about 5 min. in the following developing liquid the pH of which was adjusted to 10.5:

hydroquinone	2 g.
monomethyl-p-aminophenol hemisulphate	4 g.
potassium bromide	2 g.
sodium carbonate	40 g.
sodium sulphite	40 g.
potassium thiocyanate	5 g.
water to make	1 liter

The materials were then treated for about 5 min. in the following bleach bath:

potassium dichromate	5 g.
strong sulphuric acid (d=1.85)	10 cc.
water to make	1000 cc.

After rinsing for some minutes in water the materials were treated for 5 minutes in a clearing bath of the following composition:

sodium sulphite	100 g.
water to make	1000 cc.

After rinsing again for some minutes the materials were subjected to an overall exposure in order to render the residual silver bromide developable whereupon they were treated for about 6 minutes in the following developing liquid:

hydroquinone	5 g.
monomethyl-p-aminophenol hemisulphate	1 g.
sodium sulphite	40 g.
sodium carbonate	30 g.
potassium bromide	0.5 g.
water to make	1000 cc.

Finally the materials were rinsed and dried.

From the results obtained it was clearly apparent that in the case of reversal processing a small variation in the concentration of the light-absorbing dye had a marked influence on the accuracy of line reproduction (line-broadening). Indeed, in material A the lines having a width of 6 μ and less showed a considerable line-broadening amounting up to 100 percent for the lines having a width of 2–3 μ. In material B only the lines having a width of 3 μ and less showed a slight line-broadening. In material C there was no line-broadening at all, even lines having a width of 1 μ were still truly reproduced. In material D, the concentration of light-absorbing dye became insufficient to completely avoid light-reflection at the glass support so that the edges of the lines became unsharp. Therefore, in the latter case it would be desirable to provide the support with an antihalation backing.

EXAMPLE 2

Three plate materials A, B and C were prepared in an analogous way as described in example 1.

These materials A, B and C were exposed as described in example 1, with the difference however, that now the exposure-intensity was reduced to that necessary to obtain in the negative mask image black lines with a density sufficient to completely shield the areas desired of the integrated circuit material, with which the negative mask will be positioned into register. The exposed materials were then processed so as to obtain a negative image by means of a developing liquid of the following composition:

water	800 cc.
monomethyl-p-aminophenol hemisulphate	1.5 g.
sodium sulphite (anhydrous)	25 g.
hydroquinone	6 g.
sodium carbonate (anhydrous)	40 g.
potassium bromide	1 g.
water to make	1 liter

From the results obtained it appeared that the small variation in the concentration of the light-absorbing dye had no noteworthy influence on the accuracy of line reproduction (line-broadening).

EXAMPLE 3

A photographic plate material was prepared as described in Example 1 for material C with the difference that a silver bromoiodide emulsion comprising 3 mole percent of silver iodide is prepared, that the conditions of precipitation were adjusted so that a Lippmann emulsion with an average grain size of 0.05 μ was obtained and that the emulsion was sensitized by addition of 150 mg. per 100 g. of silver halide of a merocyanine dye by means of which a strong spectral sensitization in the region of 510–550 mμ was obtained.

After exposure and reversal processing as described in Example 1 no line-broadening at all was noticed even with the lines having a width of 1 μ.

EXAMPLE 4

A silver bromide emulsion comprising per kg. 80 g. of silver bromide and 64 g. of gelatin was prepared by simultaneous addition of a silver nitrate solution and a potassium bromide solution to a 3 percent aqueous solution of gelatin. The conditions of precipitation were adjusted so that a Lippmann emulsion with an average grain size of 0.07 μ was obtained.

The emulsion was then further treated as described in Example 1 with the difference that the emulsion portions were coated on glass plates so as to obtain after drying a layer thickness of 4 μ.

After exposure and reversal processing as described in Example 1, identical result s were obtained. Lines having a width comparable to or smaller than the emulsion layer thickness showed no line-broadening in the materials comprising an amount of light-absorbing dye in accordance with the present invention.

EXAMPLE 5

Identical results as those obtained in the preceding examples were obtained when repeating said examples using instead of the light-absorbing dye given, oxonol dye 1 wherein R = t.butyl and n=1 (abs.max. 516 mμ), oxonol dye 2 (abs.max. 530 mμ), oxonol dye 3 (abs.max. 555 mμ), oxonol dye 9 wherein R = 4-hydroxyphenyl (abs.max. 555 mμ), oxonol dye 11 (abs.max. 540 mμ), triarylmethane dye 2 (abs.max. 560 mμ), related triarylmethane dye 1 wherein R=4-sulphophenyl (abs.max. 560 mμ) or related triarylmethane dye 2 (abs.max. 560 mμ) of the above list of dyes suitable for use in accordance with the present invention.

We claim:

1. Photographic element comprising a support and a layer of a silver halide emulsion of the Lippmann type containing a hydrophilic colloid as binder for the silver halide and a non-spectrally sensitizing, light-absorbing dye that absorbs light the spectral composition of which corresponds with that of the exposure light and that is decolourized and/or removed by processing, wherein the said light-absorbing dye is present in

the amount necessary to obtain in the said emulsion layer per micron of emulsion layer thickness a density comprised between at least 0.05 and at most 0.14, measured in the spectral region of the exposure light.

2. Photographic element according to claim 1, wherein the said light-absorbing dye is present in an amount necessary to obtain per micron of layer thickness a density comprised between 0.08 and 0.12, measured in the spectral region of the exposure light.

3. Photographic element according to claim 1, wherein the ratio of silver halide to hydrophilic colloid in the said emulsion layer is comprised between 1:2 and 4:1.

4. Photographic element according to claim 1, wherein the hydrophilic colloid is gelatin.

5. Photographic element according to claim 1, wherein the emulsion is spectrally sensitized.

6. Photographic element according to claim 1, wherein the light-sensitive silver halide is silver bromoiodide, comprising at most 8 mole percent of silver iodide, and having an average grain-size of at most 0.08 μ.

7. Photographic element according to claim 1, wherein the emulsion layer has a thickness comprised between 3 and 8 microns.

8. Photographic element according to claim 1, wherein the support is a glass plate.

9. Process for the preparation of images of high resolution and acutance comprising image-wise exposing a photographic element and processing the exposed element so as to obtain a negative image of the original wherein the said element comprises a support and a layer of a silver halide emulsion of the Lippmann type containing a hydrophilic colloid as binder for the silver halide and a non-spectrally sensitizing, light-absorbing dye that absorbs light the spectral composition of which corresponds with that of the exposure light and that is decolourlized and/or removed by said processing in the amount necessary to obtain in the said emulsion layer per micron of emulsion layer thickness a density comprised between at least 0.05 and at most 0.14, measured in the spectral region of the exposure light.

10. Process for the preparation of images of high resolution and acutance comprising image-wise exposing a photographic element and processing the exposed element so as to obtain a direct-positive image of the original wherein the said element comprises a support and a layer of a silver halide emulsion of the Lippmann type containing a hydrophilic colloid as binder for the silver halide and a non-spectrally sensitizing, light-absorbing dye that absorbs light the spectral composition of which corresponds with that of the exposure light and that is decolourized and/or removed by said processing in the amount necessary to obtain in the said emulsion layer per micron of emulsion layer thickness a density comprised between at least 0.05 and at most 0.14, measured in the spectral region of the exposure light.

11. Process according to claim 10 wherein the said light-absorbing dye is present in an amount necessary to obtain per micron of layer thickness a density comprised between 0.08 and 0.12, measured in the spectral region of the exposure light.

12. Process according to claim 10 wherein the ratio of silver halide to hydrophilic colloid in the said emulsion layer is comprised between 1:2 and 4:1.

13. Process according to claim 10 wherein the hydrophilic colloid is gelatin.

14. Process according to claim 10 wherein the emulsion is spectrally sensitized.

15. Process according to claim 10 wherein the light-sensitive silver halide is silver bromoiodide, comprising a most 8 mole percent of silver iodide, and having an average grain-size of at most 0.08 μ.

16. Process according to claim 10 wherein the emulsion layer has a thickness comprised between 3 and 8 microns.

17. Process according to claim 10 wherein the support is a glass plate.

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