

The present invention relates to a positive-working photosensitive composition comprising a photosensitive compound, a binder that is insoluble in water and soluble or swellable in an aqueous-alkaline solution, and a dye.

Photosensitive compositions containing a novolak or a polyvinyl phenol as the binder and, for example, an o-quinone diazide as the photosensitive compound have been in use for a long time for the preparation of high-resolution patterns in the fabrication of semiconductor devices. Due to the advancing miniaturization of functional elements increasingly high requirements are demanded of the optical resolution of these photosensitive compositions. Difficulties have, in particular, to be expected when patterning is effected in the vicinity of the limit of resolution of the optical exposure systems. In these critical areas, resolution is, above all, influenced by disturbing optical effects, such as interference phenomena and undesirable reflexions of scattered light from the substrate surface. Effects of this kind can partly be avoided by increasing the non-bleachable absorption of the photosensitive compositions. For this purpose, for example, substances which absorb light in the actinic region are added to the photoresist compositions.

It has been known for a long time to add absorbing substances to photosensitive compositions. As described in EP-A 0 026 088, for example, the image patterns produced can be improved by adding dyes to negative-working photoresists.

The addition of dyes to positive-working photoresists has been described for the first time by A. R. Neureuther and F. H. Dill ("Photoresist Modeling and Device Fabrication Applications", in "Proceedings of Symposium on Optical and Acoustical Micro-Electronics", Polytechnic Institute of New York, April 16 to 18, 1974, pages 223-249). According to this publication, the dye addition, in the first place, reduces the adverse influences of interference effects on the optical resolution.

According to the paper "Submicron Optical Lithography: I-line Lens and Photoresist Technology" [SPIE Proceedings, Vol. 470, pages 22-23 (1984)] by H. L. Stover, M. Nagler, I. I. Bol and V. Miller, optical resolution is markedly improved by the addition of an absorbing dye which absorbs light in the region of the exposure wavelengths of $\lambda = 436$ nm while, at the same time, the exposure time required to generate image patterns has to be considerably extended, compared with a system which does not contain this absorbing substance.

PCT WO 86/01914 describes a process, in which the production of photoresist patterns is also improved by the use of a non-bleachable, light-absorbing additive. Also in this case it is pointed out that the exposure time has to be extended by about 50 to 150 %, compared with a photoresist without additive substance. Particularly preferred dyes mentioned comprise coumarin derivatives.

A coumarin derivative is also described by I. I. Bol in "High-Resolution Optical Lithography Using Dyed Single-Layer Resist" (Proceedings Kodak Microelectronics Seminar 1984, pages 19-22) and the significant improvement of the photolithographic properties of a photoresist is confirmed.

The influence of substances absorbing light in the actinic region on the photolithographic properties of positive-working photoresists is described in detail by A. V. Brown and W. H. Arnold in "Optimization of Resist Optical Density for High Resolution Lithography on Reflective Surfaces" [SPIE Proceedings, Vol. 539, pages 259-266 (1985)] and by M. P. C. Watts, D. DeBruin and W. H. Arnold in "The Reduction of Reflective Notching Using Dyed Resists" (Proceedings of Seventh International Technical Conference on Photopolymers, Ellenville, N.Y., October 1985, pages 285-296). According to these investigations, the solubility of the photoresist compositions in the aqueous-alkaline developers used is reduced by the addition of substan-

ces absorbing light in the actinic region and, as a consequence, the photosensitivity of these photoresists is lowered considerably.

In their paper "Improving Linewidth Control over Reflective Surfaces Using Heavily Dyed Resists" [Journal of the Electrochemical Society, Vol. 133, No. 1, pages 192-196 (1986)], T. R. Pampalone and K. A. Kuyan describe the influence of high concentrations of absorbing substances in a photoresist. According to these investigations particularly good results are obtained with photoresists having a very high absorption in the actinic region. Also in this case it is found that the absorbing compound added clearly reduces photosensitivity, i.e. up to a factor of 5 or even more.

US-A- 4,575,480 also describes photoresist formulations containing substances which absorb light in the actinic region. The compounds mentioned are distinguished by their low tendency to sublimation and their high absorption in the actinic region. It is a disadvantage of these photoresist formulations that - depending on the concentration of the substance added - some of them have a markedly reduced photosensitivity.

Similarly, Japanese Patent Applications 86-159626/25, 86-165777/26, 86-174465/27 and 86-174466/27 describe photoresist formulations which contain absorbing

substances that are non-bleachable and do not sublime. In all cases, however, the exposed portions of the resists have a noticeably reduced solubility in the developer solutions.

Photoresists which, apart from a dye absorbing light in the actinic region, also contain a component which increases their solubility, in particular 2,3,4-trihydroxybenzophenone, are described in US-A- 4,626,492. The 2,3,4-trihydroxybenzophenone is added in quantities ranging from 12.8 to 13.1 % by weight, which, however, leads to a considerable deterioration of the thermal stability of the photoresist. Moreover, a decline in the processing latitude of the resist is observed, since the developing rate strongly depends on the pre-baking temperature of the resist film.

In accordance with DE-C-25 47 905, a polyhydroxybenzophenone, i.e., 2,3,4-trihydroxybenzophenone or 2,4-dihydroxybenzophenone, is added to a photosensitive composition comprising an o-quinone diazide and a binder which is soluble in aqueous-alkaline solutions. Due to their chelation properties the benzophenone derivatives are claimed to exhibit good adhesion towards anodically oxidized aluminum surfaces, such as are used in the production of lithographic printing plates. No statements are made in the publication with regard to UV-absorption; besides, such statements are not required, because no monochromatic light sources are employed for

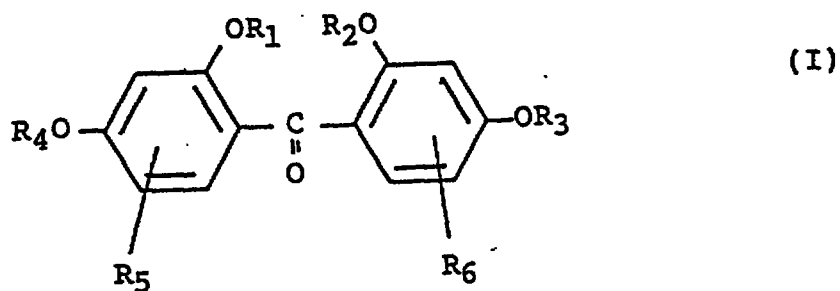
exposure. Moreover, compounds of the above type do not absorb light within the range desired according to this invention.

It is therefore an object of the present invention to provide a positive-working photosensitive composition containing a non-bleachable dye which absorbs light in the actinic region and which should either have or produce the following properties:

- good solubility in the solvent or solvent mixture of the photosensitive composition, so that undesirable deposits are not formed during storage of the composition, in particular at low temperatures,
- good thermal stability and low tendency to sublime, so that, on the one hand, constant absorption of actinic radiation is ensured - even at high temperatures - and, on the other hand, contamination of process equipment is kept as low as possible,
- high absorption in the region of actinic radiation in order to minimize undesirable optical effects in an efficient manner.

The object of the invention is achieved by providing a positive-working photosensitive composition comprising a photosensitive compound, a binder that is insoluble in water and soluble or swellable in an aqueous-alkaline

solution, and a dye, wherein the dye is a non-bleachable compound which absorbs light at $\lambda = 365 \pm 15$ nm and corresponds to the general formula I



where

R_1 to R_4 are identical or different and denote hydrogen, alkyl, hydroxyalkyl or alkoxyalkyl and

R_5 and R_6 are identical or different and denote hydrogen, alkyl, hydroxyalkyl, alkoxyalkyl, amino or halogen.

Compounds corresponding to the above-indicated general formula I are distinguished by the fact that they meet the requirements of high absorption in the actinic region to a special degree.

Particularly unexpected properties of the photosensitive composition according to the invention, which may be mentioned in addition to those indicated above, include:

- higher photosensitivity of the composition according to the present invention, compared with photosensitive compositions containing other dyes which are not claimed, but which also absorb light in the actinic region,
- no or only slight reduction of the photosensitivity of the photosensitive composition of the invention, compared with photosensitive compositions that do not contain dyes or contain other dyes.

Preferred dyes absorbing light in the actinic region are, in particular, those which, corresponding to the general formula I, contain as

R₁ to R₄ hydrogen, (C₁ to C₆)alkyl, hydroxy(C₁ to C₃)alkyl or (C₁ to C₃)alkoxy-(C₁ to C₄)alkyl, and as

R₅ and R₆ hydrogen, (C₁ to C₃)alkyl, hydroxy(C₁ to C₃)-alkyl, (C₁ to C₃)alkoxy(C₁ to C₄)alkyl or chlorine.

Particular preference is given to those dyes of the general formula I where

R₁ and R₂ are identical and denote hydrogen or (C₁ to C₃)alkyl,

R_3 and R_4 are identical or different and denote hydrogen, $(C_1 \text{ to } C_3)\text{alkyl}$ or hydroxy- $(C_1 \text{ to } C_3)\text{alkyl}$, and

R_5 and R_6 are each in the meta-position in respect of the substituents R_1 and R_4 or R_2 and R_3 , respectively, and denote hydrogen, $(C_1 \text{ to } C_3)\text{-alkyl}$, hydroxy $(C_1 \text{ to } C_3)\text{alkyl}$ or $(C_1 \text{ to } C_3)\text{-alkoxy}(C_1 \text{ or } C_2)\text{alkyl}$.

Most preferred are those dyes of the general formula I where

R_1 and R_2 denote hydrogen,

R_3 and R_4 are identical and denote hydrogen or $(C_1 \text{ to } C_3)\text{alkyl}$ and

R_5 and R_6 denote hydrogen or $(C_1 \text{ to } C_3)\text{alkyl}$ being in the meta-position in respect of the substituents R_1 and R_4 or R_2 and R_3 , respectively.

Of these dyes those are preferably employed, which have absorption capacities coinciding as exactly as possible with the wavelength of the actinic radiation used, whereby particular preference is given to those having an absorption maximum at wavelengths $\lambda = 365 \pm 15 \text{ nm}$, above all at $\lambda = 365 \pm 10 \text{ nm}$.

The quantity of dye required to obtain the desired absorption is thus reduced to a minimum.

The concentration of the absorbing dye can range from 0.05 to 5 % by weight, preferably from 0.2 to 0.8 % by weight, based on the non-volatile constituents of the photosensitive composition.

The quantity of dye added in each case is naturally dependent on the molar coefficient of extinction of the dye at the respective exposure wavelength. If the quantity of absorbing dye used is too low, the effects of reflexion are only insignificantly reduced and the photolithographic properties are either not at all or only slightly improved. On the other hand, too high a concentration of absorbing compound leads to a deterioration of image quality, since the areas of the resist layer which are relatively close to the exposure source are too strongly exposed, while the areas of the layer which are in the vicinity of the substrate are still insufficiently exposed.

The compounds corresponding to formula I, which absorb light in the actinic region, can, for example, be prepared according to the process described in "Journal of Organic Chemistry", Vol. 23, pages 1679 et seq.

The photosensitive compositions according to the present invention also contain a radiation-sensitive or photosensitive compound or a radiation-sensitive or photosensitive combination of compounds. Compounds which may be used are positive-working compounds, i.e. those which are rendered soluble upon exposure. These include, on the one hand, o-quinone diazides and, on the other hand, combinations of photolytic acid donors with acid-cleavable compounds, for example, orthocarboxylic acid or acetal compounds.

O-quinone diazides are known, for example, from DE-C- 938 233, DE-C- 15 43 721, DE-A- 23 31 377, DE-A- 25 47 905 and DE-A 28 28 037. Preferably used o-quinone diazides comprise 1,2-naphthoquinone-2-diazide-4- or -5-sulfonic acid esters or amides. Of these, the esters, especially the esters of sulfonic acids, are particularly preferred. The quantity of o-quinone diazide compounds contained in the photosensitive composition of the present invention usually ranges from 3 to 50 % by weight, preferably from 7 to 35 % by weight, based on the non-volatile constituents of the composition.

Of the acid-cleavable materials the following are used:

- a) Compounds containing at least one orthocarboxylic ester and/or carboxyamide acetal grouping, it being possible for the compounds to have a polymeric

character and for the groupings mentioned to be present as linking members in the principal chain or as lateral substituents;

- b) oligomeric or polymeric compounds containing recurrent acetal and/or ketal groups in the principal chain;
- c) compounds having at least one enol ether or N-acyliminocarbonate grouping;
- d) cyclic acetals or ketals of β -ketoesters or amides;
- e) compounds containing silylether groups;
- f) compounds containing silylenolether groups;
- g) monoacetals or monoketals, the aldehyde or ketone components of which have a solubility in the developer, which varies between 0.1 and 100 g/l;
- h) ethers based on tertiary alcohols; and
- i) carboxylic acid esters and carbonates of tertiary allylic or benzylic alcohols.

Acid-cleavable compounds of type a), which are used as components of radiation-sensitive compositions, are described in detail in DE-A- 29 28 636

(= EP-A- 0 022 571), in DE-A- 26 10 842 and in US-A- 4,101,323; compositions containing compounds of type b) are described in DE-C- 23 06 248 (= US-A- 3,779,778) and DE-C- 27 18 254; compounds of type c) are described in EP-A- 0 006 626 and EP-A- 0 006 627; compounds of type d) are described in EP-A- 0 202 196; compounds corresponding to type e) are presented in DE-A- 35 44 165 and DE-A- 36 01 264; compounds of type f) are disclosed in German Patent Application, file No. P 37 30 783.5, filed September 13, 1987; and compounds of type g) are disclosed in German Patent Applications, file Nos. P 37 30 785.1 and P 37 30 787.8, also filed September 13, 1987. Compounds of type h) are described, for example, in US-A- 4,603,101 and compounds of type i), for example, in US-A- 4,491,628 and by J. M. Fréchet et al. in J. Imaging Sci., 30, 59-64 (1986).

Preferred compounds contain C-O-C groups which can be split by acid.

US-A- 4,101,323 describes orthocarboxylic acid derivatives, and of these the bis-1,3-dioxan-2-yl ethers of aliphatic diols are used in particular. Of the polyacetals described in DE-C- 27 18 254 those containing aliphatic aldehyde and diol units are preferred.

Other suitable compositions are disclosed in EP-A- 0 022 571. This publication describes polymeric

orthoesters with recurrent orthoester groups in their principal chains, as acid-cleavable compounds. These groups comprise 2-alkylethers of 1,3-dioxo-cycloalkanes having 5 to 6 ring members. Particularly preferred are polymers with recurrent 1,3-dioxo-cyclohex-2-yl alkyl-ether units, wherein the alkylether group can be interrupted by ether oxygen atoms and is preferably linked to the 5-position of the adjacent ring.

The photosensitive or radiation-sensitive acid donors contained in these compositions primarily comprise organic halogen compounds. The halogen compounds include, in particular, the triazine derivatives disclosed in US-A- 3,515,552; US-A- 3,536,489 and US-A- 3,779,778 and in DE-C- 27 18 259; DE-C- 33 27 024; DE-C- 33 33 450; DE-C- 23 06 248, DE-C- 22 43 621 and DE-C- 12 98 414. These triazine derivatives can, however, also be used in combination with other photoinitiators, for example, oxazoles, oxadiazoles or thiazoles or in mixtures with each other.

Oxazoles, oxadiazoles, thiazoles or 2-pyrones containing trichloro- or tribromomethyl groups are also known (DE-A- 30 21 599, DE-A- 30 21 590, DE-A- 28 51 472, DE-A- 29 49 396 and EP-A- 0 135 348 and EP-A- 0 135 863).

This generic term also includes, in particular, aromatic compounds, in which halogen, preferably bromine, is attached to the aromatic ring. Compounds of this type are, for example, known from DE-A- 26 10 842.

The amount of acid-cleavable compounds contained in the photosensitive composition according to the present invention is, in general, in the range from 8 to 65 % by weight, preferably from 14 to 44 % by weight, based on the non-volatile constituents of the composition. The amount of acid-forming compounds ranges from 0.1 to 10 % by weight, preferably from 0.2 to 5 % by weight, also based on the non-volatile constituents of the composition.

In addition to the above-described photosensitive constituents the coating solutions of the present invention comprise polymeric binders. The preferred polymers are insoluble in water and soluble or at least swellable in aqueous-alkaline solutions.

Alkali-soluble or at least alkali-swellable binders which may be mentioned comprise natural resins, such as shellac and colophony, and synthetic resins, such as copolymers of styrene and maleic anhydride or copolymers of acrylic acid or methacrylic acid, in particular, with acrylic or methacrylic acid esters, and especially novolak resins.

Novolak condensation resins which have proved suitable include, in particular, the relatively highly condensed resins with substituted phenols as the condensation partners of formaldehyde. Examples of these are phenol-formaldehyde resins, kresol-formaldehyde resins, the co-condensates and mixtures thereof and phenol and kresol condensates with formaldehyde.

Instead of or in admixture with, novolaks, phenolic resins of the type of poly(4-vinylphenol) can also advantageously be used.

The type and quantity of the alkali-soluble resins used can vary according to the intended application; preference is given to amounts ranging from 30 to 90 % by weight, particularly preferably from 55 to 85 % by weight, based on total solids contained in the composition.

A great number of other resins can additionally be used; preferred are vinyl polymers, such as polyvinyl acetates, poly(meth)acrylates, polyvinyl ethers, polyvinyl pyrrolidones and styrene polymers, which themselves may be modified by comonomers. The following are mentioned in particular: polymers of styrene containing alkenylsulfonyl-aminocarbonyloxy or cycloalkenylsulfonyl-aminocarbonyloxy units (EP-A- 0 184 804); polymers of acrylic, methacrylic, maleic, itaconic acid, etc. having lateral, crosslin-

king $-CH_2OR$ groups (EP-A- 0 184 044); polymers of vinyl monomers containing alkenyl phenol units (EP-A- 0 153 682); polyvinyl phenols as substituents for novolak (DE-C- 23 22 230); polymeric binders with lateral phenolic hydroxyl groups (EP-A- 0 212 439 and EP-A- 0 212 440); styrene-maleic anhydride copolymers (DE-A- 31 30 987); polymers formed from unsaturated (thio)phosphinic acid iso(thio)cyanates with a polymer containing active hydrogen (German Patent Applications P 36 15 612.4 and P 36 15 613.2); polymers containing vinyl acetate, vinyl alcohol and vinyl acetal units (EP-A- 0 216 083) and polyvinyl acetals having units of hydroxyaldehydes (German Patent Application P 36 44 162.7).

The most favorable amount of these resins used in the binder of the photosensitive composition according to the present invention depends on application-related requirements and on the influence of the resins on development conditions and is, in general, not more than 20 % by weight of the alkali-soluble resin.

The photosensitive compositions of the present invention can optionally also be admixed with dyes, finely divided pigments, plasticizers, wetting agents and levelling agents and, in addition, polyglycols, cellulose derivatives, e.g. ethyl cellulose, to improve specific properties, such as flexibility, adhesion and gloss.

The photosensitive composition of the invention is preferably dissolved in solvents comprising, for example, ethylene glycol; glycol ethers, such as glycol monomethyl ether, glycol dimethyl ether, glycol monomethyl ether or propylene glycol monoalkyl ethers, in particular propylene glycol methyl ether; aliphatic esters, such as ethyl acetate, hydroxyethyl acetate, alkoxyethyl acetate, n-butyl acetate, propylene glycol monoalkylether acetate, in particular propylene glycol methyl ether acetate or amyl acetate; ethers, such as dioxane; ketones such as methyl ethyl ketone, methyl isobutyl ketone, cyclopentanone and cyclohexanone; dimethylformamide, dimethylacetamide, hexamethyl phosphoric acid amide, N-methylpyrrolidone, butyrolactone, tetrahydrofuran and mixtures thereof. Glycol ethers, aliphatic esters and ketones are particularly preferred.

Depending on the types of photosensitive compounds and binders used and also on the intended application, the total solids content of the composition according to the present invention generally varies between about 10 to 50 % by weight, preferably between about 15 to 35 % by weight.

The invention also provides a photosensitive recording material which essentially comprises a substrate of any of the types conventionally employed for photoresist applications and the photosensitive composition applied to this substrate.

Substrates which may be used include all materials which are suitable for the production of capacitors, semiconductors, multilayer printed circuits or integrated circuits. Particularly suitable surfaces are those which comprise a silicon material which is optionally doped, including any other substrates customarily used in semiconductor technology, for example, silicon nitride, gallium arsenide and indium phosphide. Other appropriate substrates are those known from the manufacture of liquid crystal displays, such as glass and indium/ tin oxide; and, in addition, metal plates and foils, e.g. comprising aluminum, copper or zinc; bi-metallic and trimetallic foils and also electrically nonconductive sheets which are vacuum metallized, optionally aluminum-coated SiO_2 materials and paper. These substrates may be subjected to a thermal pretreatment, roughened on their surfaces, slightly etched or treated with chemicals, in order to obtain desirable properties, e.g. an improvement of the hydrophilic character.

In a special embodiment, the photosensitive recording material may comprise an adhesion promoter dissolved in the resist formulation or applied between the resist and the substrate in order to improve the adhesion of the resist. Adhesion promoters of the aminosilane type, for example, 3-aminopropyl-triethoxysilane or hexamethyl-disilazane are appropriately used in the case of silicon or silicon dioxide substrates.

The photosensitive composition can be applied to the support to be coated using customary methods, such as dip-coating, flow-coating, spin-coating, spraying, roller-coating or application through slot dies.

The recording materials according to the present invention are exposed imagewise. Sources of actinic light include: metal halide lamps, carbon arc lamps, xenon lamps and mercury vapor lamps, which have emission peaks in the near ultraviolet or short-wave visible light. Imaging can also be effected by means of electron-beam, x-ray or laser radiation. Suitable lasers are, in particular, helium/neon lasers, argon lasers, krypton lasers and helium/cadmium lasers.

The layer thickness of the photosensitive layer depends on the intended field of application and varies between 0.1 and 100 μm , in particular, between 0.5 and 5 μm .

Aqueous-alkaline solutions of graduated alkalinity, i.e. preferably having a pH of 10 to 14, and which may also contain minor amounts of organic solvents or wetting agents are used for development. These solutions remove the exposed areas of the recording layer and thus produce a positive image of the original.

In accordance with this invention, there is furthermore claimed a process for the production of a photoresist pattern. This process comprises exposing the positive-working recording material of this invention through

a mask original at a wavelength $\lambda = 365$ nm, developing the exposed material with an aqueous-alkaline developer, and then optionally doping, etching and/or metallizing the image areas of the substrate which have been bared by development, using known methods.

It is also possible to heat the photoresist material after the imagewise exposure at $\lambda = 365$ nm to 120°C and then to subject it to a second overall exposure at $\lambda = 365$ to 436 nm and then to develop the photoresist with an aqueous-alkaline developer. By means of this image reversal process crisp negative patterns can be produced.

In the following examples preferred embodiments of the invention are described. Quantitative ratios and percentages relate to weight units, unless otherwise indicated.

Example 1

A photosensitive composition comprising

3.5 pbw (parts by weight) of the esterification product of 1 mol of 2,3,4-trihydroxybenzophenone and 2 mol of 1,2-naphthoquinone-diazide-5-sulfonyl chloride,

11.5 pbw of a poly-p-vinylphenol having a glass transition temperature of 165°C ,

0.3 pbw of 2,2',4,4'-tetrahydroxybenzophenone,
28.0 pbw of ethylene glycol monoethyl ether acetate,
3.5 pbw of n-butyl acetate, and
3.5 pbw of xylene

was applied to a silicon wafer by spin-coating at 4,000 rpm and dried in a circulating air oven at 90 °C for 30 minutes. The 1.9 μm thick layer was exposed to actinic radiation of wavelength $\lambda = 365 \text{ nm}$ through a mask original. The exposed layer was developed in a solution comprising

0.61 pbw of sodium metasilicate $\cdot 9\text{H}_2\text{O}$
0.46 pbw of trisodium phosphate $\cdot 12\text{H}_2\text{O}$
0.04 pbw of monosodium phosphate, anhydrous, in
98.89 pbw of deionized water.

After a development time of 60 seconds at 21 °C, the patterns bared by development were examined. It was found that crisp resist patterns having widths of 2 μm were obtained by exposure within the region from 167 to 268 mJ/cm^2 (latitude of exposure 101 mJ/cm^2).

Example 2 (Comparative Example)

A photosensitive composition was prepared as described in Example 1, except that the dye (UV-absorber) was omitted.

Development was also performed as in Example 1. The microscopic examination of the resulting pattern showed that 2 μm wide structures could only be produced in the region from 167 to 201 mJ/cm^2 , i.e., the exposure latitude was 34 mJ/cm^2 . The edges of the resist patterns were not sharp.

Example 3

A photosensitive composition comprising

10 pbw of a cresol-formaldehyde novolak having a softening range of 147 to 150°C, determined acc. to DIN 53, 181,

8 pbw of a 50% strength solution of polyvinylmethyl ether in toluene,

3 pbw of the 1,2-naphtoquinone-diazide-4-sulfonic acid ester of 4-(2-phenyl-prop-2-yl)phenol, and

7 pbw of 2,2'-dihydroxy-4,4'-dimethoxy-benzophenone, in

72 pbw of 1-methoxy-propan-2-ol

was processed as described in Example 1. The imagewise exposure resulted in crisp, 2 μm wide patterns with energies from 60 to 100 mJ/cm^2 (latitude of exposure 40 mJ/cm^2).

Example 4 (Comparative Example)

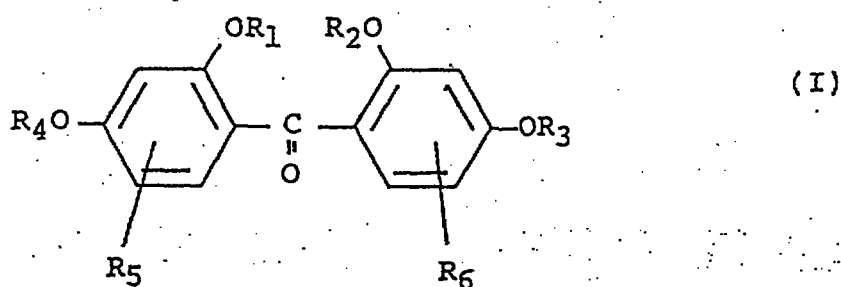
A photosensitive composition composed as described in Example 3, except that the dye (UV-absorber) was omitted, was processed as described in Example 1. 2 μm wide structures could only be produced when the image-wise exposure was performed with energies from 60 to 88 mJ/cm^2 (exposure latitude 28 mJ/cm^2), whereby no sharp edges were obtained.

Example 5

A photosensitive composition was prepared from the constituents listed in Example 3, coated onto a substrate and dried as described in Example 1, and then exposed through an exposure mask with actinic radiation of wavelength $\lambda = 365 \text{ nm}$. Subsequently the resist layer was heated to 120°C for 1 minute by means of a hot plate and thereafter subjected to an overall exposure with actinic radiation emitting from 365 to 436 nm, at an exposure energy of 200 mJ/cm^2 . Development was then performed as described in Example 1. Negative patterns with sharp edges were obtained, i.e., the image reversal process was not adversely influenced by the dye additive.

Claims:

1. Positive-working photosensitive composition comprising a photosensitive compound, a binder that is insoluble in water and soluble or swellable in an aqueous-alkaline solution, and a dye, characterized in that the dye comprises a non-bleachable compound which absorbs light at $\lambda = 365 \pm 15$ nm and corresponds to the general formula I



wherein

R_1 to R_4 are identical or different and denote hydrogen, alkyl, hydroxyalkyl or alkoxyalkyl, and

R_5 and R_6 are identical or different and denote hydrogen, alkyl, hydroxyalkyl, alkoxyalkyl, halogen or amino.



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- 26 -

2. A photosensitive composition as claimed in claim 1, characterized in that an o-quinone diazide is present as the photosensitive compound.
3. A photosensitive composition as claimed in claim 1, characterized in that a photolytic acid donor in combination with an acid-cleavable compound containing a C-O-C grouping is present as the photosensitive compound.
4. A photosensitive composition as claimed in claim 3, characterized in that an organic halogen compound is present as the photolytic acid donor.
5. A photosensitive composition as claimed in any one or several of claims 1 to 4, characterized in that a novolak condensation resin is present as the binder.
6. A photosensitive composition as claimed in claim 5, characterized in that the alkali-soluble novolak condensation resin is blended with other resins in a proportion of up to 20 % by weight.
7. Positive-working photosensitive recording material essentially comprising a substrate of any of the types conventionally employed for photoresist applications and a photosensitive layer, characterized in that the material comprises a composition as claimed in claims 1 to 6 as the photosensitive layer.



8. Process for the production of a photoresist pattern, characterized in that a positive-working recording material as claimed in claim 7 is exposed through a mask original at $\lambda = 365$ nm, whereupon it is either developed with an aqueous-alkaline developer or, alternatively, heated to 120°C, thereafter subjected to an overall exposure at $\lambda = 365$ to 436 nm and then developed with an aqueous-alkaline developer.