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(54) Silver halide photographic light-sensitive material.

(57) A silver halide photographic light-sensitive material includes at least one silver halide emulsion layer containing a silver halide emulsion prepared by adding at least one compound represented by the following general formula [I], [II], or [III] during a manufacturing process, wherein at least 50% of a total projected area of all silver halide grains of the emulsion layer are occupied by tabular silver halide grains consisting of silver iodobromide, silver iodochloride, or silver iodochlorobromide each containing not less than 3.0 mol% of silver iodide on an average, an aspect ratio of the tabular silver halide grains occupying at least 50% of the total projected area is 3.0 or more, and a relative standard deviation between silver iodide contents of individual grains is not more than 30%:

[I] $R\text{-}SO_2S\text{-}M$
[II] $R\text{-}SO_2S\text{-}R^1$
[III] $R\text{-}SO_2S\text{-}L_m\text{-}SSO_2\text{-}R^2$

wherein R, R^1, and R^2 may be the same or different and independently represent an aliphatic group, an aromatic group, or a heterocyclic group, M represents a cation, L represents a divalent linking group, and $\underline{m}$ represents 0 or 1. Compounds represented by general formulas [I] to [III] may be polymers containing divalent groups derived from structures represented by general formulas [I] to [III] as repeating units. If possible, R, R^1, R^2, and L may be bonded to each other to form a ring.

SILVER HALIDE PHOTOGRAPHIC LIGHT-SENSITIVE MATERIAL

The present invention relates to a silver halide photographic light-sensitive material having high sensitivity, high contrast and improved graininess and sharpness.

In recent years, requirements for a photographic silver halide emulsion have become more strict, and a demand has arisen for further advanced photographic properties such as sensitivity, contrast, graininess, and sharpness.

In order to satisfy the above requests, techniques of using tabular grains for, e.g., improving sensitivity including an improvement in color sensitivity using a sensitizing dye, improving a relationship between sensitivity and graininess, and improving sharpness are disclosed in U.S. Patents 4,434,226, 4,414,310, 4,433,048, 4,414,306, and 4,459,353.

When the present inventors made extensive studies about of the tabular grains disclosed in the above patents, no satisfactory contrast could be obtained.

In a tabular silver halide grain (to be referred to as a tabular grain hereinafter), when a surface area/volume ratio is increased to increase an adsorption amount of a sensitizing dye, its sensitivity is expected to be improved as light absorption increases. A tabular grain, therefore, is superior to a non-tabular grain (e.g., an octahedral grain) having the same volume in a sensitivity/graininess relationship.

In addition, since a tabular grain has only a small light scattering effect due to its geometrical shape, not only sharpness in a layer containing tabular grains but also that of its underlying layer (located farther from a light source) can be improved. According to a relationship between the shape of an emulsion grain and light scattering described in Research Disclosure No. 25330 (May, 1985), the shape of an emulsion grain largely contributes to an improvement in sharpness of a silver halide photographic light-sensitive material.

In a tabular grain, therefore, since a surface area/volume ratio is increased and light scattering is decreased by increasing an aspect ratio, it is predicted that a sensitivity/graininess relationship and sharpness can be improved.

A tabular grain having a high aspect ratio, however, makes it difficult to prepare an emulsion in which a grain size is monodispersed. Since a grain size is polydispersed consequentially, a sensitivity distribution is widened between grains to decrease the contrast.

A decrease in contrast leads to, e.g., an increase in silver coating amount. The increase in silver amount increases a manufacturing cost, and an increase in light scattering which decreases sharpness. If a film is softened in order to compensate for the decrease in contrast, graininess is degraded, and the film is easily damaged during treatments. In addition, if a coupler coating amount is increased in a color photographic light-sensitive material, disappearance of graininess in the layer is lost due to a decrease in silver/coupler ratio, thereby degrading the graininess.

A demand, therefore, has arisen for a tabular grain exhibiting high contrast.

It is an object of the present invention to provide a silver halide photographic light-sensitive material having high sensitivity and contrast and improved graininess and sharpness.

The above object of the present invention can be achieved by a silver halide photographic light-sensitive material comprising at least one silver halide emulsion layer containing a silver halide emulsion prepared by adding at least one compound represented by the following general formula [I], [II], or [III] during a manufacturing process,
wherein at least 50% of a total projected area of all silver halide grains of said emulsion layer are occupied by tabular silver halide grains consisting of silver iodobromide, silver iodochloride, or silver iodochlorobromide each containing not less than 3.0 mol% of silver iodide on an average, an aspect ratio of said tabular silver halide grains occupying at least 50% of the total projected area is 3.0 or more, and a relative standard deviation between silver iodide contents of individual grains is not more than 30%:

[I] $R\text{-}SO_2S\text{-}M$

[II] $R\text{-}SO_2S\text{-}R^1$

[III] $R\text{-}SO_2S\text{-}L_m\text{-}SSO_2\text{-}R^2$

wherein R, R^1, and R^2 may be the same or different and independently represent an aliphatic group, an aromatic group, or a heterocyclic group, M represents a cation, L represents a divalent linking group, and m represents 0 or 1.

Compounds represented by the general formulas [I] to [III] may be polymers containing divalent groups derived from structures represented by the formulas [I] to [III] as repeating units. If possible, R, R^1, R^2, and L may be bonded each other to form a ring.

In the above light-sensitive material, the tabular silver halide grains occupying at least 50% of the total projected area preferably consist of silver iodobromide, silver iodochloride, or silver iodochlorobromide each containing 3.0 mol% or more of silver iodide on an average, and a relative standard deviation between silver iodide contents of individual grains is preferably 30% or less.

Embodiments of the present invention will be described in detail below.

First, a tabular grain used in the present invention will be described in detail.

A tabular grain is a grain having a plurality of parallel twinning planes and a tabular outer shape regardless of its aspect ratio. Although a grain having no twinning plane and an aspect ratio of 2 or more is included in the tabular grain, a tabular grain having twinning planes is preferred. An example of the latter tabular grain is an anisotropically grown regular crystal grain as reported by A. Mignot et al. in Journal of Cryst. Growth, Vol. 23, page 207 (1974).

In a tabular grain, an aspect ratio means a ratio of a diameter with respect to a thickness of a silver halide grain. That is, the aspect ratio is a value obtained by dividing the diameter of each silver halide grain by its thickness. In this case, the diameter is a diameter of a circle having an area equal to a projected area of a silver halide grain upon observation of the grain by an optical microscope or electron microscope. Therefore, when the aspect ratio is 3 or more, the diameter of a circle is three times or more the thickness of a grain.

An average aspect ratio is obtained as follows. That is, 1,000 silver halide grains of the emulsion are extracted at random to measure their aspect ratios, tabular grains are selected, until that reaches 50% of the total projected area in the order from the one with the highest aspect ratio, and an average of aspect ratios of the selected tabular grains is calculated. An average of a diameter or thickness of the tabular grains used to calculate the aspect ratio corresponds to an average grain size or average grain thickness.

An example of an aspect ratio measuring method is a method of photographing an image obtained by a transmission electron microscope with a replica technique to obtain a sphere-equivalent diameter and a thickness of each grain. In this case, the thickness is calculated from the length of a shadow of the replica.

The average aspect ratio of the tabular grains used in the present invention is 3.0 or more, preferably, 3.0 to 20.0, and most preferably, 3.0 to 8.0. In one emulsion layer, a ratio occupied by tabular grains in a projected area of all the silver halide grains is 50% or more, preferably, 70% or more, and more preferably, 85% or more.

An average grain size of the tabular grains used in the present invention is 0.2 to 10.0 μm, and preferably, 0.3 to 5.0 μm, and an average grain thickness thereof is preferably 0.5 μm or less. More preferably, the average grain size is 0.3 μm to 5.0 μm, the average grain thickness is 0.5 μm or less, the average aspect ratio is 3.0 to 8.0, and 85% or more of a total projected area of all silver halide grains of the layer are occupied by the tabular grains.

The tabular grains used in the present invention are described in reports by Cugnac or Chateau, Duffin, "Photographic Emulsion Chemistry" (Focal Press, New York, 1966), pp. 66 to 72, and A.P.H. Trivelli, W.F. Smith ed., "Phot. Journal" 80 (1940), p. 285. The tabular grains can be easily prepared by methods described in JP-A-58-113927, JP-A-58-113928, and JP-A-58-127921 ("JP-A" means published unexamined Japanese patent application).

For example, the emulsions can be prepared by forming a seed crystals including 40% (by weight) or more of tabular grains in an atmosphere in which a pBr is 1.3 or less and pAg is relatively high, and simultaneously adding silver and halogen solutions to grow the seed crystals while the pBr value is maintained substantially constant. In this grain growth process, it is preferred to add the silver and halogen solutions so that no new crystal nucleus is generated.

The size of the tabular silver halide grain can be adjusted by controlling a temperature, selecting the type or quality of a solvent, or controlling addition rates of silver salts and halides used in grain formation.

A grain size distribution of the tabular grains may be either wide or narrow. In general, however, it is difficult to prepare so-called monodispersed tabular grains having a narrow grain size distribution as compared with non-tabular grains (especially an octahedral regular-crystal grain). The reason why the tabular grains cannot be monodispersed by the conventional techniques is assumed that a growth mechanism of the tabular grains is not exactly the same as that of non-tabular grains (especially an octahedral regular crystal grain).

Since the grain size distribution of the tabular grains is wide, i.e., the tabular grains are polydispersed, contrast is decreased as described above. The reason for this is assumed as follows.

If the grain size distribution is widened, a grain volume or grain surface distribution is widened, resulting in a wide difference of light absorption amount between grains. Therefore, since a sensitivity distribution between the grains is widened, the contrast of polydispersed grains becomes lower than that of monodispersed grains.

In order to improve the contrast of tabular grains, the present inventors made extensive studies of a technique entirely different from the conventional grain size monodispersing technique to achieve the expected object and could obtain a light-sensitive material having high sensitivity and contrast and improved graininess and sharpness. That is, the contrast could be improved by adding at least one compound represented by the general formulas [I] to [III] described above during a manufacturing process of a silver halide emulsion.

The silver halide manufacturing process is roughly classified into, e.g., grain formation, desalting, chemical sensitization, and coating steps. The grain formation step is subdivided into, e.g., nucleation, ripening, and growth. These steps are performed not in a predetermined order but in a reverse order or repeatedly.

The present invention contains a silver halide emulsion prepared by adding at least one compound represented by the above formulas [I] to [III] during the manufacturing process. "During the manufacturing process" means that a compound can be basically added at any timing in the manufacturing process. The compound is preferably added before chemical sensitization. The compound is most preferably added during grain formation.

Although the compound can be added in a reaction vessel beforehand, it is preferably added at an arbitrary timing during grain formation. In addition, a compound represented by general formula [I], [II], or [III] can be added in an aqueous solution of a water-soluble silver salt or water-soluble alkali halide to perform grain formation by using the aqueous solution. A method of adding a solution of a compound represented by general formula [I], [II], or [III] several times during grain formation or a method of continuously adding it over a long time period during grain formation is also preferable.

A compound represented by general formula [I], [II], or [III] is preferably added in an amount of 10^{-7} to 10^{-1} mol per mol of a silver halide. The addition amount is more preferably 10^{-6} to 10^{-2} mol/mol Ag, and most preferably, 10^{-5} to 10^{-3} mol/mol Ag.

A conventional method of adding an additive in a photographic emulsion can be adopted to add compounds represented by general formulas [I] to [III] in a manufacturing process. For example, a water-soluble compound can be added in the form of an aqueous solution having an arbitrary concentration, and a water-insoluble compound or a compound which is hardly dissolved in water is dissolved in an arbitrary organic solvent such as alcohols, glycols, ketones, esters, and amides, which is miscible with water and does not adversely affect photographic properties, and then added as a solution.

Thiosulfonic acid compounds represented by general formulas [I] to [III] will be described in more detail below. When each of R, R^1, and R^2 is an aliphatic group, it is a saturated or unsaturated, straight-chain, branched, or cyclic aliphatic hydrocarbon group and is preferably an alkyl group having 1 to 22 carbon atoms, or an alkenyl group or an alkinyl group having 2 to 22 carbon atoms. These groups may have substituents. Examples of the alkyl group are methyl, ethyl, propyl, butyl, pentyl, hexyl, octyl, 2-ethylhexyl, decyl, dodecyl, hexadecyl, octadecyl, cyclohexyl, isopropyl, and t-butyl.

Examples of the alkenyl group are allyl and butenyl.

Examples of the alkinyl group are propargyl and butynyl.

An aromatic group of R, R^1, and R^2 includes a monocyclic or condensed ring aromatic group and preferably has 6 to 20 carbon atoms. Examples of such an aromatic group are phenyl and naphthyl. These groups may be substituted.

A heterocyclic group of R, R^1, and R^2 is a 3- to 15-membered ring, preferably, a 3- to 6-membered ring having at least one element of nitrogen, oxygen, sulfur, selenium, and tellurium and at least one carbon atom. Examples of the heterocyclic group are pyrrolidine, piperidine, pyridine, tetrahydrofurane, thiophene, oxazole, thiazole, imidazole, benzothiazole, benzoxazole, benzimidazole, selenazole, benzoselenazole, tellurazole, triazole, benzotriazole, tetrazole, oxadiazole, and thiadiazole.

Examples of the substituent for R, R^1, and R^2 are an alkyl group (e.g., methyl, ethyl, and hexyl), an alkoxy group (e.g., methoxy, ethoxy, and octyl), an aryl group (e.g., phenyl, naphthyl, and tolyl), a hydroxy group, a halogen atom (e.g., fluorine, chlorine, bromine, and iodine), an aryloxy group (e.g., phenoxy), an alkylthio group (e.g., methylthio and butylthio), an arylthio group (e.g., phenylthio), an acyl group (e.g., acetyl, propionyl, butyryl, and valeryl), a sulfonyl group (e.g., methylsulfonyl and phenylsulfonyl), an acylamino group (e.g., acetylamino and benzoylamino), a sulfonylamino group (e.g., methanesulfonylamino and benzenesulfonylamino), an acyloxy group (e.g., acetoxy and benzoxy), a carboxyl group, a cyano group, a sulfo group, an amino group, an $-SO_2SM$ group (wherein M represents a monovalent cation), and an $-SO_2R^1$ group.

A divalent linking group represented by L is an atom or an atom group containing at least one of C, N, S, and O. Examples of L are an alkylene group, an alkenylene group, an alkynylene group, an arylene group, -O-, -S-, -NH-, -CO-, and $-SO_2-$. These compounds can be used singly or in a combination of two or more thereof.

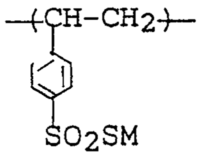
L is preferably a divalent aliphatic group or a divalent aromatic group. Examples of the divalent aliphatic group of L are $(CH_2)_n$ (n = 1 to 12), $-CH_2CH=CH-CH_2-$, $-CH_2C\equiv CCH_2-$,

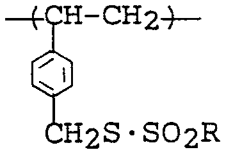
and a xylylene group. Examples of the divalent aromatic group of L are a phenylene group and a naphthylene group.

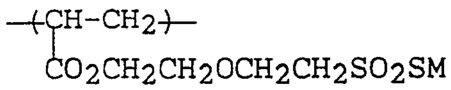
These substituents may be further substituted by the above-mentioned substituents.

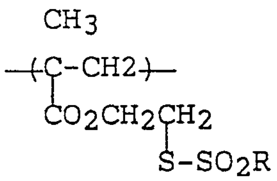
M is preferably a metal ion or an organic cation. Examples of the metal ion are a lithium ion, a sodium ion, and a potassium ion. Examples of the organic cation are an ammonium ion (e.g., ammonium, tetramethylammonium, and tetrabutylammonium), a phosphonium ion (e.g., tetraphenylphosphonium), and a guanidyl group.

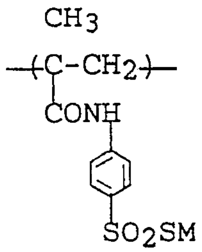
If general formulas [I] to [III] represent polymers, examples of the repeating unit are as follows:











The above polymer may be a homopolymer or a copolymer with another comonomer.

Although examples of compounds represented by general formulas [I] to [III] are listed in Table A to be presented later, compounds are not limited to these examples.

Compounds represented by general formulas [I], [II], and [III] can be easily synthesized by methods described or cited in JP-A-54-1019; British Patent 972,211; Journal of Organic Chemistry, Vol. 53, page 396 (1988); and Chemical Abstracts, Vol. 59, 9776e.

In the present invention, a most preferable compound is a compound represented by general formula [I].

Although a mechanism of the effect of improving the contrast of a silver halide emulsion by adding at least one compound represented by general formulas [I] to [III] during the manufacturing process is still unknown, this can be explained as follows.

That is, an efficiency (to be referred to as a latent image formation efficiency hereinafter) of converting photoelectrons generated by light absorption due to emulsion grains into a silver cluster (latent image) is known to be important as one factor having an effect on the sensitivity of emulsion grains. It is known that the latent image formation efficiency is not uniform but has a distribution between grains even in one emulsion. Therefore, if the distribution of the latent image formation efficiency between grains is widened, a sensitivity distribution between the grains is widened to decrease contrast. Although various factors having an effect on the latent image formation efficiency are possible, the latent image formation efficiency may be decreased if an unnecessary electron trap is present in an emulsion grain. A silver nucleus to be introduced in a grain during the manufacturing process of an emulsion can be such an electron trap.

Compounds represented by the above general formulas [I] to [III] are known to react with a silver nucleus to cause the following conversion:

$$Ag_2 + S \rightarrow Ag_2S$$

The silver nucleus is converted into a silver sulfide nucleus by this reaction.

It may be supporsed that a grain having a low latent image formation efficiency has a silver nucleus as an unnecessary electron trap inside or on the surface of the grain. This silver nucleus is converted into a silver sulfide nucleus upon addition of compounds represented by general formulas [I] to [III], and the latent image formation efficiency is improved to narrow its distribution, thereby increasing the contrast.

The tabular silver halide grains used in the present invention may consist of any of silver chloride, silver bromide, silver chlorobromide, silver iodobromide, silver iodochloride, and silver iodochlorobromide. The tabular silver halide grains preferably consist of silver iodobromide, silver iodochloride, or silver iodochlorobromide, and more preferably, silver iodobromide, silver iodochloride, or silver iodochlorobromide each having an average silver iodide content of 3.0 mol% or more, and most preferably, 3.0 to 30.0 mol%.

A grain structure considered in terms of a halogen composition of the tabular silver halide grains used in the present invention may be a double or multiple structure or a structure in which a composition distribution is localized. The grain structure, however, is preferably a double or multiple structure.

It is totally unexpectedly found that if the tabular silver halide grains used in the present invention contain silver iodide as a halogen composition, a degree of the contrast improving effect of compounds represented by general formulas [I] to [III] largely changes in accordance with a silver iodide content distribution between the grains.

The fact that the contrast of an emulsion can be improved by narrowing the silver iodide content distribution between grains is disclosed in, e.g., EP 147,868A or JP-A-62-209445. These patents, however, disclose only techniques concerning the silver iodide content distribution but have no description about compounds represented by general formulas [I] to [III]. Therefore, it cannot be predicted at all that compounds represented by general formulas [I] to [III] and a silver iodide content have a super additivity on an improvement in contrast.

If the tabular grains used in the present invention contain silver iodide, a relative standard deviation between silver iodide contents of the individual grains is 30% or less, and more preferably, 20% or less.

A silver iodide content of each grain can be measured by analyzing the composition of the grain by using, e.g., an X-ray microanalyzer. In this case, the "relative standard deviation between silver iodide contents of the individual grains" is a value calculated by dividing a standard deviation between silver iodide contents measured for at least 100 emulsion grains by an average silver iodide content and multiplying the obtained value by 100.

More specifically, the silver iodide content of each grain can be measured in accordance with a method described in JP-A-62-209445.

As described above, by using compounds represented by general formulas [I] to [III] in tabular grains having a narrow silver iodide content distribution between the individual grains, a conspicuous contrast improving effect can be obtained.

In a light-sensitive material of the present invention, preferably, at least silver halide emulsion layer, each having blue-, green-, and red-sensitivity are formed on a support, and the number and arrangement of silver halide emulsion layers and non-light-sensitive layers are not particularly limited. Typical example is a silver halide photographic light-sensitive material having at least one light-sensitive layer constituted by a plurality of silver halide emulsion layers sensitive to essentially the same color but having different sensitivities on a support. The light-sensitive layer is a unit light-sensitive layer having sensitivity to blue, red, or green light. In a multilayered silver halide color photographic light-sensitive material, unit light-sensitive layers are generally arranged such that red-, green-, and blue-sensitive layers are formed in the order named from a support. In accordance with an application, however, this order may be reversed, or light-sensitive layers having the same color sensitivity may sandwich another light-sensitive layer having different color sensitivity.

Non-light-sensitive layers such as various types of interlayers may be formed between the silver halide light-sensitive layers or as an uppermost or lowermost layer.

The interlayer may contain, e.g., couplers and DIR compounds described in JP-A-61-43748, JP-A-59-

113438, JP-A-59-113440, JP-A-61-20037, and JP-A-61-20038 or may contain a color mixing inhibitor as in a normal application.

A plurality of silver halide emulsion layers constituting each unit light-sensitive layer may preferably adopt a double-layered arrangement of high- and low-sensitivity emulsion layers as described in West German Patent 1,121,470 or British Patent 923,045. Normally, these layers are preferably arranged such that the sensitivity is sequentially decreased toward a support. In addition, a non-light-sensitive layer may be formed between the silver halide emulsions. Furthermore, the emulsion layers may be arranged such that a low-sensitivity emulsion layer is formed apart from a support and a high-sensitivity layer is formed near the support as described in, e.g., JP-A-57-112751, JP-A-62-200350, JP-A-62-206541, and JP-A-62-206543.

More specifically, the layers may be arranged, from the farthest position from a support, in an order of low-sensitivity blue-sensitive layer (BL)/high-sensitivity blue-sensitive layer (BH)/high-sensitivity green-sensitive layer (GH)/low-sensitivity green-sensitive layer (GL)/high-sensitivity red-sensitive layer (RH)/low-sensitivity red-sensitive layer (RL), an order of BH/BL/GL/GH/RH/RL, or an order of BH/BL/GH/GL/RL/RH.

The layers may be arranged in an order of blue-sensitive layer/GH/RH/GL/RL from the farthest position from a support as described in JP-B-55-34932 ("JP-B" means published examined Japanese patent application). Alternatively, the layers may be arranged in an order of blue-sensitive layer/GL/RL/GH/RH from the farthest position from a support as described in JP-A-56-25738 and JP-A-62-63936.

In addition, as described in JP-B-49-15495, the layers may be arranged such that a silver halide emulsion layer having highest sensitivity is formed as an upper layer, a silver halide emulsion layer having sensitivity lower than that of the upper layer is formed as an intermediate layer, and a silver halide emulsion layer having sensitivity lower than that of the intermediate layer is formed as a lower layer, i.e., three layers having different sensitivities may be arranged such that the sensitivity is sequentially decreased toward a support. In such a three-layered arrangement constituted by three layers having different sensitivities, emulsion layers may be arranged in a layer having the same color sensitivity in an order of medium-sensitivity emulsion layer/high-sensitivity emulsion layer/low-sensitivity emulsion layer from the farthest position from a support as described in JP-A-59-202464.

Furthermore, the layers may be arranged in an order of high-sensitivity emulsion layer/low-sensitivity emulsion layer/medium-sensitivity emulsion layer or an order of low-sensitivity emulsion layer/medium-sensitivity emulsion layer/high-sensitivity emulsion layer.

If four or more layers are to be used, a layer arrangement can be changed as described above.

In order to improve color reproducibility, a donor layer (CL) exhibiting an interlayer effect, which has a spectral sensitivity distribution different from that of a main light-sensitive layer such as BL, GL, or RL is preferably formed adjacent to or close to the main light-sensitive layer as described in U.S. Patents 4,663,271, 4,705,744, and 4,707,436, JP-A-62-160448, and JP-A-63-89850.

As described above, various layer constituents and arrangements can be selectively used in accordance with an application of a light-sensitive material.

A preferable silver halide to be contained in a photographic emulsion layer of the photographic light-sensitive material according to the present invention is silver iodobromide, silver iodochloride, or silver iodochlorobromide each containing about 30 mol% of silver iodide. The silver halide is most preferably silver iodobromide or silver iodochlorobromide containing about 2 mol% to about 25 mol% of silver iodide.

The silver halide grains in the photographic emulsion may be grains having a regular crystal such as a cubic, octahedral, or tetradecahedral crystal, grains having an irregular crystal such as a spherical or tabular crystal, grains having a crystal defect such as a twinning plane, or grains having a composite form thereof.

The silver halide grains may be fine grains having a grain size of about 0.2 μm or less or large grains having a projected area diameter of up to about 10 μm and may be a polydispersed or monodispersed emulsion.

The silver halide photographic emulsion for use in the present invention can be prepared by using methods described in, for example, Research Disclosure (RD) No. 17643 (December, 1978), pp. 22 and 23, "I. Emulsion preparation and types" and RD No. 18716 (November, 1979), page 648; P. Glafkides, "Chimie et Physique Photographique", Paul Montel, 1967; G.F. Duffin, "Photographic Emulsion Chemistry", Focal Press, 1966; and V.L. Zelikman et al., "Making and Coating Photographic Emulsion", Focal Press, 1964.

Monodispersed emulsions described in U.S. Patents 3,574,628 and 3,655,394 and British Patent 1,413,748 are also preferable.

In addition, tabular grains having an average aspect ratio of 3.0 or more and not using compounds represented by general formulas [I] to [III] in the manufacturing process can also be used in the present invention. The tabular grains can be easily prepared by methods described in, for example, Gutoff, Photographic Science and Engineering, Vol. 14, pp. 248 to 257, (1970); and U.S. Patents 4,434,226, 4,414,310, 4,433,048, and 4,439,520, and British Patent 2,112,157.

A crystal structure may be uniform, may have different halogen compositions inside and outside a crystal, or may be a layered structure. In addition, a silver halide having different compositions may be bonded by an epitaxial junction, or a compound other than a silver halide such as silver rhodanide or zinc oxide may be bonded. A mixture of grains having various crystal shapes may also be used.

The silver halide emulsion is normally subjected to physical ripening, chemical ripening, and spectral sensitization before it is used. Additives for use in such a process are described in Research Disclosure Nos. 17643 and 18716, and they are summarized in a table to be presented later.

In the present invention, a non-light-sensitive fine grain silver halide is preferably used. The non-light-sensitive fine grain silver halide consists of silver halide fine grains which are not sensitive enough during imagewise exposure for obtaining a dye image and essentially not developed during development. The silver halide grains are preferably not fogged in advance.

The fine grain silver halide has a silver bromide content of 0 to 100 mol% and may contain silver chloride and/or silver iodide at need. The fine grain silver halide preferably contains 0.5 to 10 mol% of silver iodide.

An average grain size (average value of circle-equivalent diameters of projected areas) of the fine grain silver halide is preferably 0.01 to 0.5 μm, and more preferably, 0.02 to 0.2 μm.

The fine grain silver halide can be prepared by the same method as for a conventional light-sensitive silver halide. In this case, the surface of a silver halide grain need not be optically sensitized nor spectrally sensitized. Before the fine grain silver halide is added to a coating solution, however, a known stabilizer such as a triazole-, azaindene-, benzothiazolium-, or mercapto-based compound or a zinc compound is preferably added.

Known photographic additives which can be used in the present invention are also described in the above two Research Disclosures and they are summarized in the following table.

	Additives	RD No.17643	RD No.18716
1.	Chemical sensitizer	page 23	page 648, right column
2.	Sensitivity increasing agents		do
3.	Spectral sensitizers, super sensitizers	page 23-24	page 648, right column to page 649, right column
4.	Brighteners	page 24	
5.	Antifoggants and stabilizers	pages 24-25	page 649, right column
6.	Light absorber, filter dye, ultra-violet absorbers	pages 25-26	page 649, right column to page 650, left column
7.	Anti-stain agents	page 25, right column	page 650, left to right columns
8.	Dye image stabilizer	page 25	
9.	Hardening agents	page 26	page 651, right column
10.	Binder	page 26	do
11.	Plasticizers, lubricants	page 27	page 650, right column
12.	Coating aids, surfactants	pages 26-27	do
13.	Antistatic agents	page 27	do

In addition, in order to prevent degradation in photographic properties caused by formaldehyde gas, a compound which can react with and fix formaldehyde described in U.S. Patent 4,411,987 or 4,435,503 is preferably added to the light-sensitive material.

In this invention, various color couplers can be used in the light-sensitive material. Specific examples of these couplers are described in above-described Research Disclosure, No. 17643, VII-C to VII-G as patent references.

Preferable examples of a yellow coupler are described in, e.g., U.S. Patents 3,933,501, 4,022,620, 4,326,024, 4,401,752, and 4,248,961, JP-B-58-10739, British Patents 1,425,020 and 1,476,760, U.S. Patents 3,973,968, 4,314,023, and 4,511,649, and EP 249,473A.

Examples of a magenta coupler are preferably 5-pyrazolone and pyrazoloazole compounds, and more preferably, compounds described in, e.g., U.S. Patents 4,310,619 and 4,351,897, EP 73,636, U.S. Patents 3,061,432 and 3,725,067, Research Disclosure No. 24220 (June 1984), JP-A-60-33552, Research Disclosure No. 24220 (June 1984), JP-A-60-43659, JP-A-61-72238, JP-A-60-35730, JP-A-55-118034, JP-A-60-185951, U.S. Patents 4,500,630, 4,540,654, and 4,556,630, and WO No. 04795/88.

Examples of a cyan coupler are phenol and naphthol couplers, and preferably, those described in, e.g., U.S. Patents 4,052,212, 4,146,396, 4,228,233, 4,296,200, 2,369,929, 2,801,171, 2,772,162, 2,895,826, 3,772,002, 3,758,308, 4,334,011, and 4,327,173, West German Patent Application (OLS) No. 3,329,729, EP 121,365A, EP 249,453A, U.S. Patents 3,446,622, 4,333,999, 4,775,616, 4,451,559, 4,427,767, 4,690,889, 4,254,212, and 4,296,199, and JP-A-61-42658.

Typical examples of a polymerized dye-forming coupler are described in, e.g., U.S. Patents 3,451,820, 4,080,211, 4,367,282, 4,409,320, and 4,576,910, British Patent 2,102,137, and EP 341,188A.

Preferable examples of a coupler capable of forming colored dyes having proper diffusibility are those described in U.S. Patent 4,366,237, British Patent 2,125,570, EP 96,570, and West German Patent Application (OLS) No. 3,234,533.

Preferable examples of a colored coupler for correcting additional, undesirable absorption in a colored dye are those described in Research Disclosure No. 17643, item VII-G, U.S. Patent 4,163,670, JP-B-57-39413, U.S. Patents 4,004,929 and 4,138,258, and British Patent 1,146,368. In addition, a coupler for correcting additional, undesirable absorption in a colored dye by a fluorescent dye released upon coupling described in U.S. Patent 4,774,181 and a coupler having, as a split-off group, a dye precursor group capable of forming a dye upon reaction with a developing agent described in U.S. Patent 4,777,120 are also preferable.

Couplers releasing a photographically useful moiety upon coupling are also preferably used in the present invention. Preferable examples of a DIR coupler releasing a development inhibitor are described in the patents cited in the above-described Research Disclosure No. 17643, VII-F, JP-A-57-15194, JP-A-57-154234, JP-A-60-184248, JP-A-63-37346, JP-A-63-37350, and U.S. Patents 4,248,962 and 4,782,012.

Preferable examples of a coupler imagewise releasing a nucleating agent or a development accelerator upon development are those described in British Patent 2,097,140, 2,131,188, and JP-A-157638 and JP-A-59-170840.

Examples of a compound which can be used in the light-sensitive material of the present invention are competing couplers described in, e.g., U.S. Patent 4,130,427; poly-equivalent couplers described in, e.g., U.S. Patents 4,283,472, 4,338,393, and 4,310,618; a DIR redox compound releasing coupler, a DIR coupler releasing coupler, a DIR coupler releasing redox compound, or a DIR redox releasing redox compound described in, e.g., JP-A-60-185950 and JP-A-62-24252; couplers releasing a dye which turns to a colored form after being split off described in EP 173,302A and EP 313,308A; bleaching accelerator releasing couplers described in, e.g., RD. Nos. 11449 and 24241 and JP-A-61-201247; a legand releasing coupler described in, e.g., U.S. Patent 4,555,477; a leuco dye releasing coupler described in JP-A-63-75747; and a coupler releasing a fluorescent dye described in U.S. Patent 4,774,181.

The couplers for use in this invention can be introduced in the light-sensitive material by various known dispersion methods.

Examples of a high-boiling solvent used in an oil-in-water dispersion method are described in, e.g., U.S. Patent 2,322,027.

Examples of a high-boiling organic solvent for use in the oil-in-water dispersion method and having a boiling point of 175°C or more at normal pressure are phthalate esters (e.g., dibutylphthalate, dicyclohexylphthalate, di-2-ethylhexylphthalate, decylphthalate, bis(2,4-di-t-amylphenyl)phthalate, bis(2,4-di-t-amylphenyl)isophthalate, and bis(1,1-diethylpropyl)phthalate), phosphate or phosphonate esters (e.g., triphenylphosphate, tricresylphosphate, 2-ethylhexyldiphenylphosphate, tricyclohexylphosphate, tri-2-ethylhexylphosphate, tridodecylphosphate, tributoxyethylphosphate, trichloropropylphosphate, and di-2-ethylhexylphenylphosphate), benzoate esters (e.g., 2-ethylhexylbenzoate, dodecylbenzoate, and 2-ethylhexyl-p-hydroxybenzoate), amides (e.g., N,N-diethyldodecaneamide, N,N-diethyllaurylamide, and N-tetradecylpyrrolidone), alcohols or phenols (e.g., isostearylalcohol and 2,4-di-tert-amylphenol), aliphatic carboxylate esters (e.g., bis(2-ethylhexyl)sebacate, dioctylazelate, glyceroltributylate, isostearyllactate, and trioctylcitrate), an aniline derivative (e.g., N,N-dibutyl-2-butoxy-5-tert-octylaniline), and a hydrocarbon (e.g., paraffin, dodecylbenzene, diisopropylnaphthalene). An organic solvent having a boiling point of about 30° C or more, and preferably, 50° C to about 160° C can be used as a co-solvent. Typical examples of the co-solvent are ethyl acetate, butyl acetate, ethyl propionate, methylethylketone, cyclohexanone, 2-ethoxyethylacetate, and dimethylformamide.

Procedure and effects of a latex dispersion method and examples of an impregnating latex are described in, e.g., U.S. Patent 4,199,363 and West German Patent Application (OLS) Nos. 2,541,274 and 2,541,230.

In the light-sensitive material of the present invention, various types of an antiseptic agent or an antifungal agent such as phenethyl alcohol or 1,2-benzisothiazoline-3-one, n-butyl-p-hydroxybenzoate, phenol, 4-chloro-3,5-dimethylphenol, 2-phenoxyethanol, and 2-(4-thiazolyl)benzimidazole described in JP-A-63-257747, JP-A-62-272248, and JP-A-1-80941 are preferably added.

The present invention can be applied to various color light-sensitive materials. Examples of the material are a color negative film for a general purpose or a movie, a color reversal film for a slide or a television, color paper, a color positive film, and color reversal paper.

Examples of a support suitable for use in this invention are described, e.g., in the above-mentioned RD. No. 17643, page 28 and ibid., No. 18716, page 647, right column to page 648, left column.

In the light-sensitive material of the present invention, a total film thickness of all hydrophilic colloidal layers on a side having emulsion layers is 28 μm or less, preferably, 23 μm or less, more preferably, 18 μm or less, and most preferably, 16 μm or less. In addition, a film swelling rate $T_{1/2}$ is preferably 30 seconds or less, and more preferably, 20 seconds or less. In this case, the term "film thickness" means a film thickness measured under the controlled humidity of a relative humidity of 55% at 25° C (two days), and the film swelling rate $T_{1/2}$ can be measured in accordance with known methods in this field of art. For example, $T_{1/2}$ can be measured by using a swellometer (dilatometer) described in A. Green et al., "Photogr. Sci. Eng", Vol. 19, No. 2, pp. 124 to 129. Assuming that a saturated film thickness is 90% of a maximum swelling film thickness reached when development is performed by using a color developing agent at 30° C for 3 minutes and 15 seconds, $T_{1/2}$ is defined as a time required for that the film thickness reaches 1/2 of the saturated film thickness.

The film swelling rate $T_{1/2}$ can be adjusted by adding a film hardener to gelatin as a binder or by changing aging conditions after coating. A swelling ratio is preferably 150% to 400%. The swelling ratio can be calculated from the maximum swelling film thickness obtained under the conditions described above in accordance with equation : (maximum swelling film thickness - film thickness)/film thickness.

The color photographic light-sensitive materials of this invention can be developed by the conventional methods as described in, e.g., the above-described Research Disclosure, No. 17643, pages 28 and 29 and ibid., No. 18716, page 651, left to right columns.

A color developer used in developing of the light-sensitive material of the present invention is an aqueous alkaline solution mainly consisting of, preferably, an aromatic primary amine-based color developing agent. As the color developing agent, although an aminophenol-based compound is effective, a p-phenylenediamine-based compound is preferably used. Typical examples of the p-phenylenediamine-based compound are 3-methyl-4-amino-N,N-diethylaniline, 3-methyl-4-amino-N-ethyl-N-β-hydroxyethylaniline, 3-methyl-4-amino-N-ethyl-N-β-methanesulfonamidoethylaniline, 3-methyl-4-amino-N-ethyl-N-β-methoxyethylaniline, and sulfates, hydrochlorates, and p-toluenesulfonates thereof. Of these compounds, 3-methyl-4-amino-N-ethyl-N-β-hydroxyethylaniline sulfate is most preferable. These compounds can be used in a combination of two or more thereof in accordance with applications.

In general, the color developer contains a pH buffer such as a carbonate, a borate or a phosphate of an alkali metal, and a development restrainer or antifoggant such as a chloride, a bromide, an iodide, a benzimidazole, a benzothiazole or a mercapto compound. If necessary, the color developer may also contain a preservative such as hydroxylamine, diethylhydroxylamine, sulfite, a hydrazine such as N,N-biscarboxymethylhydrazine, a phenylsemicarbazide, triethanolamine, and a catechol sulfonic acid; an organic solvent such as ethyleneglycol and diethyleneglycol; a development accelerator such as benzylalcohol, polyethyleneglycol, a quaternary ammonium salt or an amine; a dye forming coupler; a competing coupler; an auxiliary developing agent such as 1-phenyl-3-pyrazolidone; a viscosity imparting agent; and a chelating agent such as an aminopolycarboxylic acid, an aminopolyphosphonic acid, an alkylphosphonic acid, and a phosphonocarboxylic acid. Examples of the chelating agent are ethylenediaminetetraacetic acid, nitrilotriacetic acid, diethylenetriaminepentaacetic acid, cyclohexanediaminetetraacetic acid, hydroxyethyliminodiacetic acid, 1-hydroxyethylidene-1,1-diphosphonic acid, nitrilo-N,N,N-trimethylenephosphonic acid, ethylenediamine-N,N,N,N-tetramethylenephosphonic acid and ethylenediamine-di(o-hydroxyphenylacetic acid), and salts thereof.

In order to perform reversal development, black-and-white development is performed and then color development is performed. As a black-and-white developer, well-known black-and-white developing agents, e.g., a dihydroxybenzene such as hydroquinone, a 3-pyrazolidone such as 1-phenyl-3-pyrazolidone, and an aminophenol such as N-methyl-p-aminophenol can be used singly or in a combination of two or more thereof.

The pH of the color and black-and-white developers is generally 9 to 12. Although a quantity of replenisher of the developer depends on the type of a color photographic light-sensitive material to be processed, it is generally 3 liters or less per m^2 of the light-sensitive material. The quantity of replenisher can be decreased to be 500 mℓ or less by decreasing a bromide ion concentration in a replenisher. In order to decrease the quantity of replenisher, a contact area of the replenisher in a processing tank with air is preferably decreased to prevent evaporation and oxidation of the replenisher upon contact with air.

A contact area between a photographic processing solution and air in a processing tank can be represented by a numerical aperture to be defined below:

$$\text{numerical aperture} = \frac{\text{contact area between processing solution and air (cm}^2\text{)}}{\text{volume of processing solution (cm}^3\text{)}}$$

The numerical aperture is preferably 0.1 or less, and more preferably, 0.001 to 0.05. Examples of a method of decreasing the numerical aperture are, in addition to a method of providing a shielding member such as a floating cover on the surface of a photographic processing solution in the processing tank, a method of using a movable cover described in JP-A-1-82033 and a slit developing method described in JP-A-63-216050. The numerical aperture is preferably decreased not only in color development and black/white development steps but also in all subsequent steps such as bleaching, bleach-fixing, fixing, washing, and stabilizing steps. In addition, a quantity of replenisher can be decreased by using a means for suppressing accumulation of bromide ions during developer.

A time required for color development is normally set between 2 to 5 minutes. The processing time, however, can be shortened by setting a high temperature and a high pH and using the color developing agent at a high concentration.

The photographic emulsion layer is generally subjected to bleaching after color development. The bleaching may be performed either simultaneously with fixing (bleach-fixing) or independently therefrom. In addition, in order to increase a processing speed, bleach-fixing may be performed after bleaching. Also, processing may be performed in a bleach-fixing bath having two continuous tanks, fixing may be performed before bleach-fixing, or bleaching may be performed after bleach-fixing, in accordance with applications. Examples of the bleaching agent are a compound of a multivalent metal such as iron (III); a peroxide; a quinone; and a nitro compound. Typical examples of the bleaching agent are an organic complex salt of iron (III), e.g., a complex salt of an aminopolycarboxylic acid such as ethylenediaminetetraacetic acid, diethylenetriaminepentaacetic acid, cyclohexanediaminetetraacetic acid, methyliminodiacetic acid, 1,3-diaminopropanetetraacetic acid, and glycoletherdiaminetetraacetic acid, or a complex salt of citric acid, tartaric acid, or malic acid. Of these compounds, an aminopolycarboxylatoferrate (III) complex such as ethylenediaminetetraacetatoferrate (III) complex and 1,3-diaminopropanetetraacetoferrate (III) complex are preferable because they can increase a processing speed and prevent an environmental contamination. The aminopolycarboxylatoferrate (III) complex is effective in both the bleaching and bleach-fixing solutions. The pH of the bleaching or bleach-fixing solution using the aminopolycarboxylatoferrate (III) complex is normally 4.0 to 8. In order to increase the processing speed, however, processing can be performed at a lower pH.

A bleaching accelerator can be used in the bleaching solution, the bleach-fixing solution and their pre-bath, if necessary. Effective examples of the bleaching accelerator are compounds having a mercapto group or a disulfide group described in, e.g., U.S. Patent 3,893,858, West German Patents 1,290,812 and 2,059,989, JP-A-53-32736, JP-A-53-57831, JP-A-53-37418, JP-A-53-72623, JP-A-53-95630, JP-A-53-95631, JP-A-53-104232, JP-A-53-124424, JP-A-53-141623, JP-A-53-28426, and Research Disclosure No. 17129 (July, 1978); a thiazolidine derivative described in JP-A-50-140129; thiourea derivatives described in JP-B-45-8506, JP-A-52-20832, JP-A-53-32735, and U.S. Patent 3,706,561; iodide salts described in West German Patent 1,127,715 and JP-A-58-16235; polyoxyethylene compounds described in West German Patents 966,410 and 2,748,430; a polyamine compound described in JP-B-45-8836; compounds described in JP-A-

49-40943, JP-A-49-59644, JP-A-53-94927, JP-A-54-35727, JP-A-55-26506, and JP-A-58-163940; and a bromide ion. Of these compounds, a compound having a mercapto group or a disulfide group is preferable since it has a large accelerating effect. In particular, compounds described in U.S. Patent 3,893,858, West German Patent 1,290,812, and JP-A-53-95630 are preferable. A compound described in U.S. Patent 4,552,834 is also preferable. These bleaching accelerators may be added in the light-sensitive material. These bleaching accelerators are effective especially in bleach-fixing of a color light-sensitive material for picture taking with camera.

In addition to the above compounds, a bleaching solution and a bleach-fixing solution preferably contain an organic acid in order to prevent a bleach stain. Most preferable examples of the organic acid are compounds having an acid dissociation constant (pKa) of 2 to 5, e.g., acetic acid and propionic acid.

Examples of the fixing agent used in the fixing solution or bleach-fixing solution are a thiosulfate, a thiocyanate, a thioether-based compound, a thiourea, and a large amount of an iodide. Of these compounds, a thiosulfate, especially, ammonium thiosulfate can be used in a widest range of applications. In addition, a thiosulfate can be preferably used together with a thiocyanate, a thioether-based compound, and a thiourea. As a preservative for use in the fixing solution or bleach-fixing solution, a sulfite, a bisulfite, a carbonyl bisulfite adduct, or a sulfinic acid compound described in EP 294,769A is preferable. In order to stabilize the fixing solution or bleach-fixing solution, various types of aminopolycarboxylic acids or organic phosphonic acids are preferably added. A total time of a desilvering step is preferably short as long as no desilvering failure occurs. The total time is preferably one to three minutes, and more preferably, one to two minutes. The processing temperature is 25° C to 50° C, and preferably, 35° C to 45° C. Within a preferable temperature range, a desilvering rate is increased, and generation of stains after the processing can be effectively prevented.

In the desilvering step, the degree of stirring is preferably maximized. Examples of a method of increasing the degree of stirring are a method of pelting a jet stream of a processing solution against an emulsion surface of a light-sensitive material described in JP-A-62-183460, a method of enhancing a stirring effect by using a rotary means described in JP-A-62-183461, a method of moving a light-sensitive material while a wiper blade provided in a processing solution is brought into contact with an emulsion surface to produce a turbulent flow on the emulsion surface, thereby enhancing a stirring effect, and a method of increasing a circulating flow amount of a processing solution as a whole. Such methods for improving stirring are effective in any of a bleaching solution, a bleach-fixing solution, and a fixing solution. An improvement in stirring is assumed to increase a supply rate of a bleaching agent or a fixing agent into an emulsion film, thereby increasing a desilvering rate. In addition, the above methods for improving stirring are more effective when a bleaching accelerator is used. As a result, an accelerating effect can be conspicuously enhanced, or a fixing interrupting effect caused by a bleaching accelerator can be eliminated.

An automatic developing machine for developing a light-sensitive material of the present invention preferably has light-sensitive material conveyor means described in JP-A-60-191257, JP-A-60-191258, and JP-A-60-191259. As described in JP-A-60-191257, such conveyor means can conspicuously reduce an amount of a processing solution carried from a pre-bath to a post-bath, thereby effectively preventing degradation in performance of the processing solution. This effect particularly reduces a processing time or a quantity of a processing solution replenisher in each step.

The photographic light-sensitive material of the present invention is normally subjected to washing and/or stabilizing steps after desilvering. An amount of water used in the washing step can be arbitrarily determined over a broad range in accordance with the properties (e.g., a property determined by use of a coupler) of the light-sensitive material, the application of the material, the temperature of the water, the number of water tanks (the number of stages), a replenishing mode representing a counter or forward current, and other conditions. The relationship between the amount of water and the number of water tanks in a multi-stage counter-current mode can be obtained by a method described in Journal of the Society of Motion Picture and Television Engineers, Vol. 64, pp. 248 - 253 (May, 1955).

According to the above-described multi-stage counter-current mode, the amount of water used for washing can be greatly decreased. Since washing water stays in the tanks for a long period of time, however, bacteria multiply and floating substances generated may be undesirably attached to the light-sensitive material. In order to solve this problem in the process of the photographic light-sensitive material of the present invention, a method of decreasing calcium and magnesium ions can be effectively utilized, as described in JP-A-62-288838. In addition, a germicide such as an isothiazolone compound and thiabendazole described in JP-A-57-8542, a chlorine-based germicide such as chlorinated sodium isocyanurate, and germicides such as benzotriazole described in Hiroshi Horiguchi, "Chemistry of Antibacterial and Antifungal Agents" (1986), Sankyo Shuppan, Eiseigijutsu-kai ed., "Sterilization, Antibacterial, and Antifungal Techniques for Microorganisms" (1982), Industrial Technique Society, and Nippon Bokin Bobabi Gakkai ed., "Dictionary of Antibacterial and Antifungal Agents" (1986).

The pH of the water for washing the photographic light-sensitive material of the present invention is 4 to 9, and preferably 5 to 8. The water temperature and the washing time can vary in accordance with the properties and applications of the light-sensitive material. Normally, however, the washing time is 20 seconds to 10 minutes at a temperature of 15° C to 45° C, and preferably, 30 seconds to 5 minutes at 25° C to 40° C. The light-sensitive material of the present invention can be processed directly by a stabilizer in place of washing. All known methods described in JP-A-57-8543, JP-A-58-14834, and JP-A-60-220345 can be used in such stabilizing processing.

Stabilizing is sometimes performed subsequently to washing. An example is a stabilizing bath containing dye stabilizer and a surfactant to be used as a final bath of a color light-sensitive material for picture taking with camera. Examples of the dye stabilizer are an aldehyde such as formalin and glutaraldehyde, an N-methylol compound, hexamethylenetetramine, and an aldehyde sulfite adduct.

Various chelating agents or antifungal agents can be added in this stabilizing bath.

An overflow solution produced upon washing and/or replenishment of the stabilizer can be reused in another step such as a desilvering step.

If the processing solution is condensed by evaporation in processing using an automatic developing machine, water is preferably added to correct a concentration.

The silver halide photographic light-sensitive material of the present invention may contain a color developing agent in order to simplify processing and increase a processing speed. For this purpose, various types of precursors of color developing agents are preferably used. Examples of the precursor are an indoaniline-based compound described in U.S. Patent 3,342,597, Schiff base compounds described in U.S. Patent 3,342,599, Research Disclosure Nos. 14,850 and 15,159, an aldol compound described in Research Disclosure No. 13,924, a metal salt complex described in U.S. Patent 3,719,492, and an urethane-based compound described in JP-A-53-135628.

The silver halide photographic light-sensitive material of the present invention may contain various 1-phenyl-3-pyrazolidones in order to accelerate color development, if necessary. Typical examples of the compound are described in JP-A-56-64339, JP-A-57-144547, and JP-A-58-115438.

Each processing solution for the light-sensitive material of the present invention is used at a temperature of 10° C to 50° C. Although a normal processing temperature is 33° C to 38° C, processing may be accelerated at a higher temperature to shorten a processing time, or image quality or stability of a processing solution may be improved at a lower temperature.

The silver halide photographic light-sensitive material of the present invention can also be applied to light-sensitive materials for heat development described in, e.g., U.S. Patent 4,500,626, JP-A-60-133449, JP-A-59-218433, JP-A-61-238056, and EP 210,660A2.

The present invention will be described in more detail below by way of its examples, but the present invention is not limited to these examples.

Example 1

30 g of inert gelatin and 6 g of potassium bromide were dissolved in 1 ℓ of distilled water, and the resultant solution was stirred at 75° C. 35 cc of an aqueous solution containing 5.0 g of silver nitrate and 35 cc of an aqueous solution containing 3.2 g of potassium bromide and 0.98 g of potassium iodide were added to the above solution under stirring at a flow rate of 70 cc/min. for 30 seconds, and then a pAg was increased to be 10 to perform ripening for 30 minutes, thereby preparing a seed emulsion.

One liter of an aqueous solution containing 145 g of silver nitrate was prepared. Equimolar amounts of the aqueous solution and an aqueous solution mixture of potassium bromide and potassium iodide were added to the seed emulsion at a predetermined temperature and a predetermined pAg while an addition rate was maintained constant, thereby preparing a tabular core emulsion.

Subsequently, equimolar amounts of the remaining aqueous silver nitrate solution and an aqueous mixture of potassium bromide and potassium iodide having a composition different from that used in preparation of the core emulsion were added at a predetermined temperature and a predetermined pAg while an addition rate was maintained constant to cover the core, thereby preparing emulsions Em-A to Em-D including core/shell type silver iodobromide tabular grains.

An aspect ratio was adjusted by selecting the pAg upon core/shell preparation.

In addition, 30 g of inert gelatin and 8 g of potassium bromide were dissolved in 1 ℓ of distilled water, and the resultant solution was stirred at 75° C. 35 cc of an aqueous solution containing 5.0 g of silver nitrate and 35 cc of an aqueous solution containing 1.2 g of potassium bromide and 0.98 g of potassium iodide were added at a flow rate of 105 cc/min. for 20 seconds, and then a pAg was increased to be 11 to perform ripening for 30 minutes, thereby preparing another seed emulsion.

Subsequently, equimolar amounts of the same aqueous silver nitrate solution and aqueous mixture of potassium bromide and potassium iodide as those used in core emulsion preparation of the emulsions Em-A to Em-D were added to the seed emulsion at a predetermined temperature and a predetermined pAg while an addition rate was changed to be maintained at about a critical growth rate, thereby preparing a tabular core emulsion.

Subsequently, equimolar amounts of the same aqueous silver nitrate solution and aqueous mixture of potassium bromide and potassium iodide as those used in shell portion formation of the emulsions Em-A to Em-D were added at a predetermined temperature and a predetermined pAg while an addition rate was changed to be maintained at about a critical growth rate, thereby preparing emulsions Em-E and Em-F including core/shell type silver iodobromide tabular grains.

Similar to the emulsions Em-A to Em-D, an aspect ratio was adjusted by selecting the pAg upon core and shell preparation.

Measurement results of the emulsions Em-A to Em-F are summarized in Table 1-1. As for a grain volume, an average sphere-equivalent diameter of each of the emulsions Em-A to Em-F was 1.2 μm. Each of the emulsions Em-A to Em-F was an emulsion in which 85% or more of a projected area of all grains were occupied by tabular grains having a plurality of parallel twinning planes. In addition, an average silver iodide content of each of the emulsions Em-A to Em-F was 7.6 mol% in fomulation.

Table 1-1

Emulsion Name	*1 Average Aspect Ratio	*2 Average Grain Size (μm)	*2 Average Grain Thickness (μm)	*3 Silver Iodide Content Relative Standard Deviation (%)
Em-A	1.8	1.21	0.70	34
Em-B	3.7	1.45	0.42	36
Em-C	7.9	2.00	0.26	36
Em-D	17.0	2.75	0.17	37
Em-E	3.5	1.40	0.42	25
Em-F	7.6	1.95	0.27	27

*1 : Average aspect ratio
Aspect ratios of 1,000 emulsion grains extracted at random are measured, grains are selected therefrom, until that reaches 50% of the total projected area in the order from the one with the highest aspect ratio, and an arithmetic means value of the aspect ratios of the selected grains is obtained.

*2 : Average grain size, and average grain thickness
An arithmetic means value of the diameters or thicknesses of the grains corresponding to 50% of the total projected area used in calculation of the average aspect ratio.

*3 : Silver iodide content relative standard deviation
Silver iodide contents of 100 emulsion grains extracted at random were measured, and a standard deviation of the measured silver iodide contents was divided by an average silver iodide content and multiplied by 100.

In the preparing emulsions Em-A to Em-F, a compound 1-2 or a compound 1-16 was added in amounts shown in Table 1-2 immediately before starting of shell formation to perform grain formation, thereby preparing emulsions Em-1 to Em-28.

In the preparing emulsion Em-F, the compound 1-16 was added in an amount shown in Table 1-2 immediately before starting of grain formation of a core emulsion to perform grain formation, thereby preparing an emulsion Em-29.

In the preparing emulsion Em-F, the compound 1-16 was added in an amount shown in Table 1-2 10 minutes before starting of chemical sensitization to prepare an emulsion Em-30.

Each of the emulsions Em-1 to Em-30 was optimally subjected to gold-plus-sulfur sensitization by using sodium thiosulfate and chloroauric acid.

Table 1-2

Emulsion Name	Added Compound	Addition Amount (per mol of silver)	Addition Timing	Basic Emulsion
Em-1	---	---	---	Em-A
Em-2	1-2	3×10^{-5}	Before shell formation	"
Em-3	1-16	3×10^{-5}	"	"
Em-4	---	---	---	Em-B
Em-5	1-2	3×10^{-6}	Before shell formation	"
Em-6	"	3×10^{-5}	"	"
Em-7	"	3×10^{-4}	"	"
Em-8	1-16	3×10^{-6}	"	"
Em-9	"	3×10^{-5}	"	"
Em-10	"	3×10^{-4}	"	"
Em-11	---	---	---	Em-C
Em-12	1-2	3×10^{-6}	Before shell formation	"
Em-13	"	3×10^{-5}	"	"
Em-14	"	3×10^{-4}	"	"
Em-15	1-16	3×10^{-5}	"	"
Em-16	---	---	---	Em-D
Em-17	1-2	3×10^{-5}	Before shell formation	"

(continued)

Table 1-2

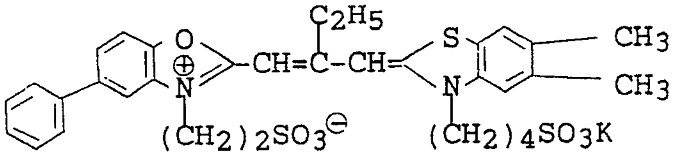
Emulsion Name	Added Compound	Addition Amount (per mol of silver)	Addition Timing	Basic Emulsion
Em-18	1-16	3×10^{-5}	Before shell formation	Em-D
Em-19	---	---	---	Em-E
Em-20	1-2	3×10^{-6}	Before shell formation	"
Em-21	"	3×10^{-5}	"	"
Em-22	"	3×10^{-4}	"	"
Em-23	1-16	3×10^{-6}	"	"
Em-24	"	3×10^{-5}	"	"
Em-25	"	3×10^{-4}	"	"
Em-26	---	---	---	Em-F
Em-27	1-2	3×10^{-5}	Before shell formation	"
Em-28	1-16	3×10^{-5}	"	"
Em-29	"	"	Before core formation	"
Em-30	"	"	Before chemical sensitization	"

The following dyes were added to the emulsions Em-1 to Em-30 immediately before coating, thereby performing spectral sensitization.

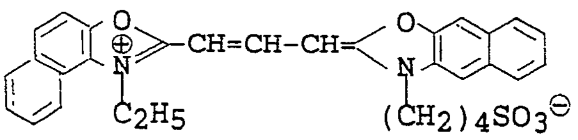
Dye group (green-sensitive dye)

Sensitizing dye I	4.2×10^{-5} mol/mol Ag
Sensitizing dye II	9.6×10^{-5} mol/mol Ag
Sensitizing dye III	3.6×10^{-4} mol/mol Ag

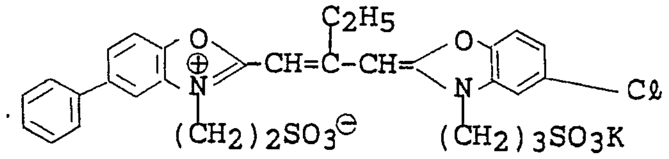
I



II



III

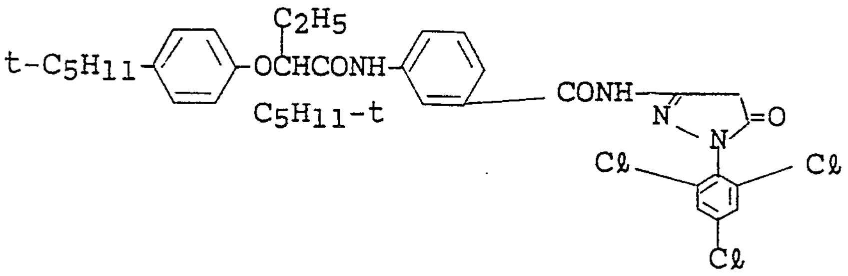


Emulsion and protective layers were coated in the following amounts on supports made of triacetylcellulose film having undercoating layers.

(1) Emulsion layer

Emulsion...emulsions Em-1 to Em-30 shown in Table 1-2 (silver 1.85×10^{-2} mol/m^2)

Coupler (1.54×10^{-3} mol/m^2)



Tricresylphosphate (1.10 g/m^2)

Gelatin (2.30 g/m^2)

(2) Protective layer

2,4-dichlorotriazine-6-hydroxy-s-triazine sodium salt (0.08 g/m^2)

Gelatin (1.80 g/m^2)

These samples were subjected to sensitometry exposure, and the following color development was performed.

The developed samples were subjected to density measurement by using a green filter. The resultant photographic properties are summarized in Table 1-5.

Development was performed under the following conditions at a temperature of 38° C.

1. Color development ...2 min. 45 sec.
2. Bleaching ...6 min. 30 sec.
3. Washing ...3 min. 15 sec.
4. Fixing ...6 min. 30 sec.
5. Washing ...3 min. 15 sec.
6. Stabilizing ...3 min. 15 sec.

The compositions of processing solutions used in the above steps were as follows.

Color developer:

Sodium nitrilotriacetate	1.4 g
Sodium sulfite	4.0 g
Sodium carbonate	30.0 g
Potassium bromide	1.4 g
Hydroxylamine sulfate	2.4 g
4-(N-ethyl-N-β-hydroxyethylamino)-2-methyl-aniline sulfate	4.5 g
Water to make	1 ℓ

Bleaching solution:

Ammonium bromide	160.0 g
Ammonia water (28%)	25.0 mℓ
Sodium ethylenediaminetetraacetate	130 g
Glacial acetic acid	14 mℓ
Water to make	1 ℓ

Fixing solution:

Sodium tetrapolyphosphate	2.0 g
Sodium sulfite	4.0 g
Ammonium thiosulfate (70%)	175.0 mℓ
Sodium bisulfite	4.6 g
Water to make	1 ℓ

Stabilizing solution:

Formalin	8.0 mℓ
Water to make	1 ℓ

In this case, normal wedge exposure was performed for 1/100 second.

A light source was adjusted at a color temperature of 4,800° K by using a filter, and a yellow filter (SC-52 (tradename): available from Fuji Photo Film Co. Ltd.) was used.

Fog: Fog is a minimum optical density in a characteristic curve and a larger value is less preferable.

Sensitivity: Sensitivity is a reciprocal of an exposure value (anti-logarithm value) for giving optical density of minimum optical density + 0.2 on a characteristic curve and represented by an relative value assuming that the sensitivity of the emulsion Em-1 is 100. A larger value means higher sensitivity and therefore is more preferable.

Gamma: Gamma is a characteristic value concerning gradation and represented by a difference between density of minimum optical density + 0.2 and a density on a characteristic curve at a point having an exposure amount 10 times that at a point of the above density. The difference is represented by a relative value assuming that the gamma of the emulsion Em-1 is 1. A larger value means high contrast and therefore is more preferable.

Transparency: Transparency is represented by a ratio of the intensity of a specular transmitted light component with respect to the intensity of an incident light obtained when specular light having a wavelength of 600 nm is irradiated on a coated sample of each emulsion. A larger value indicates that transparency is higher and a degree of light scattering in a coated film is smaller and is therefore more preferable.

Measurement results of sensitometry and transparency of each sample are summarized in Table 1-3.

Table 1-3

Emulsion Name		Fog	Sensitivity	Gamma	Transparency
Em-1	Comparison	0.12	100	1.00	0.51
Em-2	"	0.09	102	1.06	0.54
Em-3	"	0.09	100	1.06	0.50
Em-4	Comparison	0.14	105	1.04	0.65
Em-5	"	0.10	105	1.12	0.64
Em-6	"	0.10	107	1.15	0.62
Em-7	"	0.12	105	1.12	0.67
Em-8	"	0.10	105	1.14	0.64
Em-9	"	0.11	107	1.15	0.62
Em-10	"	0.12	105	1.12	0.65
Em-11	Comparison	0.16	110	1.09	0.70
Em-12	"	0.14	112	1.18	0.72
Em-13	"	0.14	112	1.21	0.72
Em-14	"	0.16	110	1.20	0.71
Em-15	"	0.15	110	1.19	0.70
Em-16	Comparison	0.20	115	1.15	0.72
Em-17	"	0.20	112	1.20	0.73
Em-18	"	0.20	112	1.20	0.73
Em-19	Comparison	0.11	110	1.14	0.63
Em-20	Invention	0.08	110	1.30	0.66
Em-21	"	0.08	112	1.35	0.64
Em-22	"	0.09	110	1.32	0.62
Em-23	"	0.09	110	1.30	0.64
Em-24	"	0.09	110	1.32	0.61
Em-25	"	0.11	107	1.30	0.65
Em-26	Comparison	0.13	115	1.21	0.70
Em-27	Invention	0.11	117	1.47	0.71
Em-28	"	0.11	117	1.42	0.72
Em-29	"	0.10	115	1.42	0.69
Em-30	"	0.11	115	1.36	0.71

As is apparent from Table 1-3, although fog of each of the emulsions Em-4 to Em-30 including tabular grains having a high aspect ratio is slightly high, its sensitivity, gamma, and transparency are higher than those of each of the emulsions Em-1 to Em-3 including tabular grains having a low aspect ratio.

As is apparent from Table 3-1, each emulsion of the present invention using the compound 1-2 or 1-16 has lower fog and higher sensitivity and gamma, i.e., has improved contrast, than those of the emulsions other than the present invention not using the compounds.

The emulsions Em-19 and Em-26 having narrow silver iodide content distributions between grains have slightly higher sensitivities and gammas than those of the emulsions Em-4 and Em-11 having close aspect ratios, respectively. In the emulsions prepared by adding the compound 1-2 or 1-16 to these emulsions, however, the emulsions Em-20 to Em-25, Em-27, and Em-28 having narrow silver iodide content distributions have an effect which conspicuously improves gamma as compared with the emulsions Em-5 to Em-10 and Em-12 to Em-15 having wide silver iodide content distributions.

In addition, as is apparent from the results of the emulsions Em-28 to Em-30, the gamma improving effect can be obtained in case of an addition of compounds represented by general formulas [I] to [III] during the grain formation process.

Example 2

A sample as a multilayered color light-sensitive material constituted by layers having the following compositions was formed on an undercoated cellulose triacetate film support.

Compositions of light-sensitive layers

The coating amounts of a silver halide and colloidal silver are represented in units of g/m^2 of silver, those of a coupler, an additive, and gelatin are represented in units of g/m^2, and that of a sensitizing dye is represented by the number of mols per mol of the silver halide in the same layer. Note that formulas of compounds represented by characters are listed in Table B to be presented later.

Layer 1: Antihalation layer

Black colloidal silver

coating silver amount	0.2
Gelatin	2.2
UV-1	0.1
UV-2	0.2
Cpd-1	0.04
Cpd-2	0.02
Solv-1	0.30
Solv-2	0.01

Layer 2: Interlayer

Fine silver iodobromide grain (AgI = 1.0 mol%, sphere-equivalent diameter = 0.07 μm)

coating silver amount	0.15
Gelatin	1.0
ExC-4	0.03
Cpd-3	0.2

Layer 3: 1st red-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 5.0 mol%, surface high AgI type, sphere-equivalent diameter = 0.9 μm, variation coefficient of sphere-equivalent diameter = 21%, tabular grain, diameter/thickness ratio = 7.5)
coating silver amount 0.42

Silver iodobromide emulsion (AgI = 4.0 mol%, internally high AgI type, sphere-equivalent diameter = 0.4 µm, variation coefficient of sphere-equivalent diameter = 18%, tetradecahedral grain)

coating silver amount	0.40
Gelatin	1.0
ExS-1	4.5×10^{-4} mol
ExS-2	1.5×10^{-4} mol
ExS-3	0.4×10^{-4} mol
ExC-1	0.50
ExC-2	0.11
ExC-3	0.009
ExC-4	0.023
Solv-1	0.24

Layer 4: 2nd red-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 8.5 mol%, internally high AgI type, sphere-equivalent diameter = 1.0 µm, variation coefficient of sphere-equivalent diameter = 25%, tabular grain, diameter/thickness ratio = 3.0)

coating silver amount	0.85
Gelatin	0.7
ExS-1	3×10^{-4} mol
ExS-2	1×10^{-4} mol
ExS-3	0.3×10^{-4} mol
ExC-1	0.10
ExC-2	0.05
ExC-4	0.025
Solv-1	0.10

Layer 5: 3rd red-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 11.3 mol%, internally high AgI type, sphere-equivalent diameter = 1.4 µm, variation coefficient of sphere-equivalent diameter = 28%, tabular grain, diameter/thickness ratio = 6.0)

coating silver amount	1.50
Gelatin	0.6
ExS-1	2 × 10^{-4} mol
ExS-2	0.6 × 10^{-4} mol
ExS-3	0.2 × 10^{-4} mol
ExC-2	0.08
ExC-4	0.01
ExC-5	0.06
Solv-1	0.12
Solv-2	0.12

Layer 6: Interlayer

Gelatin	1.0
Cpd-4	0.1
Solv-1	0.1

Layer 7: 1st green-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 5.0 mol%, surface high AgI type, sphere-equivalent diameter = 0.9 μm, variation coefficient of sphere-equivalent diameter = 21%, tabular grain, diameter/thickness ratio = 7.0)
coating silver amount 0.28
Silver iodobromide emulsion (AgI = 4.0 mol%, internally high AgI type, sphere-equivalent diameter = 0.4 μm, variation coefficient of sphere-equivalent diameter = 18%, tetradecahedral grain)

coating silver amount	0.16
Gelatin	1.2
ExS-5	5 × 10^{-4} mol
ExS-6	2 × 10^{-4} mol
ExS-7	1 × 10^{-4} mol
ExM-1	0.50
ExM-2	0.10
ExM-5	0.03
Solv-1	0.2
Solv-4	0.03

Layer 8: 2nd green-sensitive emulsion layer

Silver iodobromide emulsion I (AgI = 7.6 mol%, sphere-equivalent diameter = 1.2 μm, tabular grain)

coating silver amount	0.57
Gelatin	0.35
ExS-5	3.5×10^{-4} mol
ExS-6	1.4×10^{-4} mol
ExS-7	0.7×10^{-4} mol
ExM-1	0.12
ExM-2	0.01
ExM-3	0.03
Solv-1	0.15
Solv-4	0.03

Layer 9: Interlayer

Gelatin	0.5
Solv-1	0.02

Layer 10: 3rd green-sensitive emulsion layer

Silver iodobromide emulsion I (AgI = 11.3 mol%, internally high AgI type, sphere-equivalent diameter = 1.4 μm, variation coefficient of sphere-equivalent diameter = 28%, tabular grain, diameter/thickness ratio = 6.0)

coating silver amount	1.3
Gelatin	0.8
ExS-5	2×10^{-4} mol
ExS-6	0.8×10^{-4} mol
ExS-7	0.8×10^{-4} mol
ExM-4	0.04
ExC-4	0.005
ExM-6	0.01
Cpd-5	0.01
Solv-1	0.2

Layer 11: Yellow filter layer

Cpd-6	0.05
Gelatin-1	0.5
Solv-1	0.1

Layer 12: Interlayer

Gelatin-1	0.5
Cpd-3	0.1

Layer 13: 1st blue-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 2 mol%, homogeneous iodide type, sphere-equivalent diameter = 0.55 μm, variation coefficient of sphere-equivalent diameter = 25%, tabular grain, diameter/thickness ratio = 7.0)

coating silver amount	0.2
Gelatin	1.0
ExS-8	3×10^{-4} mol

ExY-1	0.6
ExY-2	0.02
Solv-1	0.15

Layer 14: 2nd blue-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 19.0 mol%, internally high AgI type, sphere-equivalent diameter = 1.0 μm, variation coefficient of sphere-equivalent diameter = 16%, octahedral grain)

coating silver amount	0.19
Gelatin	0.3
ExS-8	2×10^{-4} mol
ExY-1	0.22
Solv-1	0.07

Layer 15: Interlayer

Fine silver iodobromide grain (AgI = 2 mol%, homogeneous iodide type, sphere-equivalent diameter = 0.13 μm)

coating silver amount	0.2
Gelatin	0.36

Layer 16: 3rd blue-sensitive emulsion layer

Silver iodobromide emulsion (AgI = 14.0 mol%, internally high AgI type, sphere-equivalent diameter = 1.7 μm, variation coefficient of sphere-equivalent diameter = 28%, tabular grain, diameter/thickness ratio = 5.0)

coating silver amount	1.55
Gelatin	0.5
ExS-9	1.5×10^{-4} mol
ExY-1	0.2
Solv-1	0.07

Layer 17: 1st protective layer

Gelatin	1.8
UV-1	0.1
UV-2	0.2
Solv-1	0.01
Solv-2	0.01

Layer 18: 2nd protective layer

Fine silver chloride grain (sphere-equivalent diameter = 0.07 μm)

coating silver amount	0.36
Gelatin	0.7
Polymethylmethacrylate grain (diameter = 1.5 μm)	0.2
W-1	0.02
H-1	0.4
Cpd-7	1.0

In addition to the above components, B-1 (0.20 g/m^2 in total), 1,2-benzisothiazolin-3-one (about 200 ppm on the average with respect to gelatin), n-butyl-p-hydroxybenzoate (about 1,000 ppm on the average with respect to gelatin), and 2-phenoxyethanol (about 10,000 ppm on the average with respect to gelatin) were added to the layers.

The emulsion prepared in Example 1 was used as the silver iodobromide emulsion I of the layer 8. The sensitizing dyes were added to the emulsion immediately before coating. A correspondence between numbers of the formed samples and emulsions contained in the layer 8 of the samples is shown in Table 2-1.

Table 2-1

Sample No.	Emulsion Name in Layer 8	Sample No.	Emulsion Name in Layer 8
201	Em - 1	216	Em - 16
202	Em - 2	217	Em - 17
203	Em - 3	218	Em - 18
204	Em - 4	219	Em - 19
205	Em - 5	220	Em - 20
206	Em - 6	221	Em - 21
207	Em - 7	222	Em - 22
208	Em - 8	223	Em - 23
209	Em - 9	224	Em - 24
210	Em - 10	225	Em - 25
211	Em - 11	226	Em - 26
212	Em - 12	227	Em - 27
213	Em - 13	228	Em - 28
214	Em - 14	229	Em - 29
215	Em - 15	230	Em - 30

In order to measure sensitometry performance and sharpness, each sample was subjected to white wedge exposure for 1/100 second in accordance with a conventional method and developed as follows.

Development was performed under the following conditions at a temperature of 38° C.

1.	Color development	...2 min. 45 sec.
2.	Bleaching	...6 min. 30 sec.
3.	Washing	...3 min. 15 sec.
4.	Fixing	...6 min. 30 sec.
5.	Washing	...3 min. 15 sec.
6.	Stabilizing	...3 min. 15 sec.

The compositions of processing solutions used in the above steps were as follows.

Color developer:

Sodium nitrilotriacetate	1.4 g
Sodium sulfite	4.0 g

Sodium carbonate	30.0 g
Potassium bromide	1.4 g
Hydroxylamine sulfate	2.4 g
4-(N-ethyl-N-β-hydroxyethylamino)-2-methyl-aniline sulfate	4.5 g
Water to make	1 ℓ

Bleaching solution:

Ammonium bromide	160.0 g
Ammonia water (28%)	25.0 mℓ
Sodium ethylenediaminetetraacetate	130 g
Glacial acetic acid	14 mℓ
Water to make	1 ℓ

Fixing solution:

Sodium tetrapolyphosphate	2.0 g
Sodium sulfite	4.0 g
Ammonium thiosulfate (70%)	175.0 mℓ
Sodium bisulfite	4.6 g
Water to make	1 ℓ

Stabilizing solution:

Formalin	8.0 mℓ
Water to make	1 ℓ

Sensitometry measurement was performed for the developed samples to obtain characteristic curves with respect to green light. In addition, M.T.F. (Modulation Transfer Function) was obtained as sharpness with respect to red light.

Fog:	Fog is represented by a value obtained by subtracting a mask density from a minimum optical density in a characteristic curve with respect to green light. A larger value is less preferable.
Gamma:	Gamma is represented by a difference between a density of minimum optical density + 0.2 of a characteristic curve with respect to green light and a density at a point on the characteristic curve corresponding to an exposure amount 10 times that at a point of the above density. The difference is represented by a relative value assuming that the gamma of the sample 201 is 1. A larger value is more preferable.
M.T.F.:	M.T.F. for a spatial frequency of 10/mm with respect to red light was obtained and compared. A larger value means high sharpness and therefore is more preferable.

The measurement results of the samples 201 to 203 are summarized in Table 2-2.

Table 2-2

Sample No.		Fog	Gamma	M. T. F.
201	Comparison	0.17	1.00	0.70
202	"	0.12	1.04	0.72
203	"	0.13	1.05	0.68
204	Comparison	0.20	1.02	0.76
205	"	0.13	1.07	0.76
206	"	0.14	1.10	0.78
207	"	0.17	1.09	0.74
208	"	0.14	1.09	0.74
209	"	0.16	1.10	0.76
210	"	0.17	1.09	0.78
211	Comparison	0.23	1.06	0.84
212	"	0.19	1.12	0.86
213	"	0.20	1.15	0.86
214	"	0.22	1.15	0.88
215	"	0.21	1.13	0.86
216	Comparison	0.28	1.10	0.88
217	"	0.28	1.15	0.86
218	"	0.29	1.14	0.88

(continued)

Table 2-2

Sample No.		Fog	Gamma	M. T. F.
219	Comparison	0.16	1.10	0.86
220	Invention	0.10	1.20	0.84
221	"	0.12	1.26	0.86
222	"	0.13	1.24	0.84
223	"	0.12	1.21	0.88
224	"	0.13	1.24	0.86
225	"	0.14	1.21	0.86
226	Comparison	0.18	1.14	0.88
227	Invention	0.15	1.32	0.90
228	"	0.15	1.30	0.86
229	"	0.15	1.29	0.88
230	"	0.16	1.26	0.88

As is apparent from the results shown in Table 2-2, each sample using tabular grains having a high aspect ratio is excellent in sharpness.

In addition, it is apparent from Table 2-2, the light-sensitive material of the present invention produces low fog and has high gamma, i.e., has a great contrast improving effect.

Further, as is apparent from the results shown in Table 2-2, an unexpected synergistic effect of improving contrast was obtained by a combination of an emulsion having a narrow silver iodide content distribution with the compound 1-2 and 1-16.

Furthermore, as is apparent from the results of samples 228 to 230, it is preferable that the compound is added to the silver halide emulsion during formation of silver halide grains.

Example 3

A plurality of layers having the following compositions were coated on an undercoated support made of triacetylcellulose film to prepare a sample as a multi-layered color light-sensitive material.

Compositions of light-sensitive layers

Emulsions listed in Table 3-1 to be presented later were used in light-sensitive emulsion layers. Formulas of compounds represented by characters are listed in Table C to be presented later.

Numerals corresponding to the respective components indicate coating amounts in units of g/m^2. A coating amount of the silver halide is represented in a silver converted score. A coating amount of the sensitizing dye is represented in units of mols per mol of the silver halide in the same layer.

Sample 101

Layer 1: Antihalation layer

Black colloidal silver		
	silver	0.18
Gelatin		1.40

Layer 2: Interlayer

2,5-di-t-pentadecylhydroquinone	0.18
EX-1	0.07
EX-3	0.02
EX-12	0.002
U-1	0.06
U-2	0.08
U-3	0.10
HBS-1	0.10
HBS-2	0.02
Gelatin	1.04

Layer 3: 1st red-sensitive emulsion layer

Emulsion A	silver	0.25
Emulsion B	silver	0.25
Sensitizing dye I		6.9×10^{-5}
Sensitizing dye II		1.8×10^{-5}
Sensitizing dye III		3.1×10^{-4}
EX-2		0.335
Ex-10		0.020
U-1		0.07
U-2		0.05
U-3		0.07
HBS-1		0.060
Gelatin		0.87

Layer 4: 2nd red-sensitive emulsion layer

Emulsion G	silver	1.0
Sensitizing dye I		5.1×10^{-5}
Sensitizing dye II		1.4×10^{-5}
Sensitizing dye III		2.3×10^{-4}
EX-2		0.400
EX-3		0.050
EX-10		0.015
U-1		0.07
U-2		0.05
U-3		0.07
Gelatin		1.30

Layer 5: 3rd red-sensitive emulsion layer

Emulsion D	silver	1.60
Sensitizing dye I		5.4×10^{-5}
Sensitizing dye II		1.4×10^{-5}
Sensitizing dye III		2.4×10^{-4}
EX-3		0.010
EX-4		0.080
Ex-2		0.097
HBS-1		0.22
HBS-2		0.10
Gelatin		1.63

Layer 6: Interlayer

EX-5	0.040
HBS-1	0.020
Gelatin	0.80

Layer 7: 1st green-sensitive emulsion layer

Emulsion A	silver	0.15
Emulsion B	silver	0.15
Sensitizing dye V		3.0×10^{-5}
Sensitizing dye VI		1.0×10^{-4}
Sensitizing dye VII		3.8×10^{-4}
EX-6		0.260

EX-1		0.021
EX-7		0.030
EX-8		0.025
HBS-1		0.100
HBS-3		0.010
Gelatin		0.63

Layer 8: 2nd green-sensitive emulsion layer

Emulsion C	silver	0.45
Sensitizing dye V		2.1×10^{-5}
Sensitizing dye VI		7.0×10^{-5}
Sensitizing dye VII		2.6×10^{-4}
EX-6		0.094
EX-8		0.018
EX-7		0.026
HBS-1		0.160
HBS-3		0.008
Gelatin		0.50

Layer 9: 3rd green-sensitive emulsion layer

Emulsion E	silver	1.2
Sensitizing dye V		3.5×10^{-5}
Sensitizing dye VI		8.0×10^{-5}
Sensitizing dye VII		3.0×10^{-4}
Ex-13		0.015
EX-11		0.100
EX-1		0.025
HBS-1		0.25
HBS-2		0.10
Gelatin		1.54

Layer 10: Yellow filter layer

Yellow colloidal silver	silver	0.05
EX-5		0.08
HBS-1		0.03
Gelatin		0.95

Layer 11: 1st blue-sensitive emulsion layer

Emulsion A	silver	0.08
Emulsion B	silver	0.07
Emulsion F	silver	0.07

Sensitizing dye VIII	3.5×10^{-4}
EX-9	0.721
EX-8	0.042
HBS-1	0.28
Gelatin	1.10

Layer 12: 2nd blue-sensitive emulsion layer

Emulsion G	silver	0.45
Sensitizing dye VIII		2.1×10^{-4}
EX-9		0.154
EX-10		0.007
HBS-1		0.05
Gelatin		0.78

Layer 13: 3rd blue-sensitive emulsion layer

Emulsion H	silver	0.77
Sensitizing dye VIII		2.2×10^{-4}
EX-9		0.20
HBS-1		0.07
Gelatin		0.69

Layer 14: 1st protective layer

Emulsion I	silver	0.20
U-4		0.11
U-5		0.17
HBS-1		0.05
Gelatin		1.00

Layer 15: 2nd protective layer

Polymethylacrylate grains (diameter = about 1.5 μm)	0.54
S-1	0.20
Gelatin	1.20

In addition to the above components, a gelatin hardener H-1 or a surfactant were added to each layer.

Table 3-1

	Average AgI Content (%)	Average Grain Size (μm)	Variation Coefficient of Grain Size (%)	Diameter/ Thickness Ratio	Silver Amount Ratio (AgI content (%))
Emulsion A	4.0	0.45	27	1	Core/shell = 1/3(13/1), Double structure grain
" B	8.9	0.70	14	1	Core/shell = 3/7(25/2), Double structure grain
" C	10	0.75	30	2	Core/shell = 1/2(24/3), Double structure grain
" D	16	1.05	35	2	Core/shell = 4/6(40/0), Double structure grain
" E	10	1.05	35	3	Core/shell = 1/2(24/3), Double structure grain
" F	4.0	0.25	28	1	Core/shell = 1/3(13/1), Double structure grain
" H	14.5	1.30	25	3	Core/shell = 37/63(34/3), Double structure grain
" I	1	0.07	15	1	Homogeneous grain

The emulsion prepared in Example 1 was used as the silver iodobromide emulsion G of the layer 12. The sensitizing dyes were added to the emulsions at the end of chemical sensitization. A correspondence between the numbers of the formed samples and the emulsions contained in the layer 12 of the samples is shown in Table 3-2.

Table 3-2

Sample No.	Emulsion Name in Layer 12	Sample No.	Emulsion Name in Layer 12
301	Em - 1	316	Em - 16
302	Em - 2	317	Em - 17
303	Em - 3	318	Em - 18
304	Em - 4	319	Em - 19
305	Em - 5	320	Em - 20
306	Em - 6	321	Em - 21
307	Em - 7	322	Em - 22
308	Em - 8	323	Em - 23
309	Em - 9	324	Em - 24
310	Em - 10	325	Em - 25
311	Em - 11	326	Em - 26
312	Em - 12	327	Em - 27
313	Em - 13	328	Em - 28
314	Em - 14	329	Em - 29
315	Em - 15	330	Em - 30

After the samples 301 to 330 were exposed and developed following the same procedures as in Example 2, a characteristic curve with respect to blue light and an M.T.F. with respect to red light of each sample were obtained. The measurement results are summarized in Table 3-3 in the same manner as in Table 2-2.

Table 3-3

Sample No.		Fog	Gamma	M. T. F.
301	Comparison	0.11	1.00	1.06
302	"	0.08	1.03	1.06
303	"	0.08	1.04	1.02
304	Comparison	0.13	1.03	1.14
305	"	0.08	1.07	1.16
306	"	0.08	1.09	1.14
307	"	0.10	1.07	1.12
308	"	0.09	1.07	1.14
309	"	0.11	1.09	1.12
310	"	0.11	1.06	1.16
311	Comparison	0.15	1.06	1.18
312	"	0.12	1.10	1.20
313	"	0.13	1.12	1.22
314	"	0.13	1.12	1.20
315	Comparison	0.13	1.12	1.20
316	Comparison	0.17	1.09	1.20
317	"	0.17	1.12	1.22
318	"	0.17	1.12	1.20
319	Comparison	0.10	1.07	1.16
320	Invention	0.07	1.15	1.14
321	"	0.08	1.19	1.18
322	"	0.08	1.18	1.14
323	"	0.08	1.16	1.12
324	"	0.09	1.18	1.12
325	"	0.09	1.18	1.14
326	Comparison	0.12	1.11	1.18
327	Invention	0.10	1.23	1.18
328	"	0.09	1.21	1.20
329	"	0.10	1.20	1.18
330	"	0.10	1.20	1.20

As is apparent from the results shown in Table 3-3, the light-sensitive material of the present invention is excellent in sharpness and has a high gamma value, i.e., has high contrast. In addition, the light-sensitive material of the present invention produces low fog.

Furthermore, a synergistic effect in contrast improvement was obtained as in Examples 1 and 2 when an emulsion having a narrow silver iodobromide content distribution was used.

Example 4

The gamma and M.T.F. values of the samples 201 to 230 prepared in Example 2 were measured following the same procedures as in Example 2 except that processing steps were performed under the conditions shown in Table 4-1 below. As a result, each sample of the present invention was excellent in sharpness and had a great effect of increasing the gamma, i.e., improving the contrast.

Table 4-1

Process	Time	Temperature	Quantity of Replenisher	Tank Volume
Color Development	3 min. 15 sec.	38°C	45 mℓ	10 ℓ
Bleaching	1 min. 00 sec.	38°C	20 mℓ	4 ℓ
Bleach-fixing	3 min. 15 sec.	38°C	30 mℓ	8 ℓ
Washing (1)	40 sec.	35°C	Counter flow piping from (2) to (1)	4 ℓ
Washing (2)	1 min. 00 sec.	35°C	30 mℓ	4 ℓ
Stabilization	40 sec.	38°C	20 mℓ	4 ℓ
Drying	1 min. 15 sec.	55°C		

A quantity of replenisher is represented in per meter of a 35-mm wide sample.

The compositions of the processing solutions will be described below.

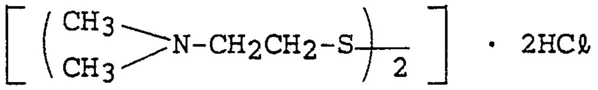
Color developer:

	Mother solution (g)	Replenisher (g)
Diethylenetriamine-pentaacetic acid	1.0	1.1

1-hydroxyethylidene-1,1-diphosphonic acid	3.0	3.2
Sodium sulfite	4.0	4.4
Potassium carbonate	30.0	37.0
Potassium bromide	1.4	0.7
Potassium iodide	1.5 mg	-
Hydroxylamine sulfate	2.4	2.8
4-(N-ethyl-N-β-hydroxylethylamino)-2-methylaniline sulfate	4.5	5.5
Water to make	1.0 ℓ	1.0 ℓ
pH	10.05	10.10

Bleaching solution: common for mother solution and replenisher (g)

Ammonium ethylenediaminetetraacetatoferrate (III) dihydrate	120.0
Disodium ethylenediaminetetraacetate	10.0
Ammonium bromide	100.0
Ammonium nitrate	10.0
Bleaching accelerator	0.005 mol



$$\left[\left(\begin{matrix}CH_3\\CH_3\end{matrix}>N-CH_2CH_2-S\right)_2\right]\cdot 2HC\ell$$

Ammonia water (27%)	15.0 mℓ
Water to make	1.0 ℓ
pH	6.3

Bleach-fixing solution: common for mother solution and replenisher (g)

Ammonium ethylenediaminetetraacetatoferrate (III) dihydrate	50.0
Disodium ethylenediaminetetraacetate	5.0
Sodium sulfite	12.0
Aqueous ammonium thiosulfate solution (70%)	240.0 mℓ
Ammonia water (27%)	6.0 mℓ
Water to make	1.0 ℓ
pH	7.2

Washing solution: common for mother solution and replenisher solutions

Tap water was supplied to a mixed-bed column filled with an H type strongly acidic cation exchange resin (Amberlite IR-120B: available from Rohm & Haas Co.) and an OH type strongly basic anion exchange resin (Amberlite IR-400) to set calcium and magnesium ion concentrations to be 3 mg/ℓ or less. Subsequently, 20 mg/ℓ of dichlorinated sodium isocyanurate and 1.5 g/ℓ of sodium sulfate were added. The pH of the solution fell within the range of 6.5 to 7.5.

Stabilizing solution: common for mother solution and replenisher (g)

Formaline (37%)	2.0 mℓ
Polyoxyethylene-p-monononylphenylether (average polymerization degree = 10)	0.3
Disodium ethylenediamine-tetraacetate	0.05
Water to make	1.0
pH	5.0 - 8.0

Example 5

The gamma and M.T.F. values of the samples 201 to 230 prepared in Example 2 were measured following the same procedures as in Example 2 except that processing steps were performed under the conditions shown in Table 5-1 below. As a result, each sample of the present invention was excellent in sharpness and had a great effect of increasing the gamma, i.e., of improving the contrast.

Table 5-1

Process	Time	Temperature	Quantity of Replenisher	Tank Volume
Color Development	1 min. 30 sec.	41°C	350 mℓ	10 ℓ
Bleaching	45 sec.	38°C	130 mℓ	5 ℓ
Fixing	1 min. 30 sec.	38°C	500 mℓ	10 ℓ
Stabilization (1)	40 sec.	38°C	3-step counter flow from (3) to (1)	5 ℓ
Stabilization (2)	40 sec.	38°C		5 ℓ
Stabilization (3)	40 sec.	38°C	350 mℓ	5 ℓ
Drying	1 min. 00 sec.	55°C		

Note: A quantity of replenisher is represented in per meter of a 35-mm wide sample.

Color developer:

	Mother solution (g)	Replenisher (g)
Diethylenetriamine pentaacetic acid	5.0	6.0
Sodium sulfite	2.0	4.0
Potassium carbonate	35.0	42.0
Potassium bromide	1.3	0.0
Potassium iodide	1.2 mg	-
Hydroxylamine sulfate	2.0	3.8
4-(N-ethyl-N-β-hydroxylethylamino)-2-methylaniline sulfate	6.0 (0.019 mol)	8.8 (0.028 mol)
4-hydroxy-6-methyl-1,3,3a-7-tetrazaindene	0.05	0.08
1-phenyl-4-methyl-4-hydroxymethyl-3-pyrazolidone	0.005	0.01
Water to make	1.0 ℓ	1.0 ℓ
pH	10.55	10.80

Bleaching solution:

	Mother solution (g)	Replenisher (g)
1,3-diaminopropane tetraacetatoferrate (III)	140	190

Ethylenediamine tetraacetic acid	4.0	5.0
Ammonium bromide	160.0	220.0
Ammonium nitrate	30.0	50.0
Ammonia water (27%)	20.0 mℓ	23.0 mℓ
Acetic acid (90%)	35.0	50.0
Hydroxyacetic acid (70%)	98.0	140.0
Water to make	1.0 ℓ	1.0 ℓ
pH	3.9	2.5

Fixing solution:

	Mother solution (g)	Replenisher (g)
Disodium ethylenediaminetetraacetate	0.5	0.7
Ammonium sulfite	15.0	25.0
Sodium bisulfite	5.0	10.0
Aqueous ammonium thiosulfate solution (700 g/ℓ)	270.0 mℓ	320.0 mℓ
Water to make	1.0 ℓ	1.0 ℓ
pH	6.7	6.6

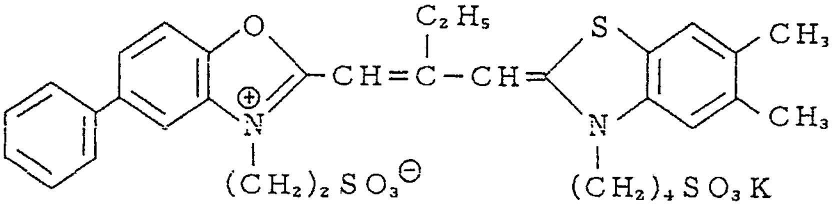
Stabilizing solution: common to mother solution and replenisher (g)

Tap water	1.0 ℓ
Formalin (37%)	1.2 mℓ
5-chloro-2-methyl-4-isothiazolin-3-one	6.0 mℓ
2-methyl-4-isothiazolin-3-one	3.0 mℓ
Surfactant	0.4
$[C_{10}H_{21}-O(CH_2CH_2O)_{10}H]$	1.0
Ethyleneglycol	
pH	7.0

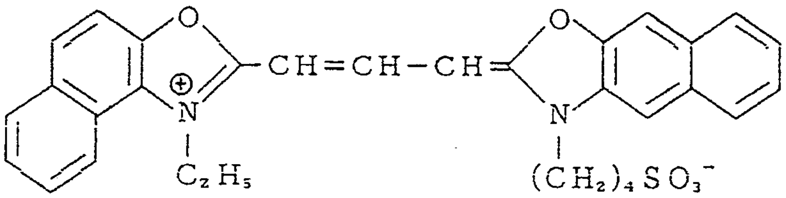
The following dyes were added to Em-1~30 thus produced, just prior to coating, theredy spectral senitizing Em-1~30:

Sensitizing Dye	I	4.2×10^{-5}	mol/mol Ag
〃	II	9.6×10^{-5}	〃
〃	III	3.6×10^{-4}	〃

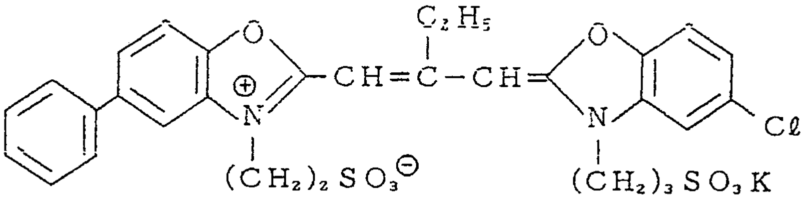
I



II



III



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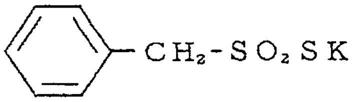
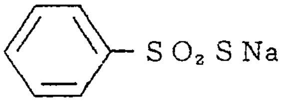
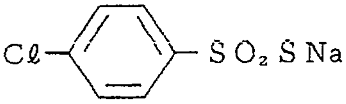


(I − 15) $CH_2{=}CHCH_2SO_2SNa$

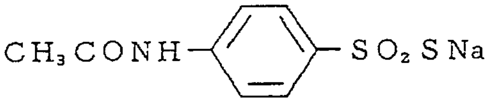
(I − 16)



(I − 17)



(I − 18)



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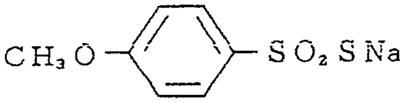

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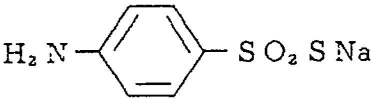

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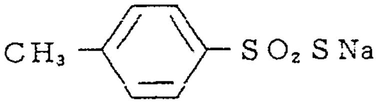

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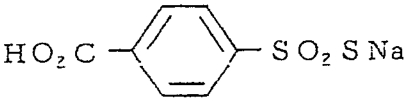

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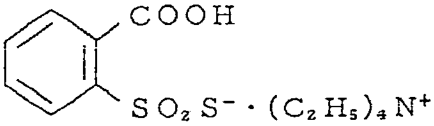
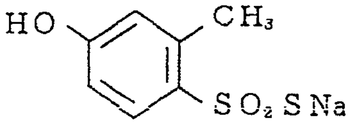


(I－24)



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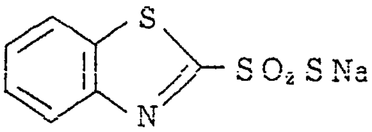

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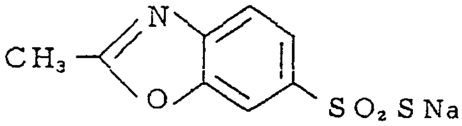
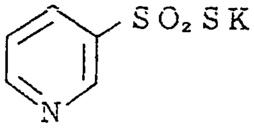


(I－27)



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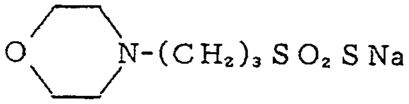
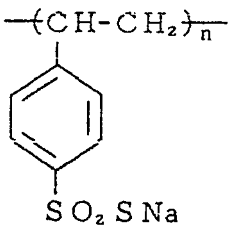


(I－29) $KSSO_2(CH_2)_2SO_2SK$

(I－30) $NaSSO_2(CH_2)_4SO_2SNa$

(I－31) $NaSSO_2(CH_2)_4S(CH_2)_4SO_2SNa$

(I－32)



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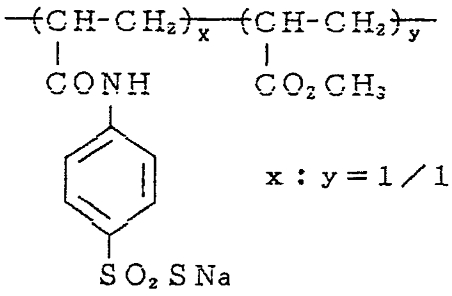
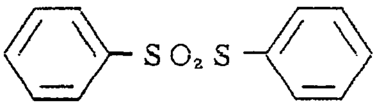


x : y＝1／1 (mol ratio)

(II－1) $C_2H_5SO_2\text{-}CH_3$

(II－2) $C_8H_{17}SO_2SCH_2CH_3$

(II－3)



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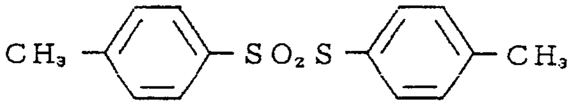
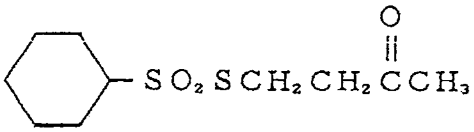


(II－5) $C_2H_5SO_2SCH_2CH_2CN$

(II－6)



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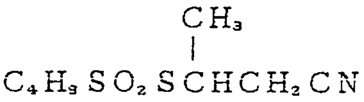
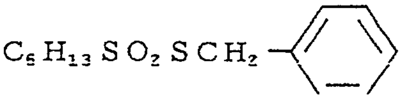


$C_4H_9SO_2S\overset{CH_3}{\overset{|}{C}}HCH_2CN$

(II－8)



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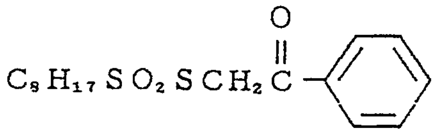

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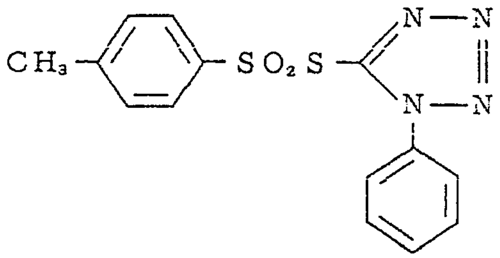

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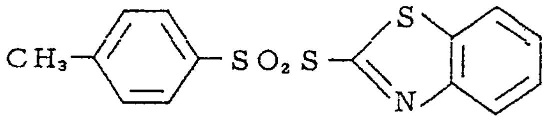

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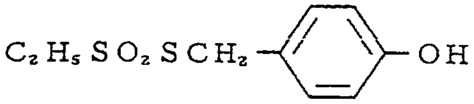

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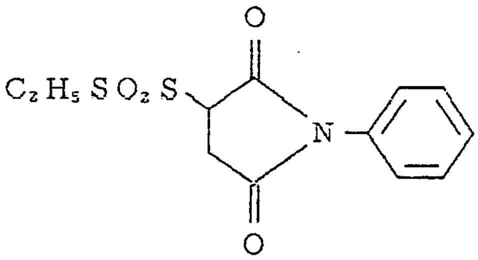

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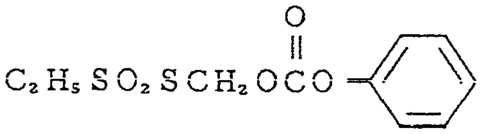

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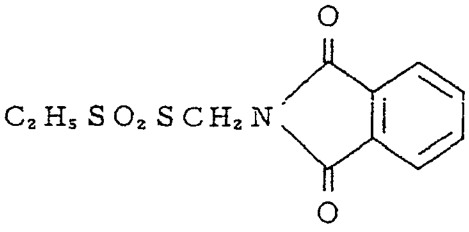
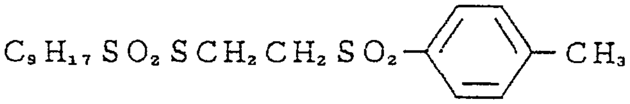
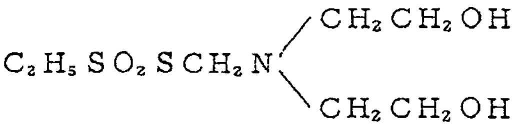


(II-16)



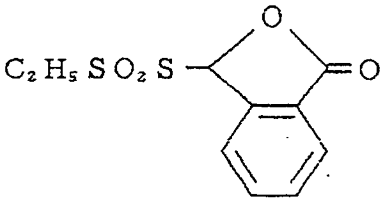
(II-17)



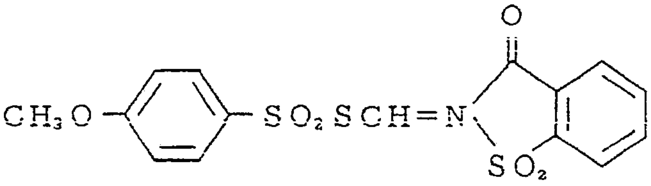
$C_2H_5SO_2SCH_2N(CH_2CH_2OH)_2$

(II-18) $C_2H_5SO_2SCH_2CH_2CH_2CH_2OH$

(II-19)



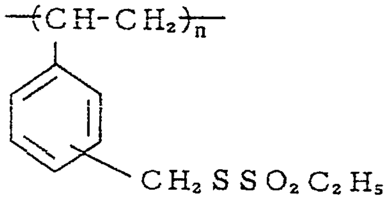
(II-20)



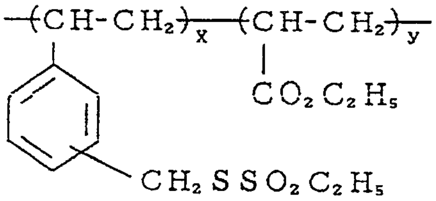
(II-21) $CH_3SSO_2(CH_2)_4SO_2SCH_3$

(II-22) $CH_3SSO_2(CH_2)_2SO_2SCH_3$

(II-23)

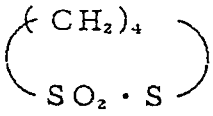


(II-24)

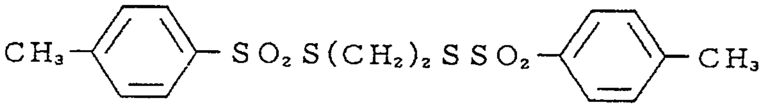


x : y = 2/1 (mol ratio)

(II-25)

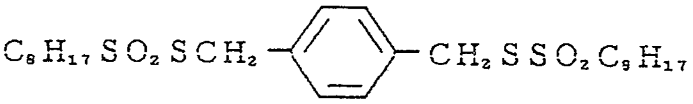


(III-1)

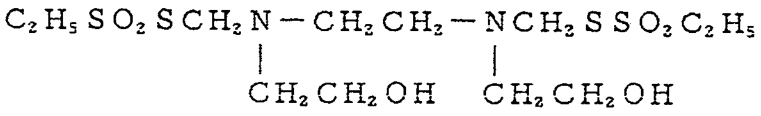


(III-2) $C_2H_5SO_2SCH_2CH_2SO_2CH_2CH_2SSO_2C_2H_5$

(III-3)

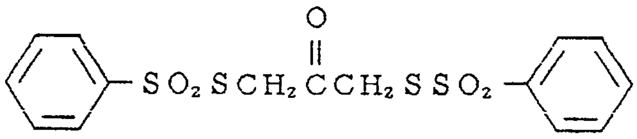


(Ⅲ－4)

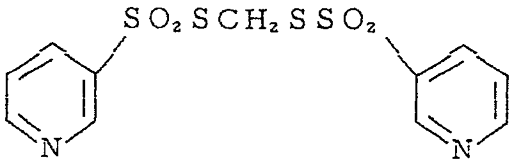


$$C_2H_5SO_2SCH_2N(CH_2CH_2OH)-CH_2CH_2-N(CH_2CH_2OH)CH_2SSO_2C_2H_5$$

(Ⅲ－5)



(Ⅲ－6)



(Ⅲ－7) $C_2H_5SO_2SSSO_2C_2H_5$

(Ⅲ－8) $(n)C_3H_7SO_2SSSO_2C_3H_7(n)$

(Ⅲ－9)

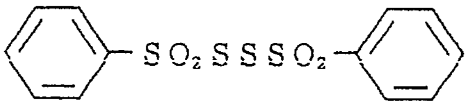
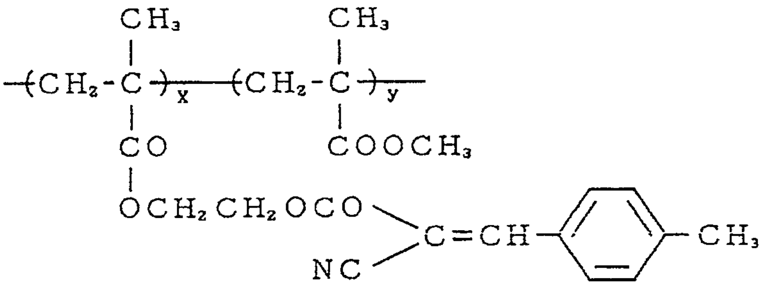


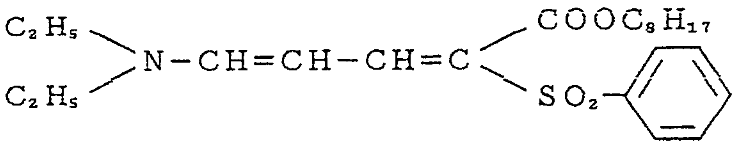
Table B

UV-1

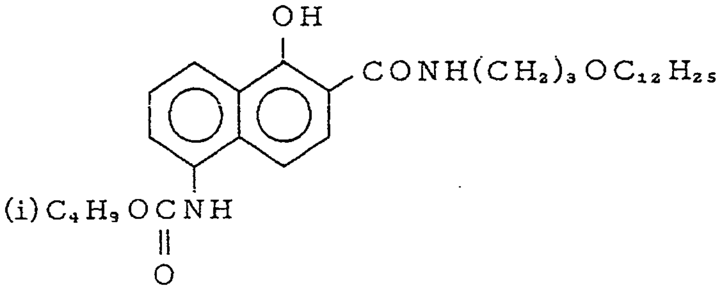


x／y＝7／3 (weight ratio)

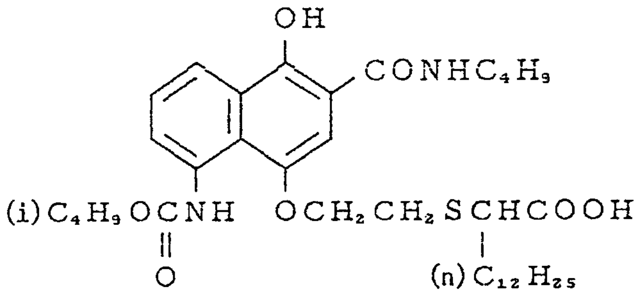
UV-2



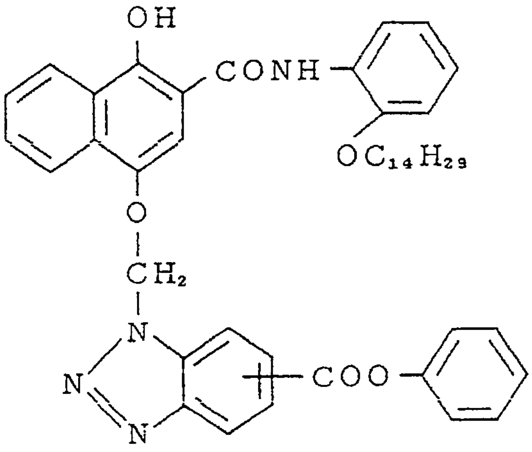
ExC-1



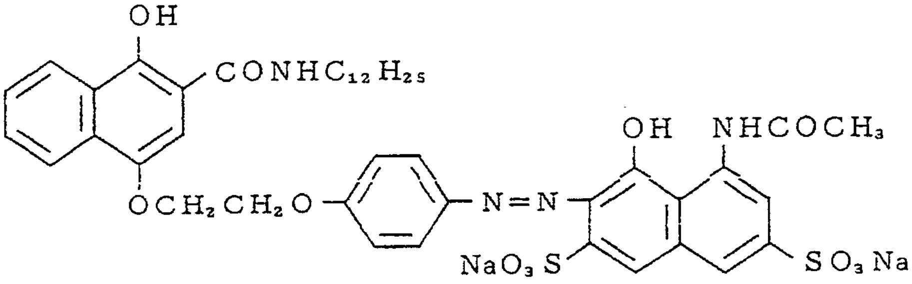
ExC-2



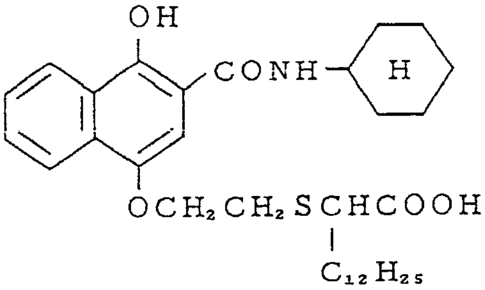
ExC-3



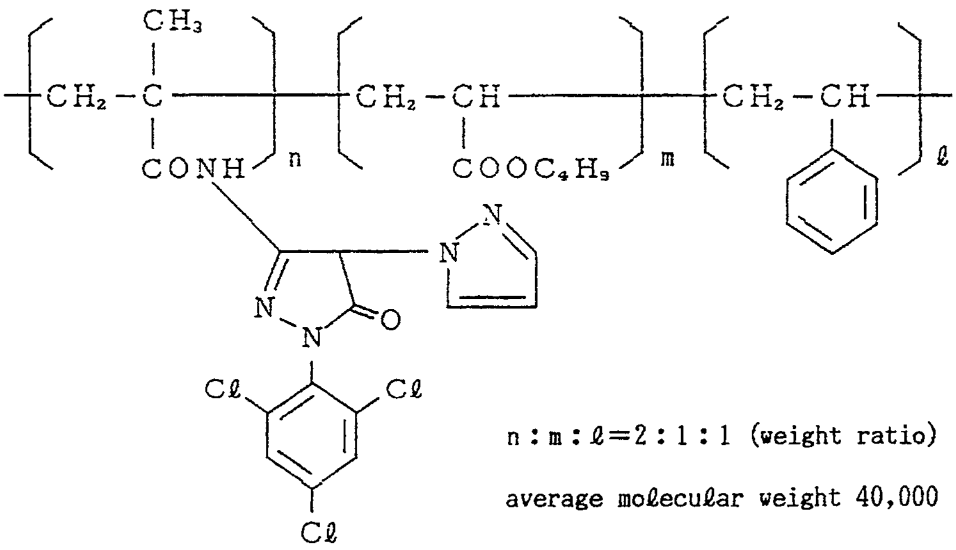
ExC-4



ExC-5



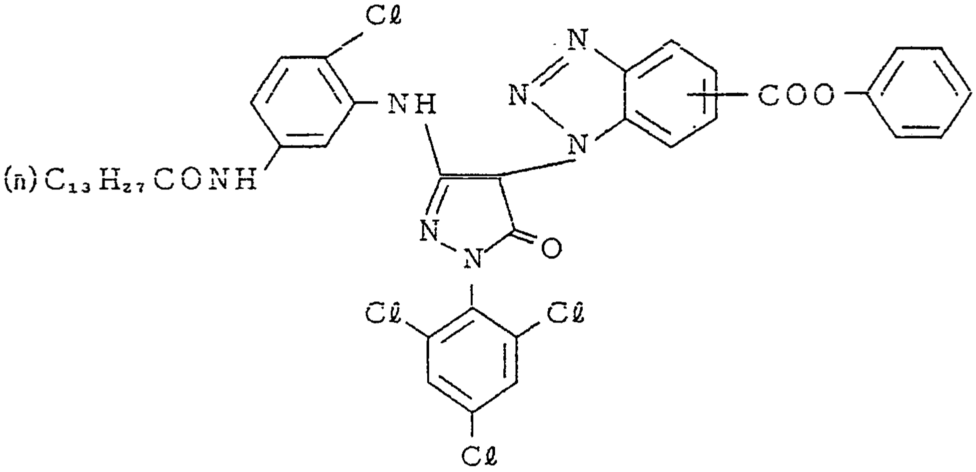
ExM-1



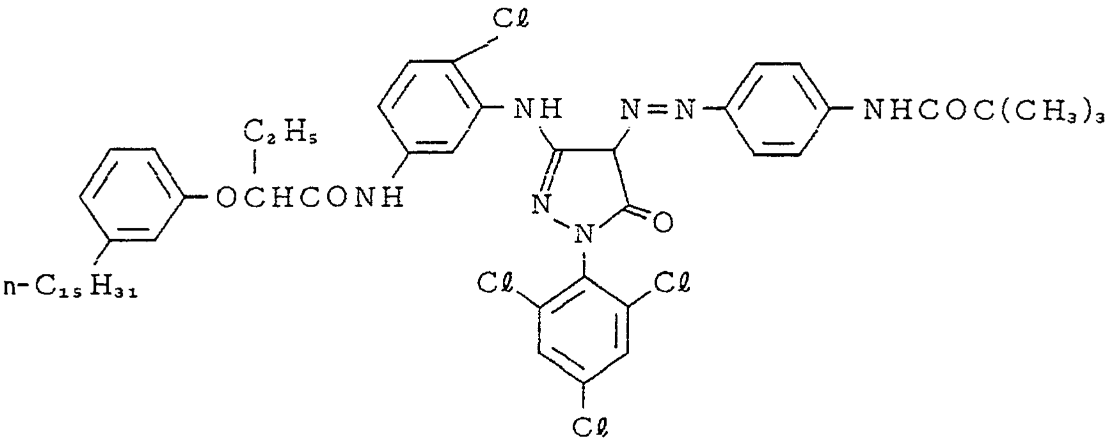
n : m : ℓ = 2 : 1 : 1 (weight ratio)

average moℓecuℓar weight 40,000

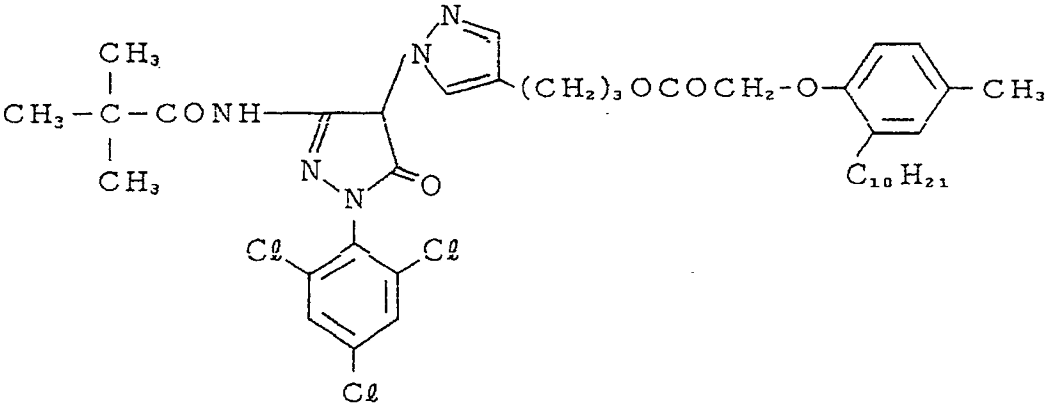
ExM-2



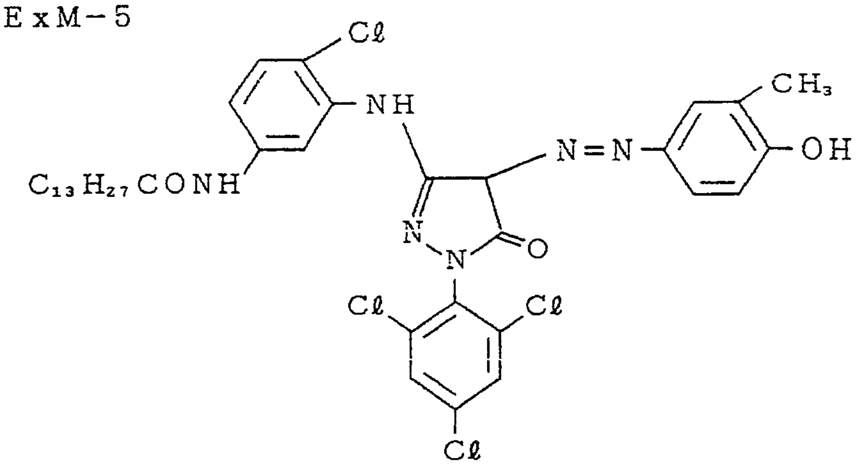
ExM−3



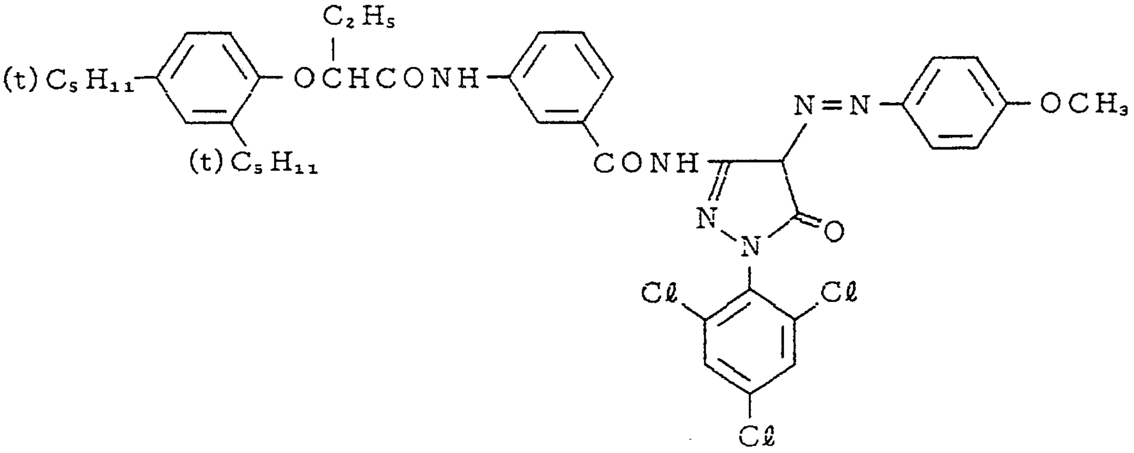
ExM−4



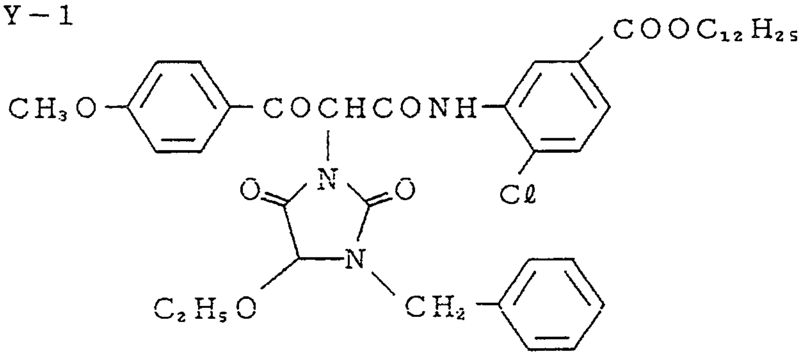
ExM-5



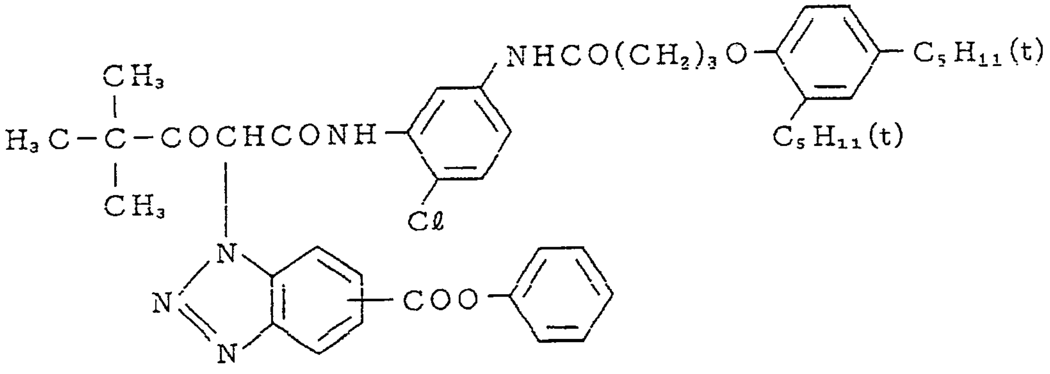
ExM-6



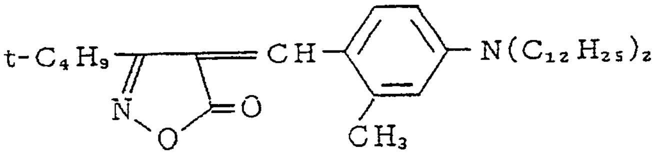
ExY-1



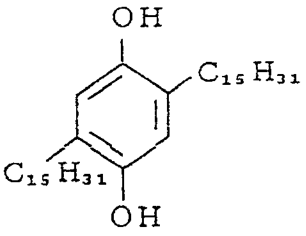
ExY−2



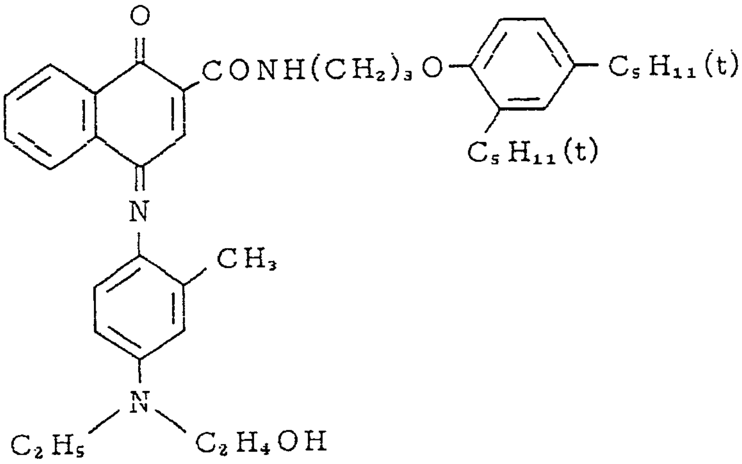
Cpd−1



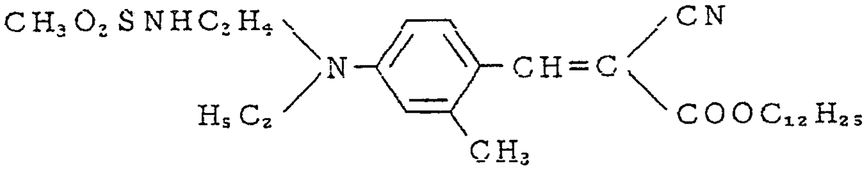
Cpd−3



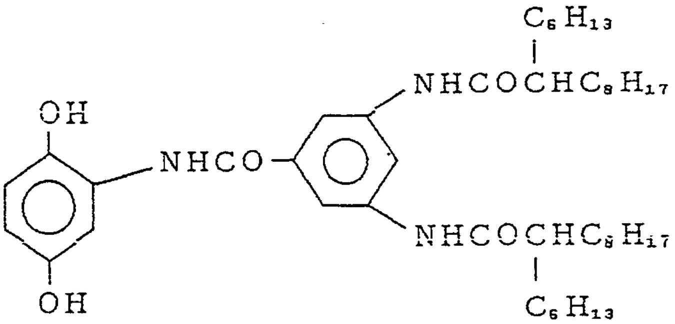
Cpd−2



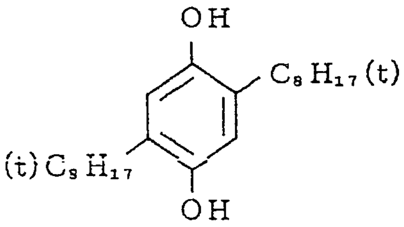
Cpd-6



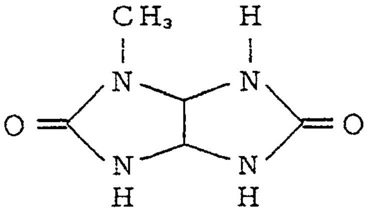
Cpd-4



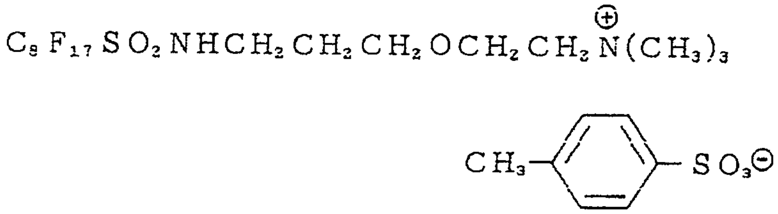
Cpd-5



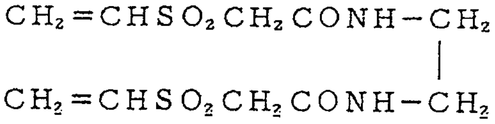
Cpd-7



W－1

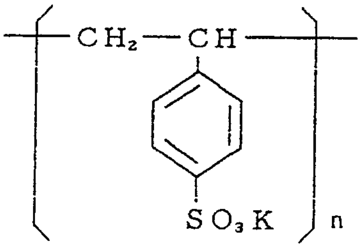


W－2

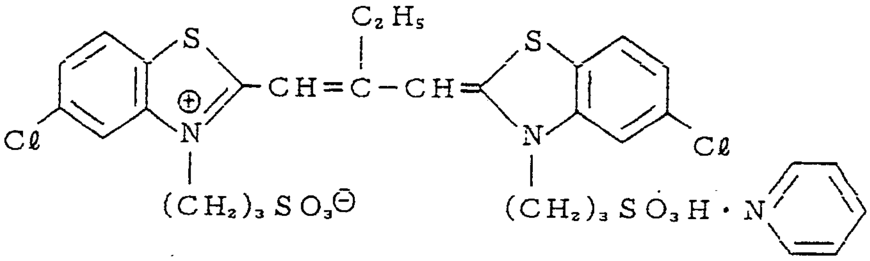


$$\begin{array}{l} CH_2{=}CHSO_2CH_2CONH{-}CH_2 \\ \qquad\qquad\qquad\qquad\qquad\quad | \\ CH_2{=}CHSO_2CH_2CONH{-}CH_2 \end{array}$$

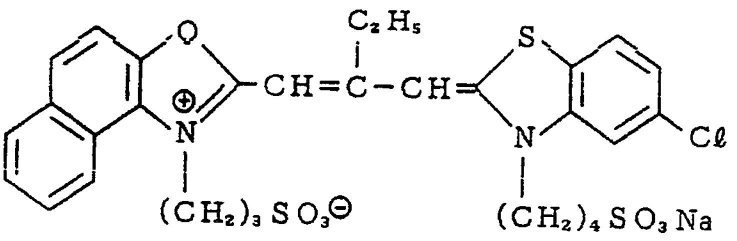
B－1



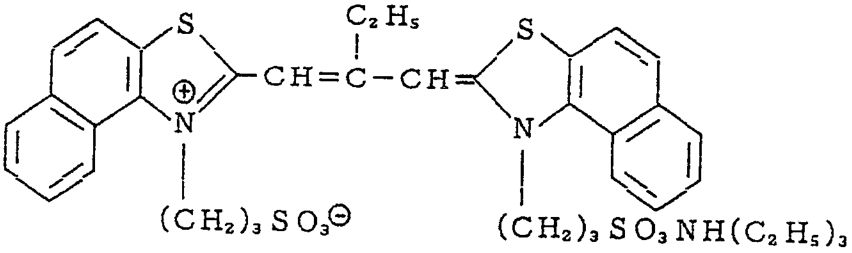
ExS－1



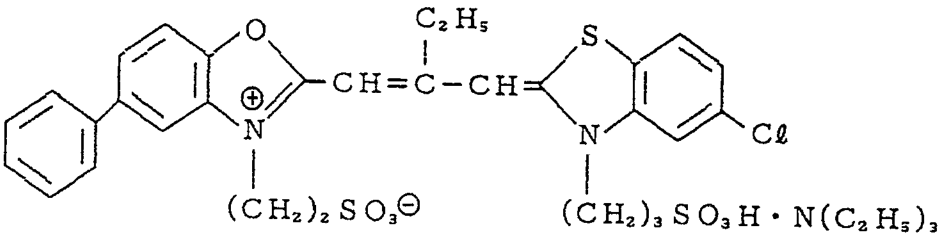
ExS-2



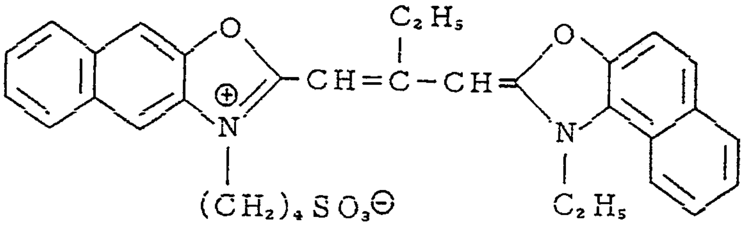
ExS-3



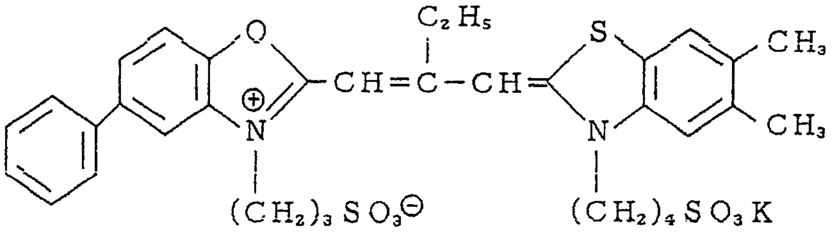
ExS-5



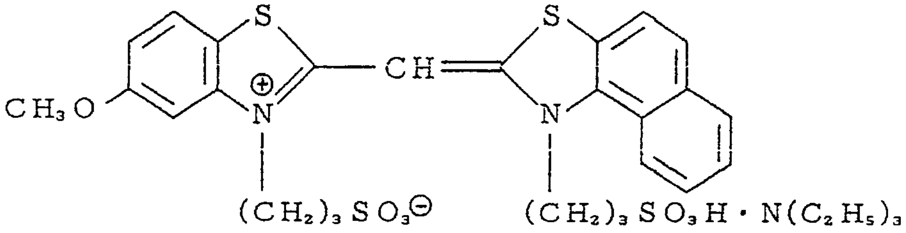
ExS-6



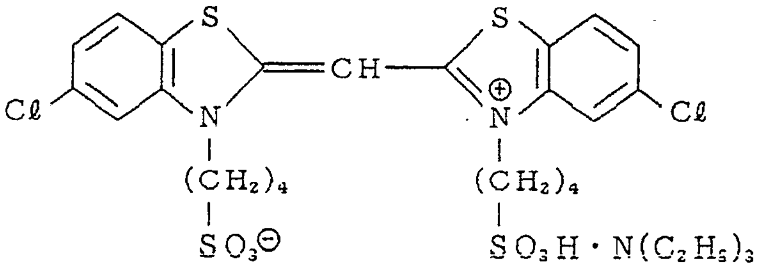
ExS-7



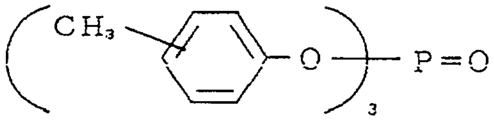
ExS-9



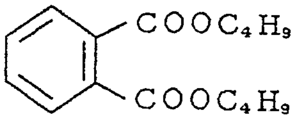
ExS-8



Solv-1



Solv−2



Solv−4

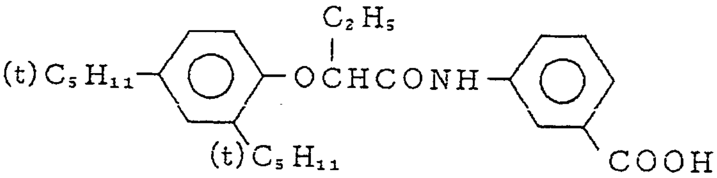
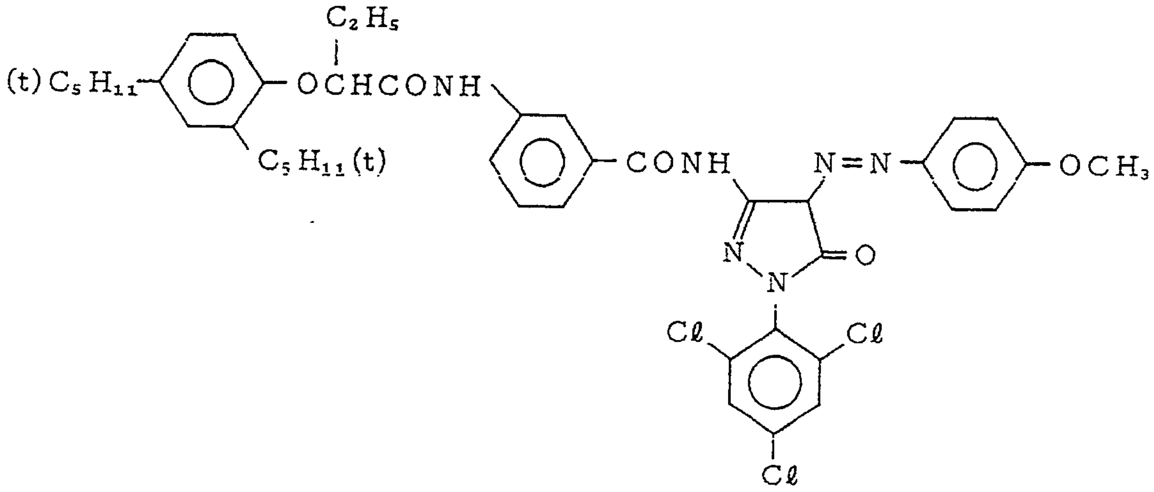
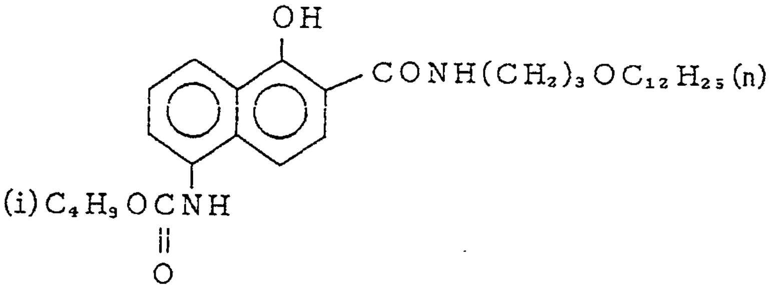


Table C

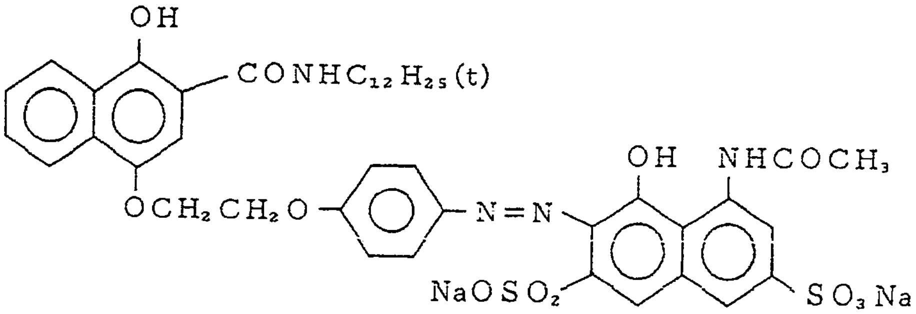
EX−1



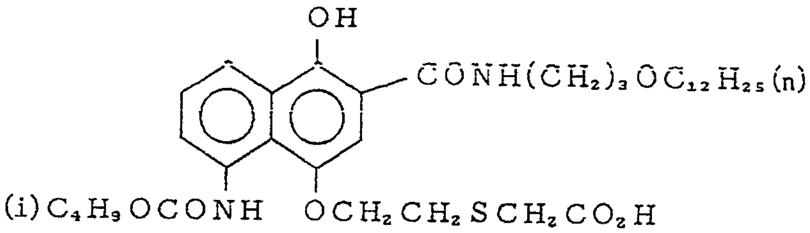
EX−2



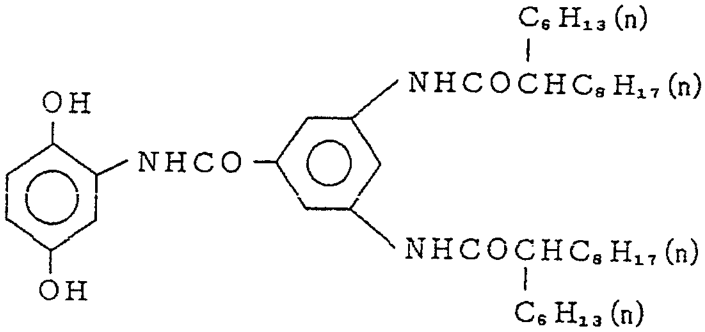
EX−3



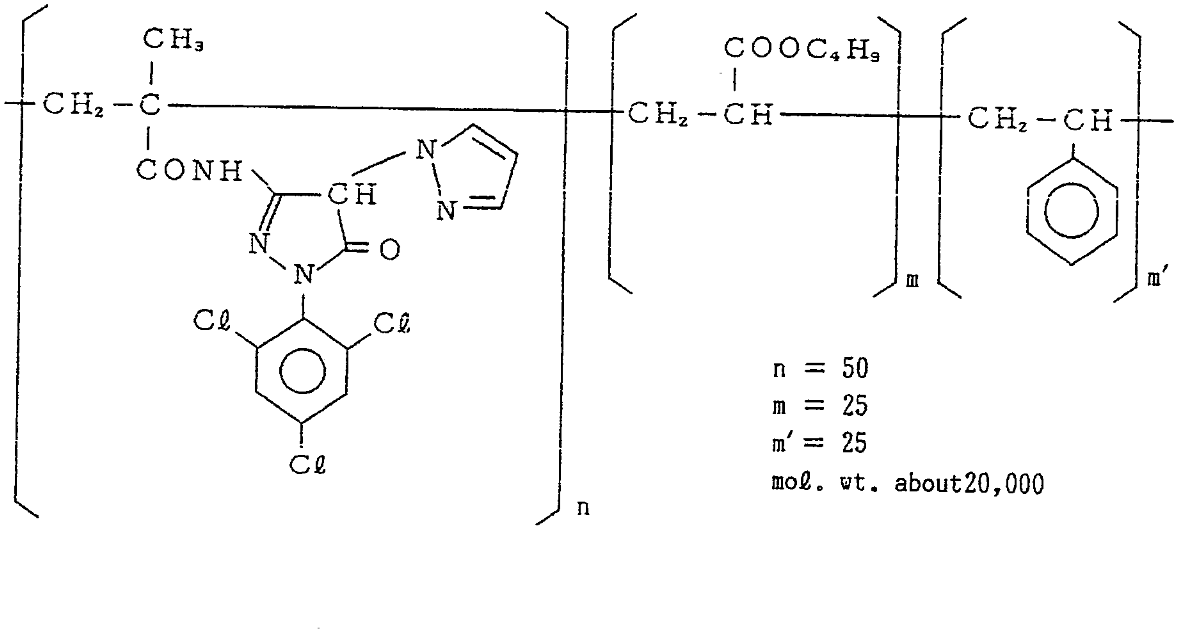
EX-4



EX-5

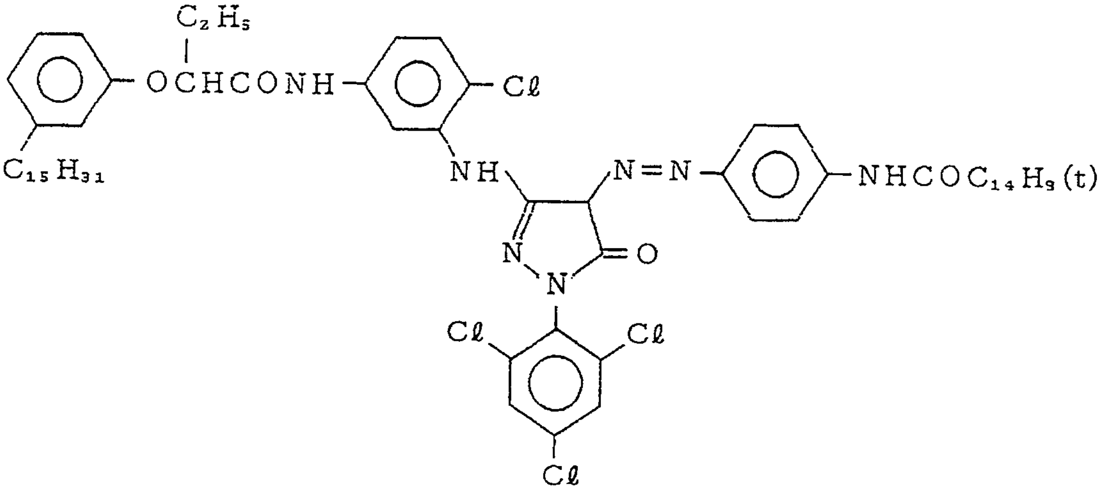


EX-6

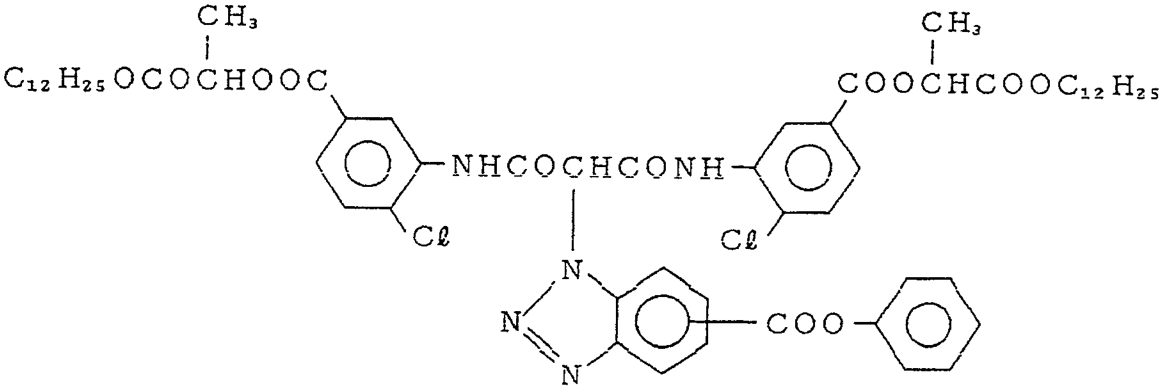


n = 50
m = 25
m' = 25
moℓ. wt. about20,000

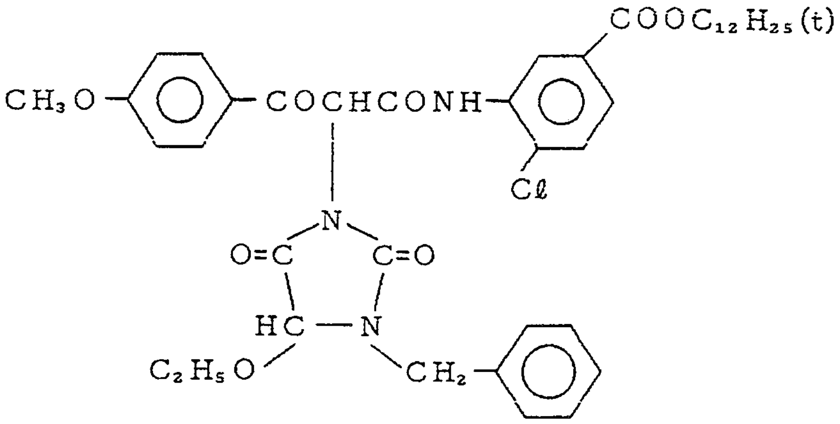
EX-7



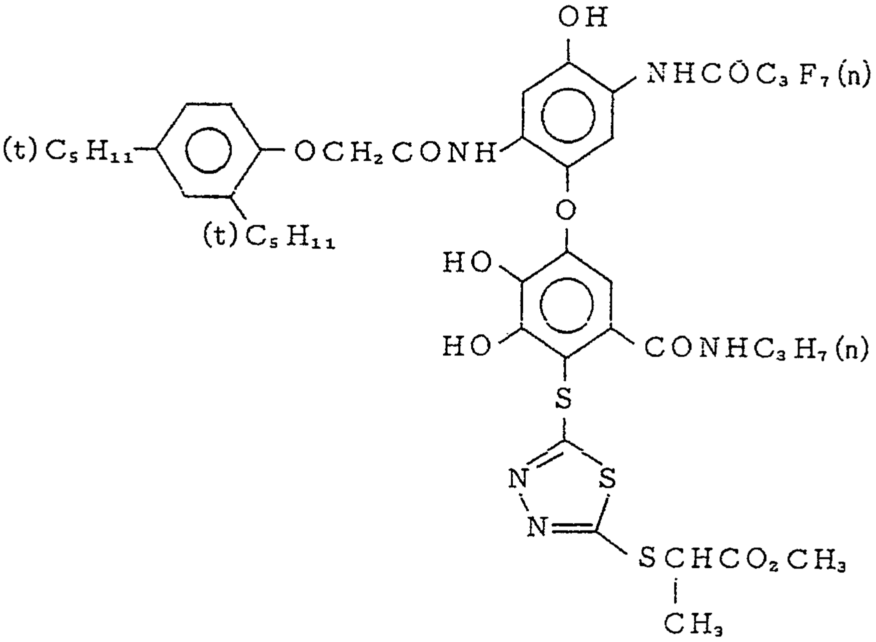
EX-8



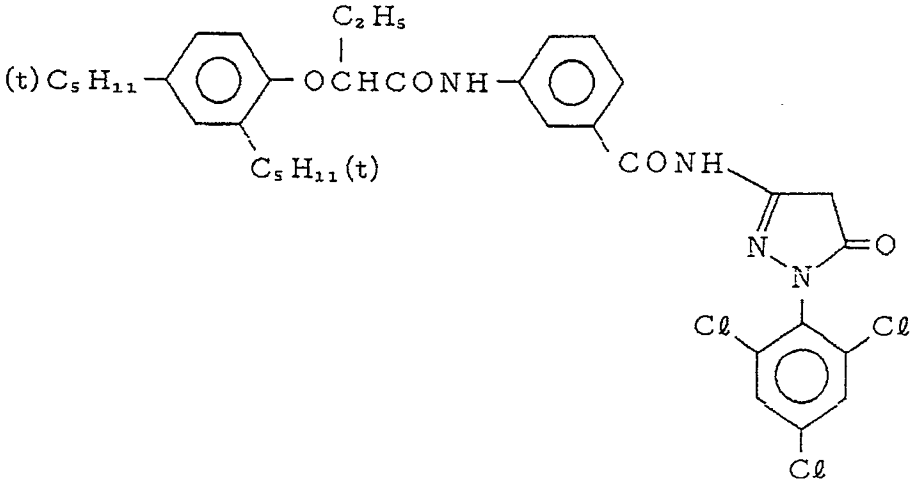
EX-9



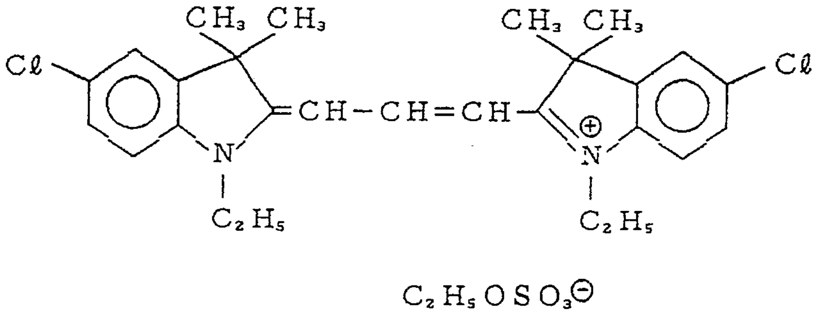
EX-10



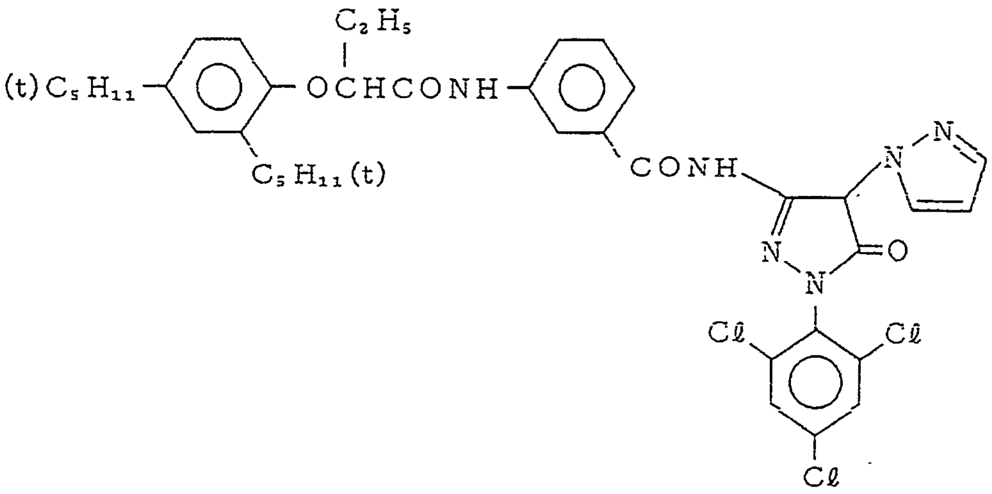
EX－11



EX－12

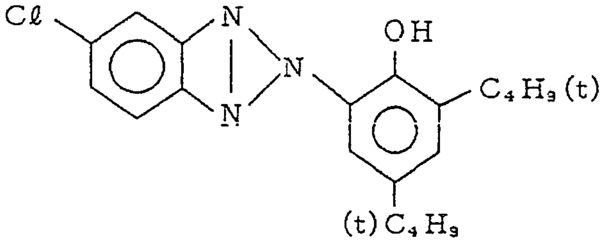


EX-13



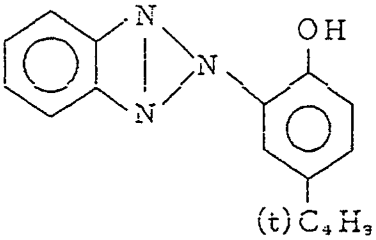
C_2H_5
$(t)C_5H_{11}$
OCHCONH
$C_5H_{11}(t)$
CONH
N
N
N
N
O
Cl
Cl
Cl

U-1



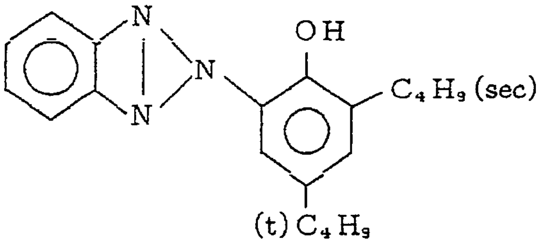
Cl
N
N
N
OH
$C_4H_9(t)$
$(t)C_4H_9$

U-2

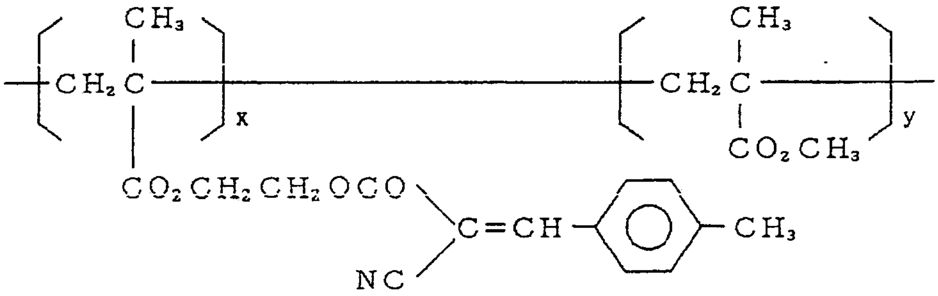


N
N
N
OH
$(t)C_4H_9$

U－3

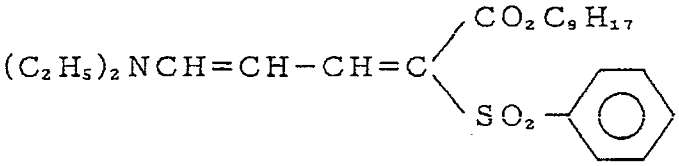


U－4



x : y = 70 : 30 (wt%)

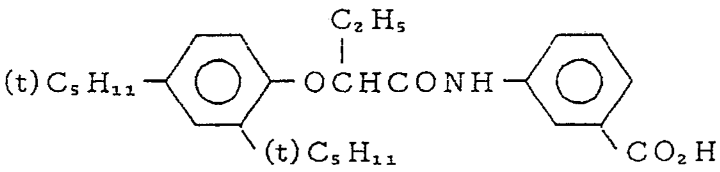
U－5



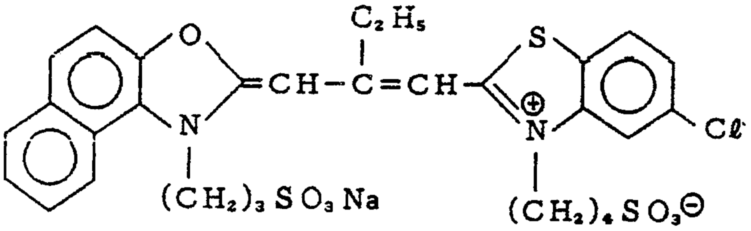
HBS－1 tricresyl phosphate

HBS－2 di-h-butylphthalate

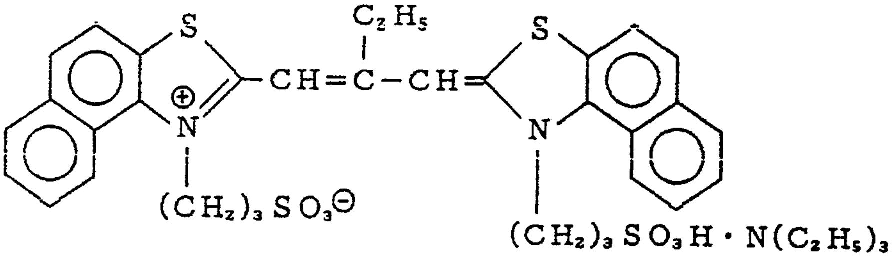
HBS－3



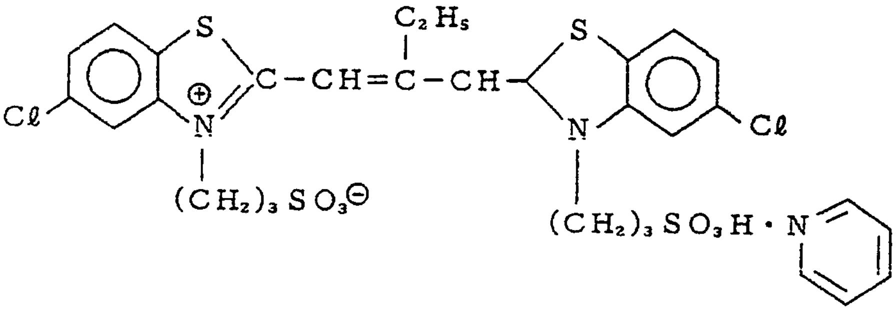
sensitizing dye I



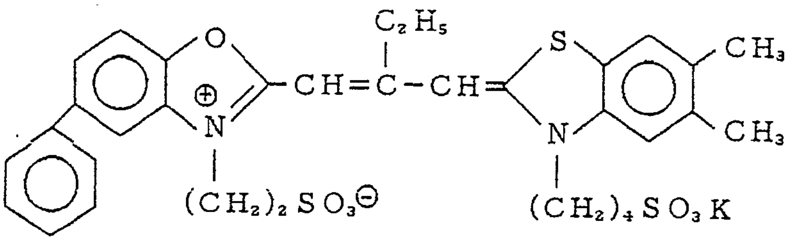
sensitizing dye II



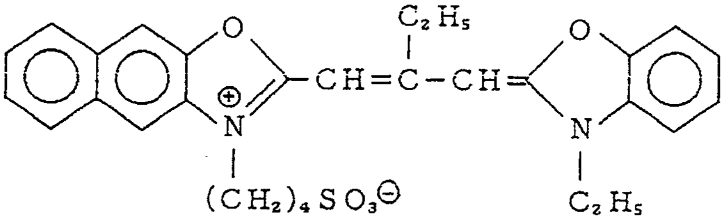
sensitizing dye III



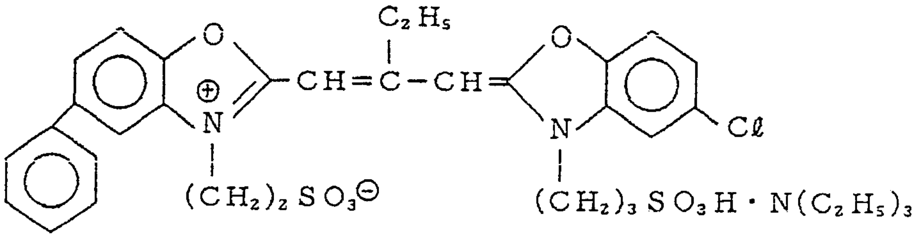
sensitizing dye V



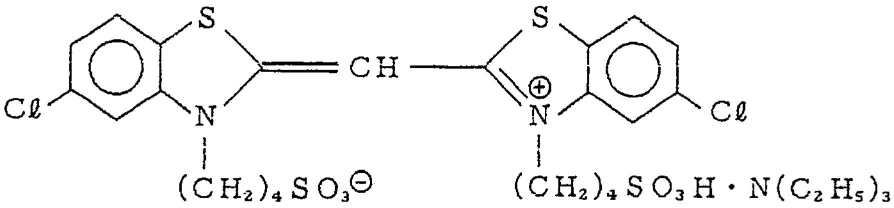
sensitizing dye VI



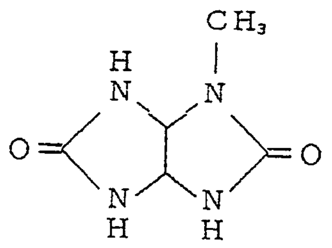
sensitizing dye VII



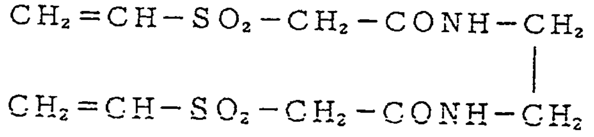
sensitizing dye VIII



S-1



S-1



$$\begin{array}{r} \mathrm{CH_2=CH-SO_2-CH_2-CONH-CH_2} \\ | \\ \mathrm{CH_2=CH-SO_2-CH_2-CONH-CH_2} \end{array}$$

Claims

1. A silver halide photographic light-sensitive material comprising at least one silver halide emulsion layer containing a silver halide emulsion prepared by adding at least one compound represented by the following general formula [I], [II], or [III] during a manufacturing process,
   wherein at least 50% of a total projected area of all silver halide grains of said emulsion layer are occupied by tabular silver halide grains consisting of silver iodobromide, silver iodochloride, or silver iodochlorobromide each containing not less than 3.0 mol% of silver iodide on an average, an aspect ratio of said tabular silver halide grains occupying at least 50% of the total projected area is 3.0 or more, and a relative standard deviation between silver iodide contents of individual grains is not more than 30%:
   [I] $R\text{-}SO_2S\text{-}M$
   [II] $R\text{-}SO_2S\text{-}R^1$
   [III] $R\text{-}SO_2S\text{-}L_m\text{-}SSO_2\text{-}R^2$
   wherein R, R^1, and R^2 may be the same or different and independently represent an aliphatic group, an aromatic group, or a heterocyclic group, M represents a cation, L represents a divalent linking group, and $\underline{m}$ represents 0 or 1, compounds represented by general formulas [I] to [III] being able to be polymers containing divalent groups derived from structures represented by general formulas [I] to [III] as repeating units, and R, R^1, R^2, and L being able to be bonded to each other to form a ring if possible.

2. A silver halide photographic light-sensitive material according to claim 1, characterized in that an aspect ratio of said tabular halide grains is 3.0 to 20, and an average thickness of said tabular silver halide grains is 0.5 μm or less.

3. A silver halide photographic light-sensitive material according to claim 1, characterized in that an aspect ratio of said tabular halide grains is 3.0 to 8.0, and an average thickness of said tabular silver halide grains is 0.5 μm or less.

4. A sliver halide photographic light-sensitive material according to claim 1, characterized in that at least 85% of said total projected area are occupied by said tabular silver halide grains, an aspect ratio of said tabular halide grains is 3.0 to 8.0, and an average thickness of said tabular halide grains is 0.5 μm or less.

5. A silver halide photographic light-sensitive material according to claim 1, characterized in that at least one compound represented by general formula [I], [II] or [III] is added during grain formation.

6. A silver halide photographic light-sensitive material according to claim 1, characterized in that at least one compound represented by general formula [I], [II] or [III] is added during grain formation in an amount of 10^{-5} mol to 10^{-3} mol per mol of silver halide.

7. A silver halide photographic light-sensitive material according to claim 1, characterized in that a compound represented by general formula [I] is added during grain formation in an amount of 10^{-5} mol to 10^{-3} mol per mol of silver halide.

8. A silver halide photographic light-sensitive material according to claim 1, characterized in that a compound represented by general formula [I] is added during grain formation in an amount of 10^{-5} mol to 10^{-3} mol per mol of silver halide, and said tabular silver halide grain has double or multiple structure.

9. A silver halide photographic light-sensitive material according to claim 1, characterized in that a compound represented by general formula [I] is added during grain formation in an amount of 10^{-5} mol to 10^{-3} mol per mol of silver halide, said tabular silver halide grain has double or multiple structure, and a relative standard deviation between silver iodide contents of the individual tabular grains is 20% or less.

European
Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 12 5597

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	Zeitschrift für wissenschaftliche Photographie vol. 63, no. 7-9, 1969, DD pages 133 - 148; Siegfried Gahler: "Benzolthiosulfonsäure und Reduktionssensibilisierung" * - line 16 * – – –	1-9	G 03 C 1/10
A	EP-A-0 147 868 (FUJI PHOTO FILM COMPANY LIMITED) * claims * – – – – –	1-9	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 03 C

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	15 March 91	BUSCHA A.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same catagory
A : technological background
O : non-written disclosure
P : intermediate document
T : theory or principle underlying the invention

E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

&: member of the same patent family, corresponding document