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(54) Scratch resistant thick T-grain.

(57) The invention is generally accomplished by providing a silver halide emulsion wherein said grains comprise tabular silver halide grains of an aspect ratio of less than 4, and wherein greater than 50 percent of said grains have a thickness (T) divided by twin planes separation (S) of greater than 15. It is preferred that such grains comprise greater than 80 percent of said emulsion and that said grains are greater than 0.1 micron equivalent circular diameter. It is further preferred that such emulsion be used in the lower yellow layer of a color negative film.

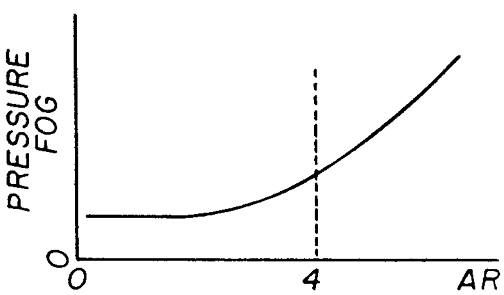


FIG. I

EP 0 550 061 A1

Field of the Invention

This invention relates to a silver halide emulsion that allows production of photographic films that have less pressure sensitivity.

Background of the Invention

Pressure applied to photographic emulsion coatings can produce both reversible and irreversible effects on the sensitometry of the photographic product. Sufficient pressure can cause irreversible distortion of the emulsion grains or cause the formation of physical defects that alter the sensitivity for latent image formation. It has been generally recognized that effect of pressure on the sensitivity of photographic products increases with the magnitude of the applied pressure.

Various types of pressure effects on silver halide photographic systems have been known for long periods of time. In general, pressure sensitivity can be described as an effect which causes the photographic sensitometry of film products to change after the application of some kind of a mechanical stress to a coated photographic film.

In photographic systems, pressure sensitivity, as described, in this general term produces considerable quality defects of products that manifest as increased or decreased density marks on them after development. Such stress may be received from transport mechanism in cameras or other exposing devices or possibly during processing operations. In general, the pressure sensitivity problem increases with the physical size of the emulsion crystals. There is, therefore, a need to produce photographic coatings that are less sensitive to mechanical stress in order to improve the quality of many of the current photographic products.

Dry gelatin is hard and can thus easily transmit applied stress to the silver halide crystals in a coated photographic system. Prior arts describe the inclusion of low glass transition temperature, Tg, soft polymer latexes into coated photographic films. It is known to include polymers in the emulsion containing layers, and to incorporate of such polymers into overcoat layers. Inclusion of polymers tends to reduce pressure sensitivity of photographic film products. Present day photographic products have higher and higher photographic speeds and consequently are larger and larger in dimension and exhibit more severe pressure sensitivity problems. It is known to use organic solvent dispersions in photographic layer to reduce the pressure sensitivities of film products. However, in order to reduce the pressure sensitivity of present day high speed and high pressure sensitivity photographic products, the solvent loads of the films have to be so high that such films show signs of delamination in the layers containing the solvent dispersion when pressure is applied for testing. Therefore, it would be desirable to reduce pressure sensitivity of photographic products without inhibiting developability or diminishing the integrity of film product.

It has also been proposed to use gelatin grafted and case hardened gelatin grafted polymer particles and photographic film products to decrease their pressure sensitivity. Such techniques are disclosed in U.S. Patents 5,066,572 - O'Connor et al and 5,026,632 - Bagchi et al.

U.S. Patent 4,853,322 - Makino et al discloses a silver halide emulsion wherein the tabular grains have a diameter of at least 0.15 micrometer, an aspect ratio of not more than 8, and a ratio of the thickness (b) of the tabular grain to the longest spacing between two or more parallel twin planes (a) of at least 5. These grains are imbedded to produce an improvement in sharpness and granularity.

Problem to Be Solved by the Invention

There remains a need for silver halide emulsions that are not pressure sensitive and have good speed and granularity performance.

Summary of the Invention

An object of this invention is to overcome disadvantages of prior silver halide emulsions.

A further object is to reduce pressure sensitivity of photographic film.

Another further object is to provide a method of forming color negative film that has reduced pressure sensitivity and good speed/grain performance.

These and other objects of the invention are generally accomplished by providing a silver halide emulsion wherein said grains comprise tabular silver halide grains of an aspect ratio of less than 4, and wherein greater than 50 percent of said grains have a thickness (T) divided by twin planes separation (S) of greater than 15. It is preferred that such grains comprise greater than 80 percent of said emulsion and that said grains are greater than 0.1 micron equivalent circular diameter. It is further preferred that such emulsion be used in at least one of the yellow layers of a color negative film.

Advantageous Effect of the Invention

The invention has many advantages over prior practices. It allows the formation of photographic products having lower fog but without an increase in granularity in comparison with photographic emulsions having a greater aspect ratio and lower thickness. These emulsions have good resistance to pressure fog but maintain a good granularity position. Also, they exhibit a lower tendency to pressure fog than grains of greater aspect ratio.

Brief Description of Drawings

Fig. 1 illustrates the relationship between aspect ratio and pressure fog in films of the invention.

Fig. 2 illustrates the relationship between granularity and ratio thickness and twin plane separation.

Detailed Description of the Invention

There has been found to be a relationship between pressure fog propensity and aspect ratio. As illustrated in Fig. 1, the slope of the pressure fog sensitivity increases drastically after an aspect ratio of greater than 4 is reached. Therefore, it would be desirable to utilize grains of an aspect ratio of less than 4 in photographic uses where pressure fog may be a problem. Pressure fog particularly affects the upper layers of emulsion in a color negative film. These typically are the blue sensitive layers that contain yellow dye-forming couplers. However, normally if a grain of less than 4 in an aspect ratio is utilized, it will have less sensitivity to light than a grain of greater aspect ratio. In accordance with the invention, however, it has been discovered that silver halide grains having a size greater than 0.1 micron in equivalent circular diameter, and wherein at least 50 percent of these tabular grains possess a thickness (T) two twin plane separation (S) ratio greater than 15 that the speed will be maintained even for less (lower aspect ratio) tabular grains.

As is illustrated in Fig. 2, there has been found to exist a relationship between granularity position and the thickness for twin plane separation ratio (T/S) for emulsions of the invention. As illustrated in Fig. 2, granularity decreases as the T/S ratio increases. A preferred ratio of T/S is greater than 15 with a most preferred embodiment being greater than about 20. S is defined as the longest spacing between adjacent twin planes in a twin crystal. It is also preferred that at least 80 percent of the total projected area be comprised of grains of greater than 0.1 micron.

The emulsions of the invention as above stated find their preferred use in the upper layer or layers of a color negative film. Such films are generally formed with the upper layers being blue sensitive and, therefore, containing yellow dye-forming couplers. The upper layers being nearer the surface of the film are most subject to pressure sensitivity deterioration. Generally, the effect of pressure on the film is to increase the fog level in the yellow layers.

While the preferred use is in the blue layer, the emulsions of the invention also may be utilized in the cyan dye-forming layer or in the magenta dye-forming layer. They also are suitable for use in color paper or in black-and-white films.

The thick tabular grain emulsions of the invention generally are produced by adjustment of the conditions disclosed in U.S. Patent 4,853,322 - Makino et al, U.S. Patent 4,434,226 - Wilgus et al, U.S. Patent 4,414,310 - Daubendiek et al, U.S. Patent - Wey, U.S. Patent 4,433,048 - Solberg et al, U.S. Patent 4,386,156 - Mignot, U.S. Patent 4,504,570 - Evans et al, U.S. Patent 4,400,463 - Maskasky, U.S. Patent 4,414,306 - Wey et al, U.S. Patents 4,435,501 and 4,643,966 - Maskasky, and U.S. Patents 4,672,027 and 4,693,964 - Daubendiek et al. Also specifically contemplated are those silver bromoiodide grains with a higher molar proportion of iodide in the core of the grain than in the periphery of the grain, such as those described in G.B. Patent 1,027,146; Japanese 54/48521; U.S. Patent 4,379,837; U.S. Patent 4,444,877; U.S. Patent 4,665,012; U.S. Patent 4,686,178; U.S. Patent 4,565,778; U.S. Patent 4,728,602; U.S. Patent 4,668,614; U.S. Patent 4,636,461; E.P 264,954. The silver halide emulsions can be either monodisperse or somewhat polydisperse as precipitated. The grain size distribution of the emulsions can be controlled by silver halide grain separation techniques or by blending silver halide emulsions of differing grain sizes.

Sensitizing compounds, such as compounds of copper, thallium, lead, bismuth, cadmium, and Group VIII noble metals can be present during precipitation of the silver halide emulsion, as illustrated by U.S. Patents 1,195,432; 1,951,933; 2,448,060; 2,628,167; 2,950,972; 3,448,709; and 3,737,313.

The silver halide emulsions can be either monodispersed or polydispersed as precipitated. The grain size distribution of the emulsions can be controlled by silver halide grain separation techniques or by blending silver halide emulsions of differing grain sizes. The emulsions can include Lippmann emulsions and ammoniacal emulsions, as illustrated by Glafkides, Photographic Chemistry, Vol 1. Fountain Press, London, 1958, pp. 365-368 and pp. 301-304; excess halide ion ripened emulsions as described by G.F. Duffin, Photographic Emulsion Chemistry, Focal Press Ltd., London, 1966, pp. 60-72; thiocyanate ripened emulsions, as illustrated by U.S. Patent 3,320,069; thioether ripened emulsions, as illustrated by U.S. Patents 3,271,157; 3,574,628; and 3,737,313 or emulsions containing weak silver halide solvents, such as ammonium salts, as illustrated by U.S. Patent 3,784,381 and Research Disclosure, December 1978, No. 134, June 1975, Item 13452.

The silver halide emulsions can be surface sensitized. Noble metal (e.g., gold), middle chalcogen (e.g., sulfur, selenium, or tellurium), and reduction sensitizers, employed individually or in combination, are specifically contemplated. A preferred method of sensitization is sulfur and gold.

Typical chemical sensitizers are listed in Research Disclosure, December 1978, Item 17643, Section III.

The silver halide emulsions can be spectrally sensitized with dyes from a variety of classes, including the polymethine dye class, which included the cyanines, merocyanines, complex cyanines and merocyanines (i.e., tri-, tetra-, and polynuclear cyanines and merocyanines), oxonols, hemioxonols, styryls, merostyryls, and streptocyanines. Illustrative spectral sensitizing dyes are disclosed in Research Disclosure, Item 17643, cited above, Section IV. The preferred sensitizing compound has been found to be the dye given in the examples below for good speed/grain performance.

The silver halide emulsions, as well as other layers of the photographic recording materials, of this invention can contain as vehicles hydrophilic colloids, employed alone or in combination with other polymeric materials (e.g., lattices). Suitable hydrophilic materials include both naturally occurring substances such as proteins, protein derivatives, cellulose derivatives - e.g., cellulose esters, gelatin - e.g., alkali treated gelatin (cattle, bone, or hide gelatin) or acid treated gelatin (pigskin gelatin), gelatin derivatives - e.g., acetylated gelatin, phthalated gelatin and the like, polysaccharides such as dextran, gum arabic, zein, casein, pectin, collagen derivatives, collodion, agar-agar, arrowroot, and albumin. The vehicles can be hardened by conventional procedures. Further details of the vehicles and hardeners are provided in Research Disclosure, Item 17643, cited above, Sections IX and X.

The following examples are illustrative and not exhaustive of the embodiments of the invention. The invention is intended to be only limited by the claims. Parts and percentages are by weight unless otherwise indicated.

Examples 1-8

The description below is representative of the general process of forming silver halide grains of the invention.

(a) 94.0 cc of 1.5N $AgNO_3$ was added in two minutes to 4.5 liters of 0.1N NaBr solution containing 4 g/l gelatin @ 35 °C. The pBr starts at 1.11 and finishes at 1.25.

(b) To the above solution was added 4.5 liters of 37.8 g/l gelatin solution @ 85 °C. This was allowed to stir 16.7 minutes. The resulting solution equilibrated at 77 °C with a pBr of 1.56.

(c) 1.5N $AgNO_3$ and 1.5N NaBr were then run 8.0 to 42.0 cc/min. over 10.5 min. at constant pBr.

(d) 250cc of 1.0N KI solution was added in two minutes.

(e) 3.0N $AgNO_3$ and 3.0N NaBr were then run from 21 to 51 cc/min. over 10 minutes. Initially only $AgNO_3$ is added until original pBr is reached than pBr is held constant. Then 3.0N solution from 51 to 103 cc/min. for 9 minutes. A solution of potassium hexachloroiridate (4.0×10^{-7} mole/mol Ag) was added during the last 2.5 minutes of the last run.

(f) To this solution 0.5 liters of 3.8N NaBr was added, then 0.15 mole AgI lippman. The resulting pBr was 0.84.

(g) 3.0N $AgNO_3$ was then added @ 47.0 cc/min. until a pBr of 2.35 was reached. Any remaining $AgNO_3$ - (total 10.0 moles AgX made) was added @ 47.0 cc/min. and constant VAg using 3.0N NaBr.

(h) The emulsion was then washed via ultrafiltration and spectrally and chemically sensitized in a conventional manner.

Example 1 modifies the above general procedure in that AgI lippman was used in step D in place of the KI.

Example 2 differs from the representative process by decreasing the amount of $AgNO_3$ added in Step A to 47 cc delivered in one minute.

Example 3 differs from the representative process by adding the iodide solution from Step D concurrently with the first 10 minutes of Step E.

Example 4 is like Example 2 except Step A equals 2 minutes.

Example 5 differs from the representative process by Step A equaling 70.5 cc over 90 seconds and Step C is extended from 8 to 72 cc/min. over 20 minutes. An equal amount of silver was removed from the beginning of Step E, thereby keeping the total silver added in Steps C and E constant.

Example 6 is like Example 2 except Step A equals 70.5 cc for 1.5 minutes.

Example 7 is like Example 5 except Step C is 8.0 to 57 cc/min. over 15 min. keeping the total silver added in Steps C and E constant.

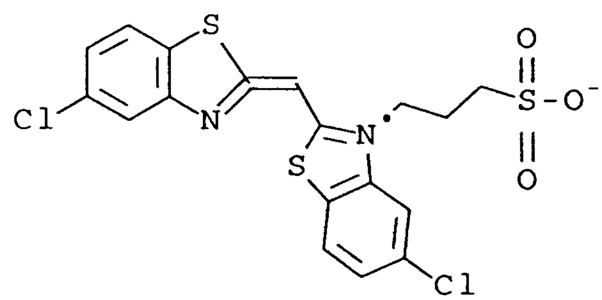
Example 8 is the representative process as described above.

Example 9 uses the known fast yellow emulsion of the Kodak Ektar 125 film.

Example 10 uses the known mid-yellow emulsion from the Gold 100 film.

Each emulsion was separately optimized with NaSCN, dye, $KAuCl_4$, $Na_2S_2O_3 \cdot SH_2O$ and 3-methyl benzothiazolium iodide. All emulsions independently arrived at approximately the same degree of dye per surface area. Chemical sensitizers were also at about the same amount of sensitizer per surface area for each grain. The sensitized dye used is given below.

TEA^+



$C_{27}H_{35}Cl_2N_3O_6S_4$

As the spectral sensitizing dyes and degree of chemical sensitization are the same, any beneficial behavior is therefore characteristic of the grain. Those optimized finishes were then tested in a variety of formats for several characteristics.

The benefits of this invention may be realized when this emulsion is used as a mid-component in a three (or more) emulsion blue sensitive layer(s) of a color negative system.

The emulsions were specifically tested in the multilayer structure illustrated below.

SOC
Gelatin and ultraviolet absorber
Fast Yellow
Slow Yellow
Intermediate Layer
Fast Magenta
Slow Magenta
Intermediate Layer
Fast Cyan
Slow Cyan
Antihalation
Support

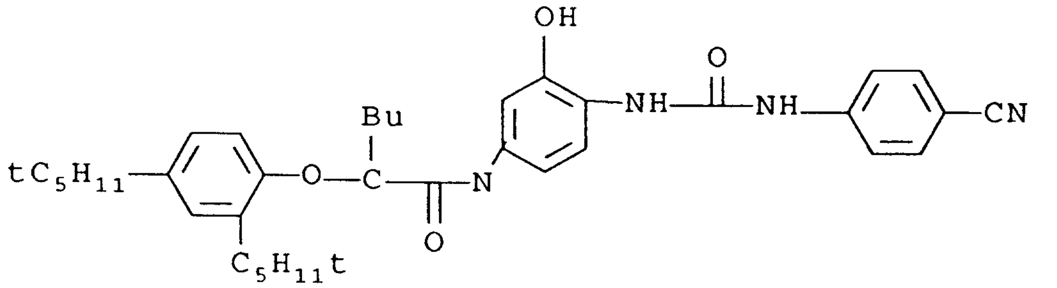
It would, however, be obvious to one skilled in the art that these benefits could be derived in virtually any structure and also not unique to a negative format or tested.

Since these candidates are intended to be mid-components of a multilayer system, it is impractical to measure their light sensitivity as they are practically used. Therefore, the speeds quoted in Table I were generated in a single layer format given below.

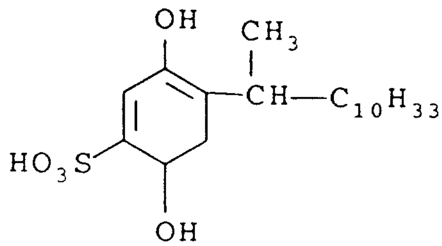
TABLE I

Example ID	mm ECD	mm THICK	T/S	A.R.	SPEED	Speed Gamma Normal Grain	Rough Roller
1	0.89	0.48	24	1.85	304	-0.3	18
2	1.06	0.58	29	1.83	315	+1.0	19
3 control	1.12	0.17	8	6.60	305	+3.5	28
4	1.11	0.59	30	1.88	318	+2.0	25
5	1.00	0.38	19	2.63	305	+2.0	23
6	0.93	0.55	28	1.69	309	+1.5	19
7	0.95	0.50	25	1.90	313	+2.0	19
8	0.84	0.53	26	1.58	294	0.0	20
9 control	1.40	0.13	7	10.76	300	+6.0	47
10 control	0.90	0.41	-	2.20	295	+4.0	18

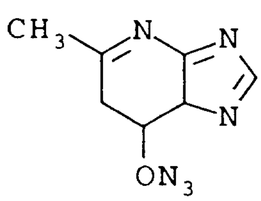
Emulsions 9 and 10 are comparative examples - one with high A.R. and one with low A.R.
ECD = equivalent circular diameter
A.R. = aspect ratio



Cyan Coupler



DOX Scavenger

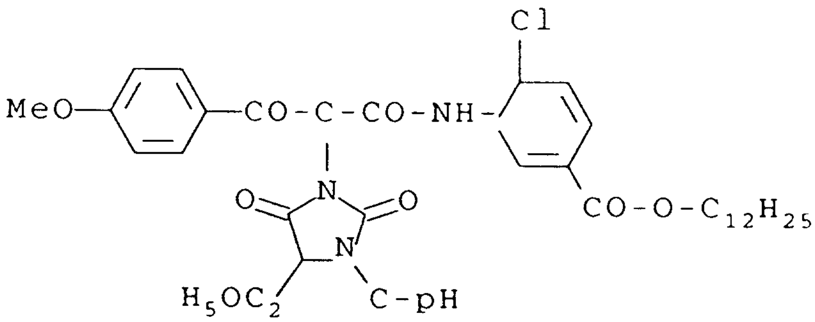


Antifoggant

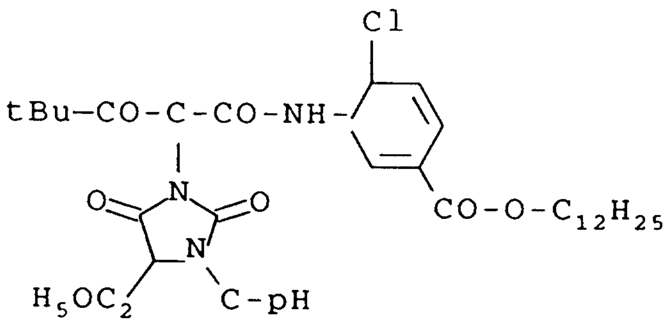
The cyan coupler at 1076 m/m^2, silver bromide iodide at 1076 mg/m^2, gel at 5167 mg/m^2 and DOX SCAVENGER at 19.4 mg/m^2 and antifoggant at 49.5 mg/m^2 were coated on an acetate support in a gelatin matrix and cross-linked with 1.5% BVSM. Said coatings were exposed with a 5500 K light source using DLV filter. These were then developed in a C41 process. Densities were measured as a function of exposure, speed was defined as 0.15 above D_{min} normalized for contrast.

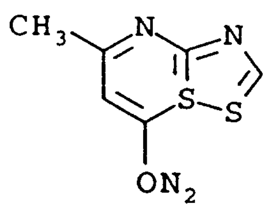
The granularity (Speed Gamma Normal Grain) and pressure sensitivity (Rough Roller) quantities of Table I were measurable in a format that reflects practical multilayer usage of these emulsions. These multilayers were generated by coating the following formula on an acetate support which has been previously coated with all of the layers below the SY layer. This formula was simultaneously overcoated such that the layers above and below were constant. These mid components were coated with a constant slow component so that any difference in behavior could be attributed to the mid-component.

R_1

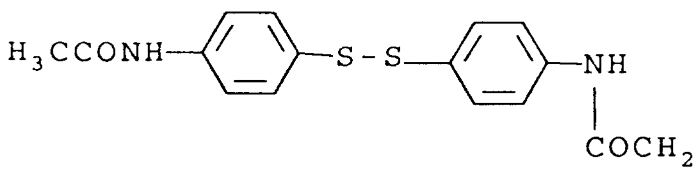


R_2

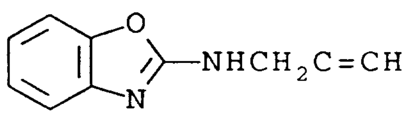




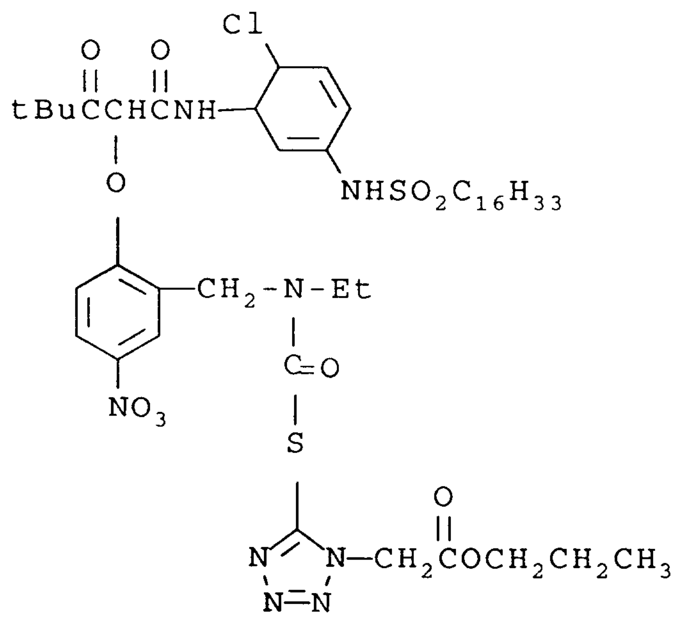
ANTIFOGGANT (1)



ANTIFOGGANT (2)



LATENT IMAGE ADDENDA



DIAR COUPLER

The laydown of the common slow component was 161 mg/m^2 of silver bromide grains that are 0.5μ ECD, 0.17μ thick, and 1.3 molar percent iodide. The level of the invention and control emulsion is always 323 mg/m^2 silver bromoiodide. Yellow coupler (R_1) was coated at 377 mg/m^2 yellow coupler (R_2) at 805 mg/m^2, antifoggant (1) at 8 mg/m^2, antifoggant (2) 0.15 mg/m^2. Latent image addenda at 0.03 mg/m^2 and the diar coupler at 64.6 mg/m^2. All materials are in a 538 mg/m^2 gel matrix hardened with 1.5% BVSM.

The pressure sensitivity responses were created by the use of a rough roller on the multilayer coatings. Half of a film specimen are subjected to a pressure of 40 psi by a roller which is not smooth. This hardened stainless steel roller has been roughened to a specified peaks/area. The rollers peaks count is 50 peaks/sq. cm. This leads to very high local pressures which are intended to mimic the pressures associated with a practical scratch. The film is then exposed and processed in a normal fashion. The delta densities quoted in the rough roller column are simply the density difference in a non-exposed region between a subjected to the pressure roller area and a non-subjected area. A decrease in this difference implies a decreased sensitivity to scratches.

Granularity (Speed Gamma Normal Grain) was also measured in a multilayer format. The numbers quoted in Table I are an average of three points, normalized for contrast taken from the region where the candidate is known to be imaging. They are quoted relative to Example 8 and speed is normalized by assuming one stop equals 7 grain units.

The grain sizes quoted are obtained by actually measuring and summing each grain as photographed on scanning electron microscope. This technique was also used to obtain grain thicknesses. The twin plane separations were individually measured concurrently with thickness on a transmission electron microscope. In order to accomplish this, grains were cross-sectioned at very low temperatures to obtain workable specimens. The thicknesses obtained with the TEM was very much in agreement with those from the SEM.

The following Examples 11 and 12 illustrate the emulsions of the invention utilized in preferred film structures. The emulsions in the invention are used in the slow blue layer in the 3 percent iodide emulsion.

Example 11

A three color photographic film was prepared as follows using conventional surfactants, and antifoggants and the materials indicated. After providing a developable image and then processing in accordance with the Kodak C-41 process (British Journal of Photography, pp. 196-198(1988)) excellent results were obtained.

Support	mg/dm^2	
Layer 1		
Antihalation layer	1.4	Black filamentary silver
	1.6	Oxidized developer (D-Ox) scavanging coupler (1)
	0.5	Magenta filter dye (1)
	0.1	Cyan filter dye (2)
	0.5	Magenta dye forming coupler (2)
	0.75	UV absorbing dye (8)
	24	Gelatin.
Layer 2		
First red layer	6.1	Slow Ag Br/I emulsion containing 1.3 mole% iodide and 55 mg of sensitizing dye (1) and 693 mg of sensitizing dye (2) per mole of silver halide.
	6.6	Slow Ag Br/I Tabular grain("T-grain") emulsion containing 3 mole% iodide and 57 mg of sensitizing dye (1) and 689 mg of sensitizing dye (2) per mole of silver halide.
	4.5	Cyan dye forming coupler (3)

	0.5	Cyan dye forming development inhibitor releasing coupler ("DIR")(4).
	0.5	Cyan dye forming couplers (5)
	0.05	Cyan filter dye(4)
	26.9	Gelatin

Layer 3

Second Red Layer	8.6	Fast Ag Br/I T-Grain emulsion containing 3 mole% iodide and 55 mg of sensitizing dye(1) and 691 mg of sensitizing dye(2) per mole of silver halide.
	1.2	Cyan dye forming coupler (3)
	0.4	Cyan dye forming coupler(6)
	0.3	Cyan dye forming DIR coupler(4)
	17.2	Gelatin

Layer 4

Color Corr. Layer	2.7	Fast Ag Br/I T-grain emulsion containing 3 mole% iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide.
	0.3	Magenta dye forming DIR coupler(7)
	0.14	Orange filter dye(5)
	7.5	Gelatin

Layer 5

Interlayer	6.5	Gelatin

Layer 6

First Green Layer	5.6	Slow Ag Br/I emulsion containing 1.3 mole% iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide
	5.6	Slow Ag Br/I T-grain emulsion containing 1.5 mole% iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide
	4.4	Fast Ag Br/I T-grain emulsion containing 3 mole% iodide and 575 mg of sensitizing dye(3) and 160 mg of sensitizing dye(4) per mole of silver halide
	2.3	Magenta dye forming coupler(8)
	1.8	Magenta dye forming coupler(9)
	0.2	Magenta dye forming DIR coupler(7)
	0.03	Cyan dye forming coupler(5)
	0.1	Magenta filter dye(6)
	21.2	Gelatin

Layer 7

Second Green Layer	7.5	Fast Ag Br/I T-grain emulsion containing 3 mole% iodide and 575 mg of sensitizing dye(3) and 160 mg of sensitizing dye(4) per mole of silver halide
	0.8	Magenta dye forming coupler(8)
	0.3	Magenta dye forming (DIR)coupler(7)
	0.03	Cyan dye forming coupler(5)
	14.0	Gelatin

Layer 8		
Yellow Coll. Silver Filter Layer	0.5	D-Ox scavanging coupler(1)
	8.6	Gelatin
Layer 9		
First Blue Layer	1.2	Slow Ag Br/I emulsion containing 1.3 mole% iodide and 808 mg of sensitizing dye(5) per mole of silver halide
	5.1	Slow Ag Br/I emulsion containing 3 mole% iodide of 383 mg of sensitizing dye(5) per mole of silver halide.
	3.8	Yellow dye forming coupler(10)
	9.1	Yellow dye forming coupler(11)
	0.6	Yellow dye forming DIR coupler(12)
	21.5	Gelatin
Layer 10		
Second Blue Layer	6.5	Fast Ag Br/I emulsion containing 7.5 mole% of iodide and 383 mg of sensitizing dye(5) per mole of silver halide.
	1.4	Yellow dye forming coupler(11)
	0.8	Yellow dye forming (DIR) coupler(12)
	0.05	Cyan dye forming coupler(5)
	0.8	Yellow filter dye(7)
	9.7	Gelatin
Layer 11		
	2.1	Lippman Ag Br emulsion
	1.1	UV absorbing dye(3)
	1.1	UV absorbing dye(8)
	7.0	Gelatin
Layer 12		
Protective Gel Overcoat	8.8	Gelatin

Example 12

A three color photographic film was prepared as follows using conventional surfactants, and antifoggants and the materials indicated. After providing a developable image and then processing in accordance with the Kodak C-41 process (British Journal of Photography, pp. 196-198(1988)) excellent results were obtained.

Support	mg/dm2	
Layer 1		
Antihalation layer	1.4	Black filamentary silver
	1.6	D-Ox scavanging coupler (1)
	0.5	Magenta filter dye (1)
	0.1	Cyan filter dye (2)
	0.85	Magenta dye forming coupler (2)
		UV absorbing dye (3)
	0.75	
	0.3	UV aborbing dye (8)
	0.1	Orange filter dye (5)
	24	Gelatin.
Layer 2		
First red layer	7.9	Slow Ag Br/I emulsion containing 1.3 mole% iodide and 55 mg of sensitizing dye (1) and 693 mg of sensitizing dye (2) per mole of silver halide.
	7.3	Slow Ag Br/I (T-grain) emulsion containing 3 mole% iodide and 55 mg of sensitizing dye (1) and 691 mg of sensitizing dye (2) per mole of silver halide.
	4.5	Cyan dye forming coupler (3)
	0.5	Cyan dye forming DIR coupler (4).
	0.5	Cyan dye forming coupler (5)
	0.14	Cyan filter dye (4)
	27	Gelatin

Layer 3		
Second Red Layer	10.8	Fast Ag Br/I T-Grain emulsion containing 4 mole % iodide and 71 mg of sensitizing dye (1)and 645 mg of sensitizing dye(2) per mole of silver halide.
	1.5	Cyan dye forming coupler(3)
	0.4	Cyan dye forming DIR coupler(4)
	0.4	Cyan dye forming coupler (6)
	18.1	Gelatin
Layer 4		
Interlayer	12.9	Gelatin

Layer 5

First Green layer	5.7	Slow Ag Br/I emulsion containing 1.3 mole % iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide
	4.8	Slow Ag Br/I T-grain emulsion containing 1.5 mole % iodide and 510 mg of sensitizing dye(3) and 145mg of sensitizing dye(4) per mole of silver halide.
	2.9	Slow Ag Br/I T-grain emulsion containing 3 mole % iodide and 575 mg of sensitizing dye(3) and 160 mg of sensitizing dye (4) per mole of silver halide.
	2.0	Fast Ag Br/I T-grain emulsion containing 3 mole% iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide
	2.0	Magenta dye forming coupler(8)
	1.8	Magenta dye forming coupler(9)
	0.2	Magenta dye forming DIR coupler(7).
	0.03	Cyan dye forming coupler (5)
	0.1	Magenta filter dye(6)
	21.2	Gelatin

Layer 6		
Second Green layer	8.1	Fast Ag Br/I T-grain emulsion containing 3 mole% iodide and 510 mg of sensitizing dye(3) and 145 mg of sensitizing dye(4) per mole of silver halide.
	1.0	Magenta dye forming coupler (8)
	0.2	Magenta dye forming DIR coupler(7)
	0.01	Cyan dye forming coupler(5)
	16.1	Gelatin
Layer 7		
Yellow Colloidal Silver filer layer	0.5	D-Ox scavanging coupler(1)
	8.6	Gelatin
Layer 8		
First Blue layer	1.4	Slow Ag Br/I emulsion containing 1.3 mole% iodide and 808 mg of sensitizing dye(5) per mole of silver halide.
	3.4	Slow Ag Br/I emulsion containing 3 mole% iodide and 383 mg of sensitizing dye(5) per mole of silver halide.
	1.9	Yellow dye forming coupler(10)
	8.6	Yellow dye forming coupler(11)
	0.6	Yellow dye forming DIR coupler(12)
	21.3	Gelatin

Layer 9

Second blue layer	5.9	Fast Ag Br/I emulsion containing 7.5 mole% iodide and 383 mg of sensitizing dye(5) per mole of silver halide
	3.8	Yellow dye forming coupler(10)
	2.2	Yellow dye forming coupler(11)
	0.8	Yellow dye forming DIR coupler(12)
	0.08	Cyan dye forming coupler (5)
	0.9	Yellow filter dye(7)
	12.9	Gelatin

Layer 10

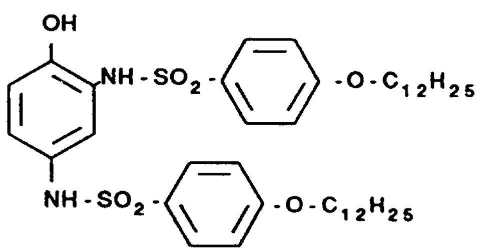
	2.1	Lippman Ag Br emulsion
	1.1	UV absorbing dye(3)
	1.1	UV absorbing dye(8)
	7.0	Gelatin

Layer 11

Protective Gel. Overcoat	8.8	Gelatin

Couplers

1)



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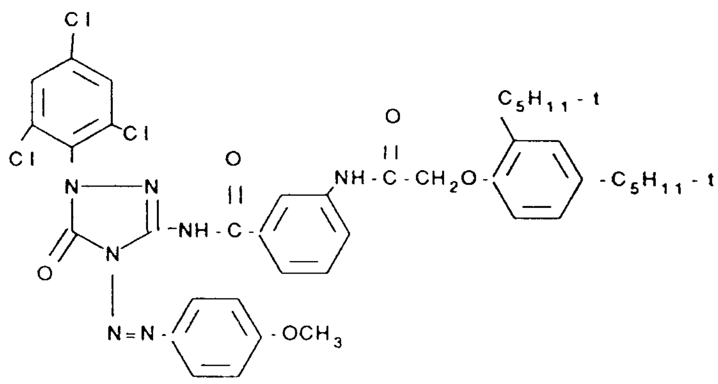

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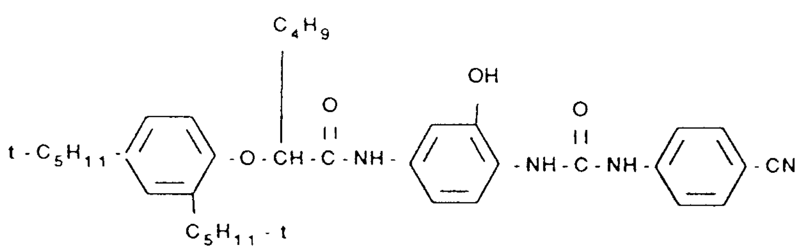

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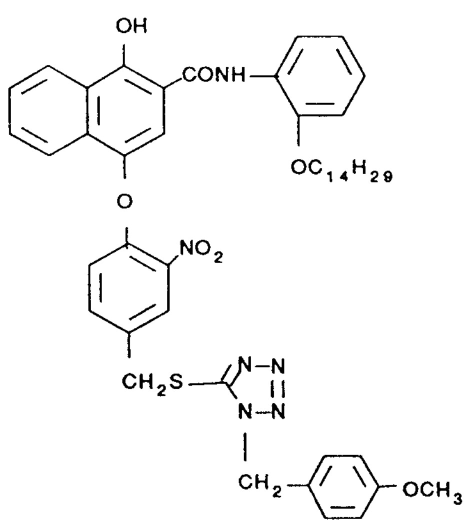

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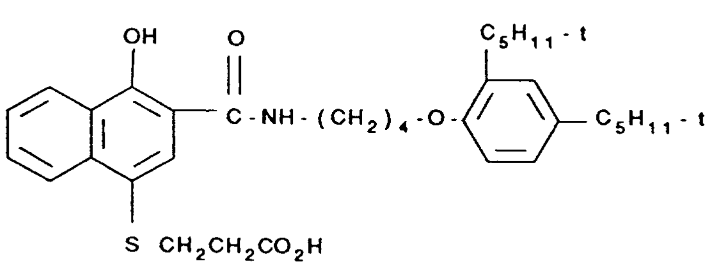

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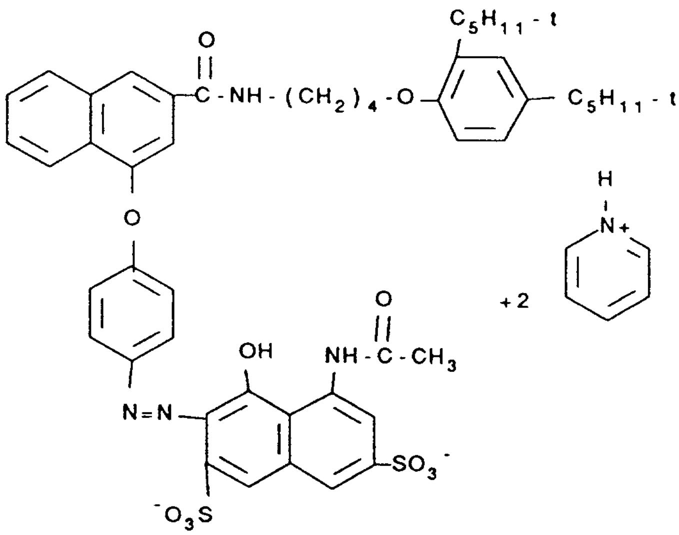

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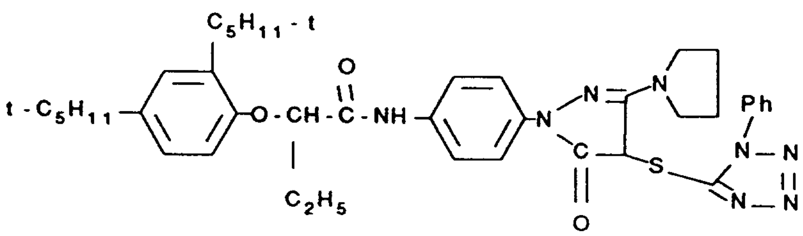

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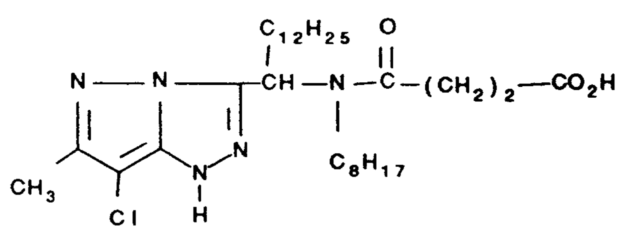

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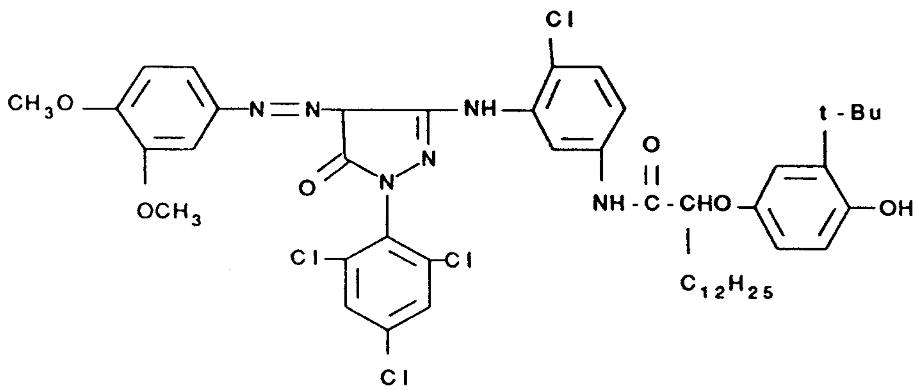

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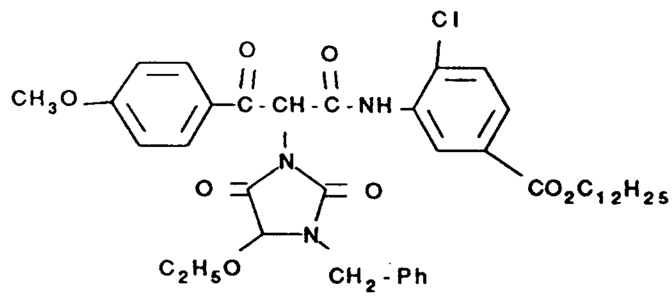

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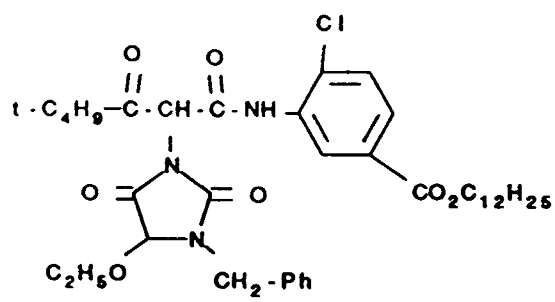

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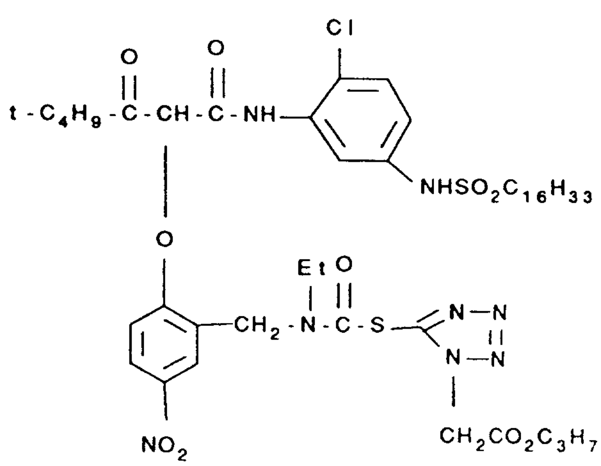
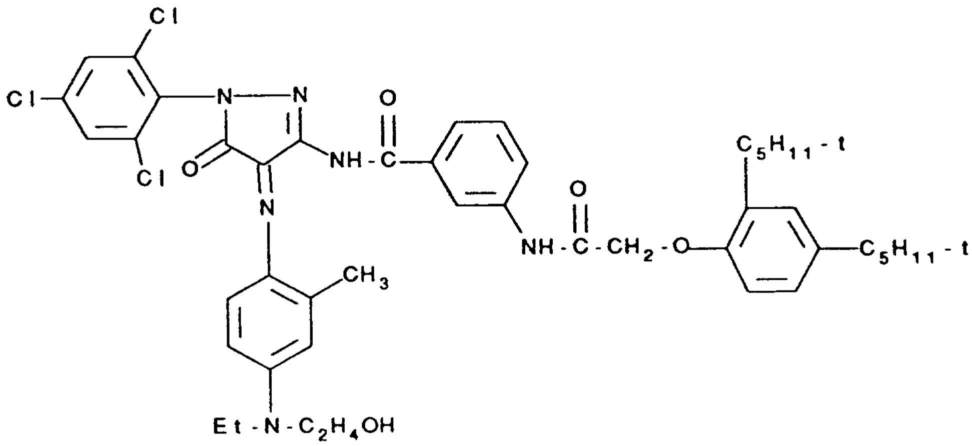


Dyes

(1)



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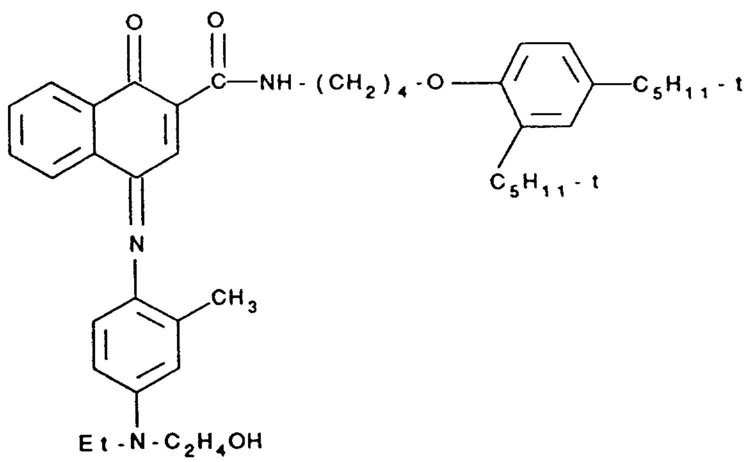
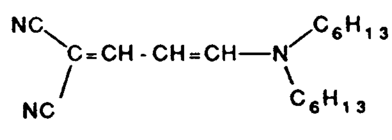
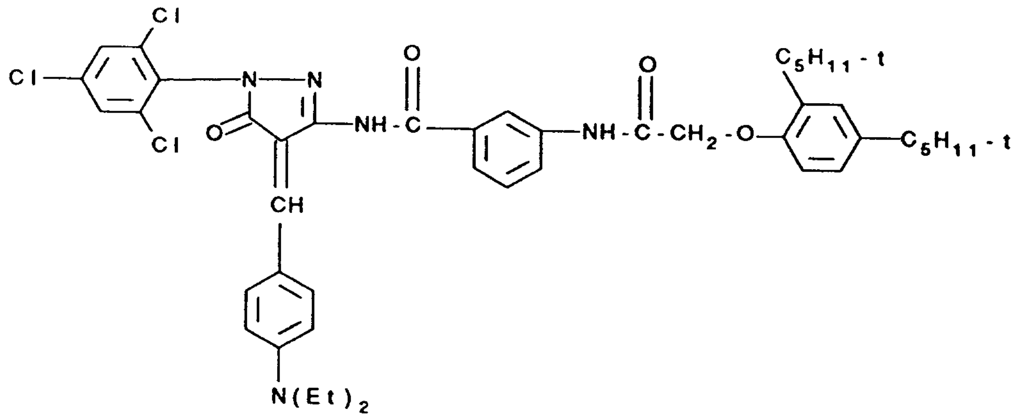


(3)

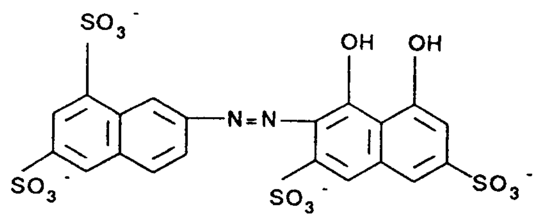


(4) 4,8-bis-(SULFOMETHYLAMINO)-ANTHRARUFIN-2,6-DISULFONIC ACID, TETRASODIUM SALT

(5)

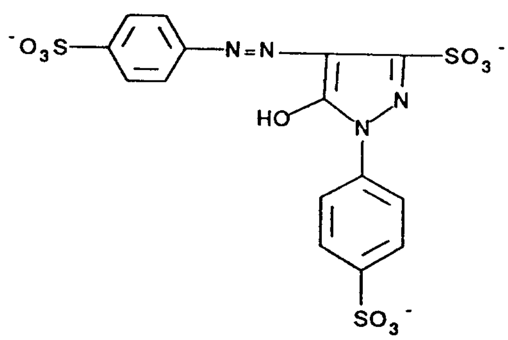


(6)



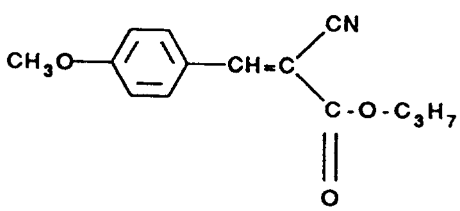
$4Na^+$

(7)



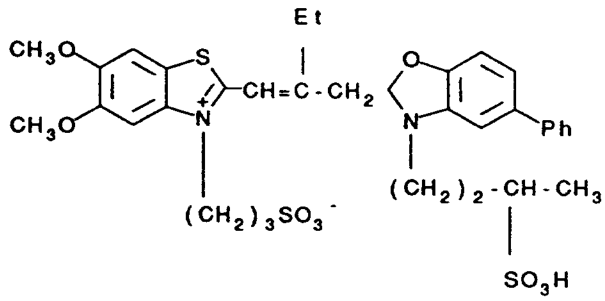
$3Na^+$

(8)

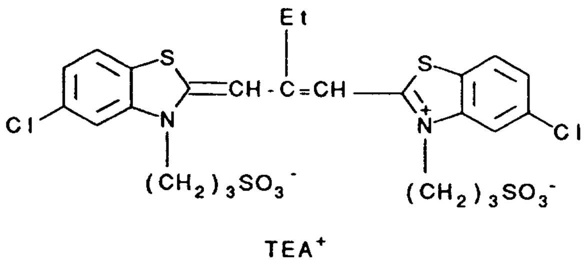


Sensitizing Dyes

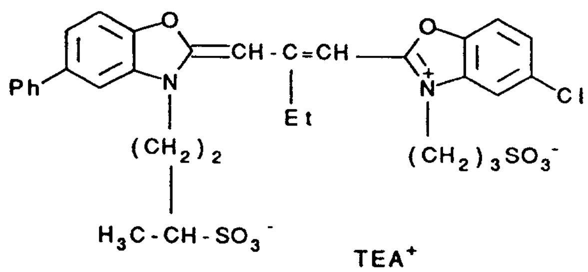
(1)


Et
CH3O
CH3O
S
N
CH=C-CH2
O
N
Ph
(CH2)3SO3-
(CH2)2-CH-CH3
SO3H

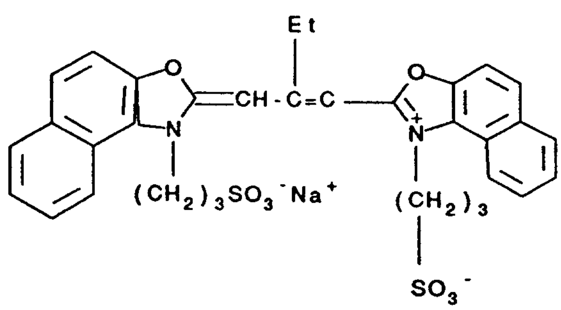
(2)


Et
S
CH-C=CH
S
Cl
N
N
Cl
(CH2)3SO3-
(CH2)3SO3-
TEA+

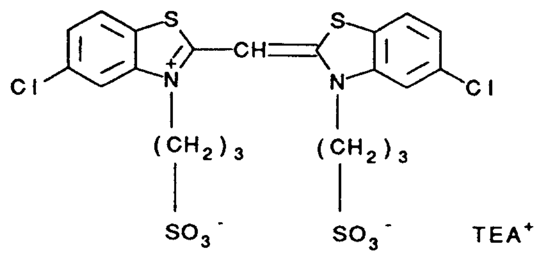
(3)


O
CH-C=CH
O
Ph
N
N
Cl
Et
(CH2)2
(CH2)3SO3-
H3C-CH-SO3-
TEA+

(4)


Et
O
CH-C=C
O
N
N
(CH2)3SO3-Na+
(CH2)3
SO3-

(5)



Claims

1. A photographic emulsion comprising silver halide grains wherein said grains comprise tabular silver halide grains of an aspect ratio of less than 4, and wherein greater than 50 percent of said grains have a thickness (T) divided by twin plane separation (S) of greater than 15.

2. The photographic emulsion of Claim 1 wherein said grains are sensitized with blue dye.

3. The emulsion of Claim 1 wherein the T/S equals greater than 20.

4. The emulsion of Claim 1 wherein said aspect ratio is about 3.

5. The emulsion of Claim 1 wherein greater than 80 percent of said grains are greater than 0.1 micron equivalent circular diameter.

6. The photographic film element wherein at least one layer of said element comprises silver halide grains wherein said grains comprise tabular silver halide grains of an aspect ratio of less than 4, and wherein greater than 50 percent of said grains have a thickness (T) divided by twin plane separation (S) of greater than 15.

7. The photographic element of Claim 6 wherein said grains are sensitized with blue dye.

8. The element of Claim 6 wherein the T/S equals greater than 20.

9. The element of Claim 6 wherein said aspect ratio is about 3.

10. The element of Claim 6 wherein greater than 80 percent of said grains are greater than 0.1 micron equivalent circular diameter.

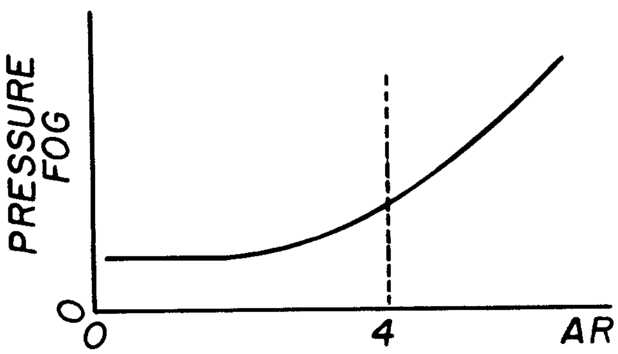


FIG. 1

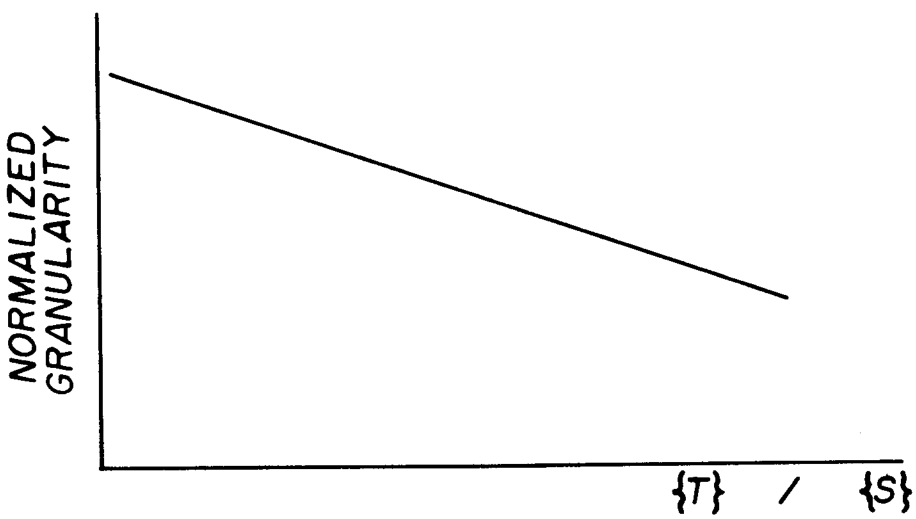


FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 12 2110

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)
X,Y	EP-A-0 410 410 (KONICA CORPORATION) * figure 3; example 5 *	1-10	G03C1/005
X,Y	EP-A-0 421 740 (KONICA CORPORATION) * compound S-7 on p.17 * * figure 3 *	1-10	
X,Y D	EP-A-0 273 411 (FUJI PHOTO FILM COMPANY LTD.) * dye ExS-6 on p.42; layers 11 and 12 on p.27; table 8; figures 1 and 7 * & US-A-4 853 322	1-10	
Y	DATABASE WPIL Week 8928, Derwent Publications Ltd., London, GB; AN 89203368 & JP-A-1 142 627 (FUJI PHOTO FILM K.K.) 5 June 1989 * abstract * & Derwent Publications Ltd., London, GB; * abstract *	1-10	
Y	WO-A-9 118 320 (EASTMAN KODAK COMPANY) * claims 1-26 *	1-10	**TECHNICAL FIELDS SEARCHED (Int. Cl.5)** G03C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07 APRIL 1993	BUSCHA A.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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

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