



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 1 422 560 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

26.05.2004 Bulletin 2004/22

(51) Int Cl.7: **G03C 5/17**, G03C 1/005

(21) Application number: **03078494.6**

(22) Date of filing: **06.11.2003**

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR**

Designated Extension States:

AL LT LV MK

(30) Priority: **19.11.2002 US 299237**

19.05.2003 US 440950

(71) Applicant: **EASTMAN KODAK COMPANY**

Rochester, New York 14650 (US)

(72) Inventors:

- **Dickerson, Robert E.,
c/o Eastman Kodak Company
Rochester New York 14650-2201 (US)**

- **Adin, Anthony, c/o Eastman Kodak Company
Rochester New York 14650-2201 (US)**
- **Beal, Richard E., c/o Eastman Kodak Company
Rochester New York 14650-2201 (US)**
- **Gingello, Anthony D.,
c/o Eastman Kodak Company
Rochester New York 14650-2201 (US)**

(74) Representative: **Haile, Helen Cynthia et al**

**Kodak Limited,
Patents Department (W92-3A),
Headstone Drive
Harrow, Middlesex HA1 4TY (GB)**

(54) **Radiographic film for mammography with improved processability**

(57) A radiographic silver halide film has improved processability because it includes a silver halide emulsion composed of cubic grains having a critical molar ratio of chloride, iodide, and bromide. In particular, the

cubic grains comprise from 1 to 20 mol % of chloride and from 0.25 to 1.5 mol % of iodide, with the remainder being bromide. The cubic grains also have an ECD of from 0.65 to 0.8 μm . This film is particularly useful in mammography for imaging dense soft tissue.

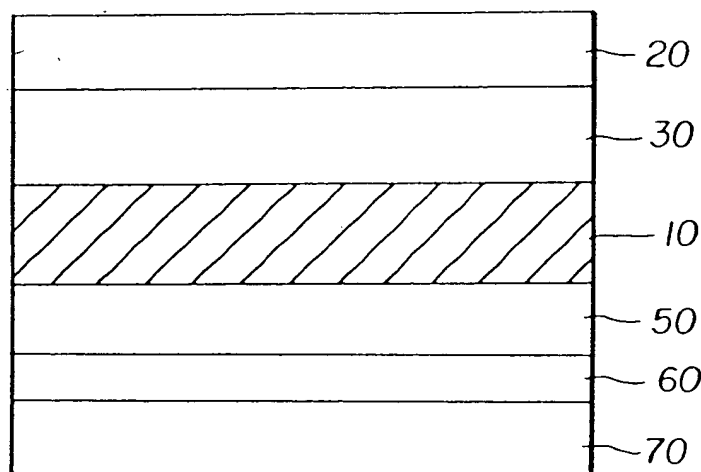


FIG. 1

EP 1 422 560 A1

Description

[0001] This invention is directed to radiography. In particular, it is directed to a radiographic silver halide film that provides improved medical diagnostic images of soft tissues such as in mammography and exhibits improved processing characteristics.

[0002] In conventional medical diagnostic imaging the object is to obtain an image of a patient's internal anatomy with as little X-radiation exposure as possible. The fastest imaging speeds are realized by mounting a dual-coated radiographic element between a pair of fluorescent intensifying screens for imagewise exposure. 5% or less of the exposing X-radiation passing through the patient is adsorbed directly by the latent image forming silver halide emulsion layers within the dual-coated radiographic element. Most of the X-radiation that participates in image formation is absorbed by phosphor particles within the fluorescent screens. This stimulates light emission that is more readily absorbed by the silver halide emulsion layers of the radiographic element.

[0003] While the necessity of limiting patient exposure to high levels of X-radiation was quickly appreciated, the question of patient exposure to even low levels of X-radiation emerged gradually. The separate development of soft tissue radiography, which requires much lower levels of X-radiation, can be illustrated by mammography. The first intensifying screen-film combination (imaging assembly) for mammography was introduced to the public in the early 1970's. Mammography film generally contains a single silver halide emulsion layer and is exposed by a single intensifying screen, usually interposed between the film and the source of X-radiation. Mammography utilizes low energy X-radiation, that is radiation that is predominantly of an energy level less than 40 keV.

[0004] U.S. Patent 6,033,840 (Dickerson) and U.S. Patent 6,037,112 (Dickerson) describe asymmetric imaging elements and processing methods for imaging soft tissue.

[0005] In mammography, as in many forms of soft tissue radiography, pathological features sought to be identified are often quite small and not much different in density than surrounding healthy tissue. Thus, mammography is a very difficult task in medical radiography. In addition, microcalcifications must be seen when they are as small as possible to improve detection and treatment of breast cancers. As a result, mammographic films often include relatively high amounts of silver and gelatin to maximize image sharpness when used with a single intensifying screen. The higher amounts of silver and gel may mean that the films are more difficult to process or require longer processing times.

[0006] This invention provides a solution to the noted problems with a radiographic silver halide film comprising a support having first and second major surfaces and that is capable of transmitting X-radiation,

the radiographic silver halide film having disposed on the first major support surface, one or more hydrophilic colloid layers including at least one cubic silver halide grain emulsion layer, and on the second major support surface, one or more hydrophilic colloid layers including at least one silver halide emulsion layer,

the film characterized wherein the cubic silver halide grain emulsion layer comprises cubic silver halide grains comprising from 1 to 20 mol % chloride and from 0.25 to 1.5 mol % iodide, both based on total silver in the emulsion layer, which cubic silver halide grains have an average ECD of from 0.65 to 0.8 μm .

[0007] Further, this invention provides a method of providing a black-and-white image comprising exposing a radiographic silver halide film of this invention and processing it, sequentially, with a black-and-white developing composition and a fixing composition, the processing being carried out within 90 seconds, dry-to-dry.

[0008] This invention also provides a radiographic imaging assembly comprising a radiographic silver halide film of this invention that is arranged in association with a fluorescent intensifying screen.

[0009] The present invention provides a means for providing radiographic images for mammography with a radiographic film that is readily processed using the conventional processing solutions known in the art. In addition, all other desirable sensitometric properties are maintained or improved (such as photographic speed). If desired, the amount of silver used in the films can be reduced without a significant loss in photographic speed.

[0010] These advantages are achieved by including certain cubic silver halide grains that are comprised of specific amounts of chloride, iodide, and bromide. The critical amount of iodide provides desired photographic speed and the critical amount of chloride provides desired image tone and rapid processability.

[0011] FIG. 1 is a schematic cross-sectional illustration of a radiographic silver halide film of this invention.

[0012] FIG. 2 is a schematic cross-sectional illustration of a radiographic imaging assembly of this invention comprising a radiographic silver halide film of this invention arranged in association with a single fluorescent intensifying screen in a cassette holder.

[0013] The term "contrast" as herein employed indicates the average contrast derived from a characteristic curve of a radiographic film using as a first reference point (1) a density (D_1) of 0.25 above minimum density and as a second reference point (2) a density (D_2) of 2.0 above minimum density, where contrast is ΔD (i.e. 1.75) $\div \Delta \log_{10} E$ ($\log_{10} E_2 - \log_{10} E_1$), E_1 and E_2 being the exposure levels at the reference points (1) and (2).

[0014] The term "dual-coated" is used to define a radiographic film having silver halide emulsion layers disposed on both the front- and backsides of the support. The radiographic silver halide films of the present invention are "dual-coated."

[0015] The term "fluorescent intensifying screen" refers to a screen that absorbs X-radiation and emits light. A "prompt" emitting fluorescent intensifying screen will emit light immediately upon exposure to radiation while "storage" fluorescent screen can "store" the exposing X-radiation for emission at a later time when the screen is irradiated with other radiation (usually visible light).

[0016] The radiographic silver halide films of this invention include a flexible support having disposed on both sides thereof, one or more photographic silver halide emulsion layers and optionally one or more non-radiation sensitive hydrophilic layer(s). The silver halide emulsions in the various layers can be the same or different and can comprise mixtures of various silver halide emulsions within the requirements of this invention.

[0017] In preferred embodiments, the photographic silver halide film has at least one different silver halide emulsion on each side of the support. It is also preferred that the film has a protective overcoat (described below) over the silver halide emulsions on each side of the support.

[0018] The support is preferably a transparent film support. In its simplest possible form the transparent film support consists of a transparent film chosen to allow direct adhesion of the hydrophilic silver halide emulsion layers or other hydrophilic layers.

[0019] Polyethylene terephthalate and polyethylene naphthalate are the preferred transparent film support materials.

[0020] Preferably, the "frontside" of the support comprises one or more silver halide emulsion layers, one of which contains predominantly cubic grains (that is, more than 50 weight % of all grains). These cubic silver halide grains particularly include predominantly (at least 69 mol %) bromide, and preferably up to 89.75 mol % bromide, based on total silver in the emulsion layer. In addition, these cubic grains must have from 1 to 20 mol % chloride (preferably from 10 to 20 mol % chloride) and from 0.25 to 1.5 mol % iodide (preferably from 0.5 to 1 mol % iodide), based on total silver in the emulsion layer. The cubic silver halide grains in each silver halide emulsion unit (or silver halide emulsion layers) can be the same or different.

[0021] The amount of chloride in the cubic silver halide grains is critical to provide desired processability and image tone while the amount of iodide is critical to provide desired photographic speed. Too much chloride results in poor absorption of spectral sensitizing dyes to the grains.

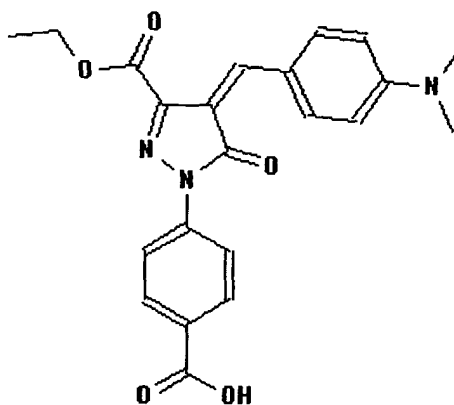
[0022] It may also be desirable to employ silver halide grains that exhibit a coefficient of variation (COV) of grain ECD of less than 20% and, preferably, less than 10%. In some embodiments, it may be desirable to employ a grain population that is as highly monodisperse as can be conveniently realized.

[0023] The average silver halide grain size can vary within each emulsion layer within the film. For example, the cubic grain ECD in the radiographic silver halide film is independently and generally from 0.65 to 0.8 μm (preferably from 0.7 to 0.75 μm).

[0024] The backside ("second major support surface") of the support includes one or more silver halide emulsions, preferably at least one of which comprises predominantly tabular silver halide grains. Generally, at least 50% (and preferably at least 80%) of the silver halide grain projected area in this silver halide emulsion layer is provided by tabular grains having an average aspect ratio greater than 5, and more preferably greater than 10. The remainder of the silver halide projected area is provided by silver halide grains having one or more non-tabular morphologies. In addition, the tabular grains are predominantly (at least 90 mol %) bromide based on the total silver in the emulsion layer and includes up to 1 mol % iodide. Preferably, the tabular grains are pure silver bromide.

[0025] The backside of the radiographic silver halide film also preferably includes an antihalation layer disposed over the silver halide emulsion layer(s). This layer comprises one or more antihalation dyes or pigments dispersed on a suitable hydrophilic binder (described below). In general, such antihalation dyes or pigments are chosen to absorb whatever radiation the film is likely to be exposed to from a fluorescent intensifying screen. For example, pigments and dyes that can be used as antihalation pigments or dyes include various watersoluble, liquid crystalline, or particulate magenta or yellow filter dyes or pigments including those described for example in U.S. Patent 4,803,150 on et al.), U.S. Patent 5,213,956 (Diehl et al.), U.S. Patent 5,399,690 (Diehl et al.), U.S. Patent 5,922,523 (Helber et al.), U.S. Patent 6,214,499 (Helber et al.), and Japanese Kokai 2-123349. One useful class of particulate antihalation dyes includes nonionic polymethine dyes such as merocyanine, oxonol, hemioxonol, styryl, and arylidene dyes as described in U.S. Patent 4,803,150 (noted above) that is incorporated herein for the definitions of those dyes. The magenta merocyanine and oxonol dyes are preferred and the oxonol dyes are most preferred.

[0026] The amounts of such dyes or pigments in the antihalation layer are generally from 1 to 3 mg/dm². A particularly useful antihalation dye is the magenta filter dye M-1 identified as follows:



M-1.

[0027] The silver halide emulsion layers and other hydrophilic layers on both sides of the support of the radiographic films of this invention generally contain conventional polymer vehicles (peptizers and binders) that include both synthetically prepared and naturally occurring colloids or polymers. The most preferred polymer vehicles include gelatin or gelatin derivatives alone or in combination with other vehicles.

[0028] The silver halide emulsion layers (and other hydrophilic layers) in the radiographic films are generally hardened to various degrees using one or more conventional hardeners.

[0029] The levels of silver and polymer vehicle in the radiographic silver halide film of the present invention are not critical. In general, the total amount of silver on each side of the film is at least 10 and no more than 55 mg/dm² in one or more emulsion layers. In addition, the total coverage of polymer vehicle on each side of the film is generally at least 35 and no more than 45 mg/dm² in all of the hydrophilic layers on that side. The amounts of silver and polymer vehicle on the two sides of the support in the radiographic silver halide film can be the same or different. These amounts refer to dry weights.

[0030] The radiographic silver halide films of this invention generally include a surface protective overcoat disposed on each side of the support that typically provides physical protection of the emulsion layers. Each protective overcoat can be sub-divided into two or more individual layers.

[0031] The various coated layers of radiographic silver halide films of this invention can also contain tinting dyes to modify the image tone to transmitted or reflected light. These dyes are not decolorized during processing and may be homogeneously or heterogeneously dispersed in the various layers. Preferably, such non-bleachable tinting dyes are in a silver halide emulsion layer.

[0032] Preferred embodiments of this invention include radiographic silver halide films comprising a support having first and second major surfaces and that is capable of transmitting X-radiation, the radiographic silver halide films having disposed on the first major support surface, one or more hydrophilic colloid layers including at least one cubic silver halide grain emulsion layer, and on the second major support surface, one or more hydrophilic colloid layers including at least one silver halide emulsion layer comprising predominantly tabular silver halide grains, and an anti-halation layer,

wherein the silver halide cubic grain emulsion layer comprises predominantly cubic silver halide grains comprising from 10 to 20 mol % chloride and from 0.5 to 1.5 mol % iodide, both based on total silver in the emulsion layer, which cubic grains have an average ECD of from 0.7 to 0.75 μ m, and

a protective overcoat disposed over the silver halide emulsion layers on both sides of the support.

[0033] The radiographic imaging assemblies of the present invention are composed of one radiographic silver halide film of this invention and a fluorescent intensifying screen. Usually, a single fluorescent intensifying screen is used on the "frontside" for mammography. Fluorescent intensifying screens are typically designed to absorb X-rays and to emit electromagnetic radiation having a wavelength greater than 300 nm. These screens can take any convenient form providing they meet all of the usual requirements for use in radiographic imaging.

[0034] An embodiment of the radiographic film of the present invention is illustrated in FIG. 1. On the frontside of support **10** are disposed overcoat **20**, and emulsion layer **30**. On the backside of support **10** are disposed emulsion layer **50**, antihalation layer **60**, and overcoat **70**.

[0035] FIG. 2 shows the radiographic film of FIG. 1 that is arranged in association with fluorescent intensifying screen **80** on the frontside, and both in cassette holder **90**.

[0036] Exposure and processing of the radiographic silver halide films of this invention can be undertaken in any

convenient conventional manner. The exposure and processing techniques of U.S. Patent 5,021,327 and U.S. Patent 5,576,156 (both noted above) are typical for processing radiographic films. Other processing compositions (both developing and fixing compositions) are described in U.S. Patent 5,738,979 (Fitterman et al.), U.S. Patent 5,866,309 (Fitterman et al.), U.S. Patent 5,871,890 (Fitterman et al.), U.S. Patent 5,935,770 (Fitterman et al.), U.S. Patent 5,942,378 (Fitterman et al.). The processing compositions can be supplied as single- or multi-part formulations, and in concentrated form or as more diluted working strength solutions.

[0037] Exposing X-radiation is generally directed through a single fluorescent intensifying screen before it passes through the radiographic silver halide film for imaging of soft tissue such as breast tissue.

[0038] It is particularly desirable that the radiographic silver halide films of this invention be processed within 90 seconds ("dry-to-dry") and preferably within 60 seconds and at least 20 seconds, for the developing, fixing and any washing (or rinsing) steps. Such processing can be carried out in any suitable processing equipment including but not limited to, a Kodak X-OMAT™ RA 480 processor that can utilize Kodak Rapid Access processing chemistry. Other "rapid access processors" are described for example in U.S. Patent 3,545,971 (Barnes et al.) and EP 0 248,390A1 (Akio et al.). Preferably, the black-and-white developing compositions used during processing are free of any photographic film hardeners, such as glutaraldehyde.

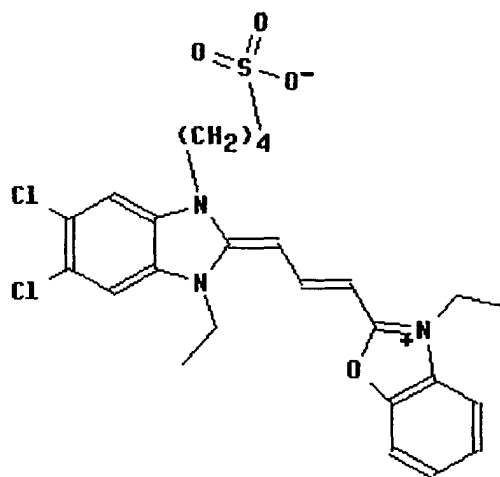
[0039] Radiographic kits can include a radiographic silver halide film or imaging assembly of this invention, one or more additional fluorescent intensifying screens and/or metal screens, and/or one or more suitable processing compositions (for example black-and-white developing and fixing compositions).

[0040] The following examples are presented for illustration and the invention is not to be interpreted as limited thereby.

Example 1:

Radiographic Film A (Control):

[0041] Radiographic Film A was a dual-coated radiographic film with 2/3 of the silver and gelatin coated on one side of the 170 μm blue-tinted poly(ethylene terephthalate) support and the remainder coated on the opposite side of the support. The frontside had a cubic grain emulsion chemically sensitized with sulfur and gold and spectrally sensitized with Dye A-1 noted below. On the backside was an antihalation layer containing solid particle dyes to provide improved sharpness over a green-sensitized high aspect ratio tabular grain emulsion (Emulsion Layer 2). At least 50% of the total grain projected area was accounted for by tabular grains having a thickness of less than 0.3 μm and having an average aspect ratio greater than 8:1. The emulsion was monodisperse in distribution and was spectrally sensitized with 400 mg/Ag mole of anhydro-5,5-dichloro-9-ethyl-3,3'-bis(3-sulfopropyl)oxacarbocyanine hydroxide, followed by potassium iodide (300 mg/Ag mole).



A-1

[0042] Film A had the following layer arrangement and formulations on the film support:

Overcoat 1
Interlayer

EP 1 422 560 A1

Emulsion Layer 1
Support
Emulsion Layer 2
Halation Control Layer
Overcoat 2

Overcoat 1 Formulation	Coverage (mg/dm ²)
Gelatin vehicle	4.4
Methyl methacrylate matte beads	0.35
Carboxymethyl casein	0.73
Colloidal silica (LUDOX AM)	1.1
Polyacrylamide	0.85
Chrome alum	0.032
Resorcinol	0.73
Dow Corning Silicone	0.153
TRITON X-200 surfactant (Union Carbide)	0.26
LODYNE S-100 surfactant (Ciba Specialty Chem.)	0.0097

Interlayer Formulation	Coverage (mg/dm ²)
Gelatin vehicle	4.4

Emulsion Layer 1 Formulation	Coverage (mg/dm ²)
Cubic grain emulsion [AgBr 0.85 μ m average ECD]	40.3
Gelatin vehicle	29.6
4-Hydroxy-6-methyl-1,3,3a,7-tetraazaindene	1 g/Ag mole
1-(3-Acetamidophenyl)-5-mercaptotetrazole	0.026
Maleic acid hydrazide	0.0076
Catechol disulfonate	0.2
Glycerin	0.22
Potassium bromide	0.13
Resorcinol	2.12
Bisvinylsulfonylmethane	0.4 % based on total gelatin in all layers on that side

Emulsion Layer 2 Formulation	Coverage (mg/dm ²)
Tabular grain emulsion [AgBr 1.8 x 0.12 μ m average size]	10.9
Gelatin vehicle	16.4
4-Hydroxy-6-methyl-1,3,3a,7-tetraazaindene	2.1 g/Ag mole
1-(3-Acetamidophenyl)-5-mercaptotetrazole	0.013
Maleic acid hydrazide	0.0032
Catechol disulfonate	0.2
Glycerin	0.11
Potassium bromide	0.06
Resorcinol	1.0
Bisvinylsulfonylmethane	2 % based on total gelatin in all layers on that side

Halation Control Layer	Coverage (mg/dm ²)
Magenta filter dye M-1 (noted above)	2.2

EP 1 422 560 A1

(continued)

Halation Control Layer	Coverage (mg/dm ²)
Gelatin	10.8

Overcoat 2 Formulation	Coverage (mg/dm ²)
Gelatin vehicle	8.8
Methyl methacrylate matte beads	0.14
Carboxymethyl casein	1.25
Colloidal silica (LUDOX AM)	2.19
Polyacrylamide	1.71
Chrome alum	0.066
Resorcinol	0.15
Dow Corning Silicone	0.16
TRITON X-200 surfactant	0.26
LODYNE S-100 surfactant	0.01

Radiographic Film B (Invention)

[0043] Film B was like Film A except that Emulsion Layer 1 contained a AgIClBr (0.5:15:84.5 halide mole ratio) cubic grain emulsion (0.71 μm average ECD) that was chemically sensitized with sulfur and gold and spectrally sensitized with a 340 mg/mole of Ag of Dye A-1 noted above, and Emulsion Layer 2 had the following formulation:

Emulsion Layer 2 Formulation	Coverage (mg/dm ²)
Tabular grain emulsion [AgBr 2.0 x 0.10 μm average size]	16.1
Gelatin vehicle	10.8
4-Hydroxy-6-methyl-1,3,3a,7-tetraazaindene	2.1 g/Ag mole
1-(3-Acetamidophenyl)-5-mercaptotetrazole	0.013
Maleic acid hydrazide	0.0032
Catechol disulfonate	0.2
Glycerin	0.11
Potassium bromide	0.06
Resorcinol	1.0
Bisvinylsulfonylmethane	2 % based on total gelatin in all layers on that side

Radiographic Film C (Control):

[0044] Film C was like Film A except that Emulsion Layer 1 contained AgIClBr (0.5:25:74.5 halide mole ratio) cubic grain emulsion that was chemically sensitized with sulfur and gold and spectrally sensitized with a 285 mg/mole of Ag of Dye A-1 noted above.

[0045] Samples of the films were exposed through a graduated density step tablet to a MacBeth sensitometer for 0.5 second to a 500-watt General Electric DMX projector lamp that was calibrated to 2650°K filtered with a Coming C4010 filter to simulate a green-emitting X-ray screen exposure. The film samples were processed using a processor commercially available under the trademark KODAK RP X-OMAT® film Processor M6A-N, M6B, or M35A. Development was carried out using the following black-and-white developing composition:

Hydroquinone	30 g
Phenidone	1.5 g
Potassium hydroxide	21 g
NaHCO ₃	7.5 g
K ₂ SO ₃	44.2 g

EP 1 422 560 A1

(continued)

Na ₂ S ₂ O ₅	12.6 g
Sodium bromide	35 g
5-Methylbenzotriazole	0.06 g
Glutaraldehyde	4.9 g
Water to 1 liter, pH 10	

[0046] The film samples were processed in each instance for less than 90 seconds. Fixing was carried out using KODAK RP X-OMAT® LO Fixer and Replenisher fixing composition (Eastman Kodak Company).

[0047] Optical densities are expressed below in terms of diffuse density as measured by a conventional X-rite Model 310TM densitometer that was calibrated to ANSI standard PH 2.19 and was traceable to a National Bureau of Standards calibration step tablet. The characteristic D vs. Log E curve was plotted for each radiographic film that was imaged and processed. Speed was measured at a density of 1.4 + D_{min}. Gamma (contrast) is the slope (derivative) of the noted D vs. Log E curves.

[0048] Residual dye stain ("Dye Stain") was measured using spectrophotometric methods and calculated as the difference between density at 505 nm that corresponds to the dye absorption peak, and the density at 700 nm. This measurement corrects for differences in film fog. Measurements were done on film samples that have been processed without exposure and are nominally clear of developed silver except for fog silver. Processing was carried out in an RP X-OMAT Processor Model 480RA using KODAK RA30 Developer and KODAK LO Fixer.

[0049] The following TABLE I shows the relative sensitometry of Films A-C. Control Film A had the lowest photographic speed and contrast and the highest dye stain.

TABLE I

Film	Average Cubic Grain ECD (μm)	Grain Halide(s) (mol %)	Relative Speed	Contrast	Dye Stain
A (Control)	0.73	Br (100)	408	3.5	0.06
B (Invention)	0.73	IClBr (0.5:15:84.5)	420	4.3	0.04
C (Control)	0.71	IClBr (0.5:25:74.5)	416	4.0	0.03

Example 2:

[0050] Further radiographic films were prepared similar to Film B of Example 1 but with various silver halide ratios and grain sizes in Emulsion Layer 1. TABLE II below provides the data for these films and the sensitometric results.

TABLE II

Film	Average Cubic Grain ECD (μm)	Halide Molar Ratio	Speed	Gamma at Density of 1.0
D (Control)	0.72	AgBr	400	4
E (Control)	0.71	AgI Br (0.5:99.5)	404	4.2
F (Control)	0.73	AgClBr (15:85)	405	4.5
G (Invention)	0.71	AgIClBr (0.5:15:84.5)	409	4.6
H (Control)	0.75	AgIClBr (0.5:30:69.5)	402	1.9

[0051] The data in TABLE II show that both speed and contrast increase with increasing chloride up to 30 mole % chloride. However, at that upper level, contrast and speed were severely affected. The reason for this is that it is extremely difficult to maintain good cubicity and grain monodispersity for these grain size emulsions with such high amounts of chloride. Only Film G of the present invention provided maximum speed and contrast.

Example 3:

[0052] Several radiographic films were prepared similar to Film B of Example 1 using cubic silver halide grains with various amounts of iodide content. The chloride content for the cubic grains in each film was 13.2 mol %. The following TABLE III shows the various grain content and sensitometric results.

TABLE III

Film	Iodide Content (mol %)	Speed	Contrast
I (Control)	0	400	3.96
J (Control)	0.1	401	4.11
K (Invention)	0.3	402	4.13
L (Invention)	0.5	406	4.42
M (Invention)	1	405	4.38
N (Invention)	1.5	408	4.27
O (Control)	2	408	3.88

[0053] The data in TABLE III show the effect of iodide incorporation on speed and contrast. Speed increased with increased iodide levels and contrast also increased until the iodide levels reached 1.5 mol %. At higher iodide content, contrast began to drop. Films L, M, and N provided desirable speed and contrast.

[0054] The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

Claims

1. A radiographic silver halide film comprising a support having first and second major surfaces and that is capable of transmitting X-radiation,
said radiographic silver halide film having disposed on said first major support surface, one or more hydrophilic colloid layers including at least one cubic silver halide grain emulsion layer, and on said second major support surface, one or more hydrophilic colloid layers including at least one silver halide emulsion layer,
the film **characterized** wherein said silver halide cubic grain emulsion layer comprises cubic silver halide grains comprising from 1 to 20 mol % chloride and from 0.25 to 1.5 mol % iodide, both based on total silver in the emulsion layer, which cubic grains have an average ECD of from 0.65 to 0.8 μm .
2. The film of claim 1 wherein said cubic silver halide grains are composed of from 10 to 20 mol % chloride, based on total silver in the emulsion layer, and from 0.5 to 1.5 mol % iodide, based on total silver in the emulsion layer.
3. The film of claims 1 or 2 wherein said cubic grains have an ECD of from 0.7 to 0.75 μm .
4. The film of any of claims 1 to 3 wherein said silver halide emulsion layer on said second major support surface comprises predominantly tabular silver halide grains.
5. The film of any of claims 1 to 4 further comprising an antihalation layer disposed on said second major support surface.
6. The film of any of claims 1 to 5 wherein the amount polymer vehicle on each side of its support in a total amount of from 35 to 45 mg/dm^2 and a level of silver on each side of from 10 to 55 mg/dm^2 .
7. A radiographic imaging assembly comprising the radiographic silver halide film of any of claims 1 to 6 that is arranged in association with a fluorescent intensifying screen.
8. The radiographic imaging assembly of claim 7 comprising a single fluorescent intensifying screen.
9. A method of providing a black-and-white image comprising exposing the radiographic silver halide film of any of claims 1 to 6, and processing it, sequentially, with a black-and-white developing composition and a fixing composition, the processing being carried out within 90 seconds, dry-to-dry.
10. The method of claim 9 being carried out for 60 seconds or less.

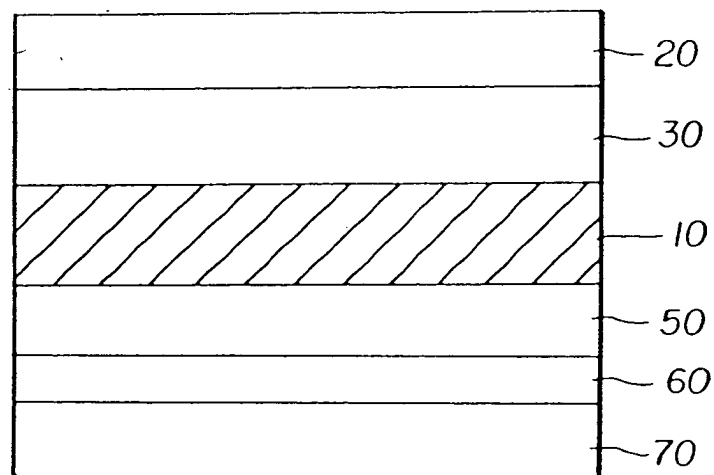


FIG. 1

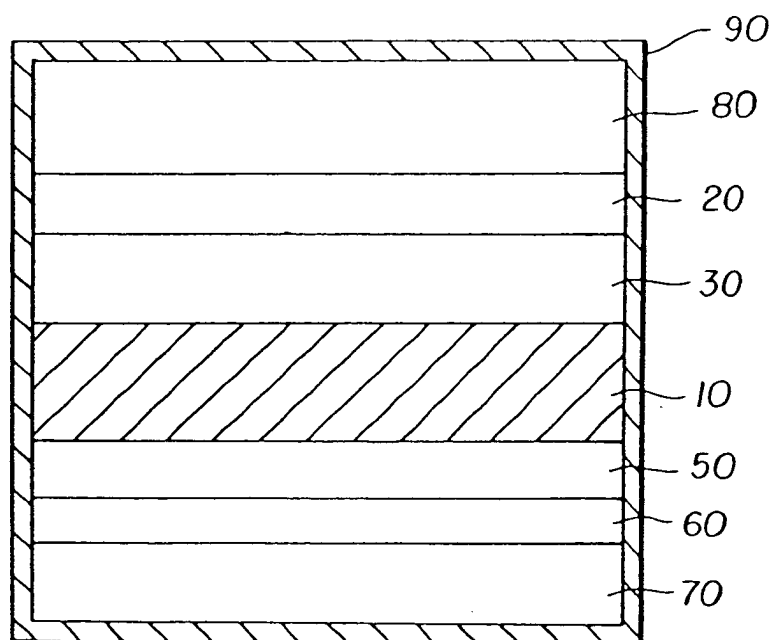


FIG. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 07 8494

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.7)
A	US 5 455 139 A (WADA YASUNORI ET AL) 3 October 1995 (1995-10-03) * column 1, line 13 - line 16 * * column 6, line 7 - line 13 * * column 9, line 13 - line 19 * * column 11, line 51 - line 57 * * claims 1,7 * -----	1-10	G03C5/17 G03C1/005
A	US 5 491 058 A (EASTMAN KODAK CO) 13 February 1996 (1996-02-13) * claim 1 * -----	1-10	
A	EP 1 217 433 A (EASTMAN KODAK CO) 26 June 2002 (2002-06-26) * claim 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			G03C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 February 2004	Examiner West, N
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			

EPO FORM 1503 03.82 (P04001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 07 8494

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-02-2004

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5455139	A	03-10-1995	DE	69117779 D1	18-04-1996
			DE	69117779 T2	14-11-1996
			EP	0440367 A1	07-08-1991
			JP	3041723 B2	15-05-2000
			JP	5249580 A	28-09-1993
			JP	6118527 A	28-04-1994
			JP	2847574 B2	20-01-1999
			JP	4181238 A	29-06-1992

US 5491058	A	13-02-1996	DE	69501527 D1	05-03-1998
			DE	69501527 T2	06-08-1998
			EP	0696757 A2	14-02-1996
			JP	8106136 A	23-04-1996

EP 1217433	A	26-06-2002	US	2002106576 A1	08-08-2002
			EP	1217433 A2	26-06-2002
			JP	2002196445 A	12-07-2002
			US	2002155373 A1	24-10-2002
			US	6582874 B1	24-06-2003

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82