



(51) International Patent Classification:

G11B 7/244 (2006.01) G11B 7/245 (2006.01)
G11B 7/246 (2006.01) G11B 7/24 (2006.01)

(21) International Application Number:

PCT/US2009/004301

(22) International Filing Date:

24 July 2009 (24.07.2009)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/189,239 11 August 2008 (11.08.2008) US

(71) Applicant (for all designated States except US): **EASTMAN KODAK COMPANY** [US/US]; 343 State Street, Rochester, New York 14650-2201 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ROBELLO, Douglas, Robert** [US/US]; 343 State Street, Rochester, New York 14650 (US). **MIS, Mark R.** [US/US]; 343 State Street, Rochester, New York 14650 (US).

(74) Common Representative: **EASTMAN KODAK COMPANY**; 343 State Street, Rochester, New York 14650-2201 (US).

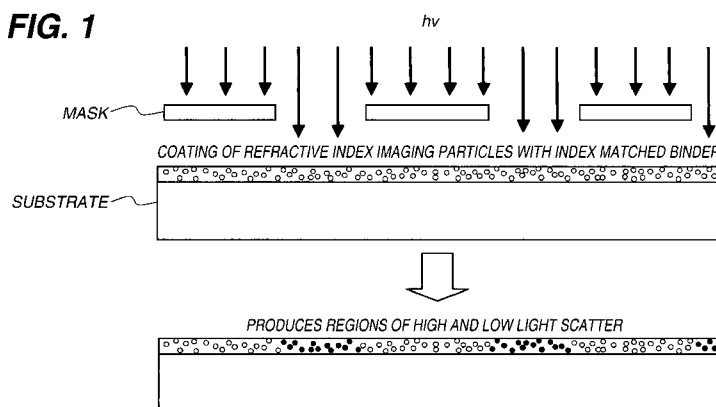
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: IMAGING ELEMENT AND METHOD USING DIFFERENTIAL LIGHT SCATTERING

FIG. 1

(57) Abstract: An imaging element is used to provide images based on the difference in index of refraction caused by imaging actinic radiation. Imaging provides desired results by the creation or elimination of light scattering in a two-phase imaging medium in which at least one phase contains a material that is capable of having a refractive index change in response to imaging actinic radiation. For example, if the refractive indices of the two phases are initially matched, imaging can cause a mismatch in imaged regions. Alternatively, the refractive indices of the two phases can be initially mismatched and imaging can create a match of refractive indices in imaged regions. An image can be produced using a controlled amount of imaging actinic radiation without any chemical processing or heating.

IMAGING ELEMENT AND METHOD USING DIFFERENTIAL LIGHT SCATTERING

FIELD OF THE INVENTION

5 This invention relates to an imaging element that provides an image from a change in refractive index that occurs in the imaging layer as a result of irradiation by actinic radiation. It also relates to a method of providing an image using the imaging element.

10 BACKGROUND OF THE INVENTION

 Small particles (particulate phase) embedded within and having a different refractive index (η) than a continuous phase or matrix can cause light passing through the continuous phase to scatter. Milk is a common example of this phenomenon. However, if the indices of refraction of the particles and
15 continuous phase approximately equal, the entire medium appears to be transparent. More specifically, the amount of light scattering in such a medium depends upon the contrast in (η) between the two phases, the size distribution and concentration of the particles, and the thickness (optical path) of the medium.

 Murase et al. (*Macromolecules* **1997**, *30*, 8088-8090) describe
20 creating a change in refractive index by photodimerization of poly(vinyl cinnamate) films.

 U.S. Patent 6,569,600 (Dinnocenzo et al.) describes optical recording materials that when exposed to actinic radiation, produce a change in optical properties in the exposed regions, thereby providing an image or stored
25 data. These results can be achieved by using organic materials that are altered by exposure to actinic radiation and through one electron oxidation, cause the desired change in optical properties. Such organic materials can be changed by isomerization reaction such as cyclizations, cycloadditions, and cycloreversions, and are disposed within a suitable organic polymeric matrix. The changes in
30 optical properties are useful for recording holograms, diffraction gratings, and waveguides. There is no indication that the index of refraction of the organic

materials should be chosen with a specific relationship to the index of refraction of the polymeric continuous phase.

Problem to be Solved

- 5 There is a need for improved imaging media that can utilize known reactive chemicals in a more efficient manner and in which the image is controlled by effective use of differential light scattering by various components in the imaging composition.

10 SUMMARY OF THE INVENTION

This invention provides an imaging element comprising a layer comprising:

- a polymeric binder that is substantially transparent to incident actinic radiation and thus has an index of refraction that is unchangeable as a
15 result of exposure to the incident actinic radiation, the polymeric binder comprising a continuous phase,

 a particulate material comprising a reactant, the particulate material being dispersed within the polymeric binder and that:

- a) has an index of refraction that is substantially the same as that of
20 the polymeric binder before exposure to the incident actinic radiation, and upon exposure to the incident actinic radiation, the index of refraction of the particulate material becomes substantially different from that of the polymeric binder, or

- b) has an index of refraction that is substantially different from that of
the polymeric binder before exposure to the incident actinic radiation, and upon
25 exposure to the incident actinic radiation, the index of refraction of the particulate material becomes substantially the same as that of the polymeric binder,

 that is capable of producing an optically detectable image from differential light scattering in the layer.

- This invention also provides a method of producing an image
30 comprising:

 imagewise exposing an imaging element to imaging actinic radiation, the imaging element comprising a layer comprising:

a polymeric binder that is substantially transparent to incident actinic radiation and thus has an index of refraction that is unchangeable as a result of exposure to the incident actinic radiation, the polymeric binder comprising a continuous phase,

5 a particulate material comprising a reactant, the particulate material being dispersed within the polymeric binder and that:

a) has an index of refraction that is substantially the same as that of the polymeric binder before exposure to the incident actinic radiation, and upon exposure to the incident actinic radiation, the index of refraction of the particulate
10 material becomes substantially different from that of the polymeric binder, or

b) has an index of refraction that is substantially different from that of the polymeric binder before exposure to the incident actinic radiation, and upon exposure to said incident actinic radiation, the index of refraction of the particulate material becomes substantially the same as that of the polymeric
15 binder,

to provide exposed and non-exposed regions in the layer so as to provide a difference in index of refraction between the exposed and non-exposed regions.

The present invention provides desired results by the creation or elimination of light scattering in a two-phase imaging medium in which at least
20 one phase contains a material that is capable of having a refractive index change in response to imaging actinic radiation. For example, if the refractive indices of the two phases are initially matched, imaging can cause a mismatch in refractive indices in imaged regions. Alternatively, if the refractive indices of the two phases are initially mismatched, imaging can create a match of refractive indices
25 in imaged regions. Thus, an image can be produced using a controlled amount of imaging actinic radiation without any chemical processing or heating.

The present invention can be useful, for example, for security printing, optical devices, detection of ionizing radiation, and detection of UV radiation.

30

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graphical illustration of an imaging scheme using an imaging element wherein the refractive indices of the two phases are substantially the same before imaging, for example as carried out in Example 1 below.

5 FIG. 2 is an image obtained while carrying out Example 1 below.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

As used herein, the term “matched” in reference to indices of refraction refer to two phases having substantially the same indices of refraction, that is the difference in n of no more than 0.005.

As used herein, the term “mismatched” in reference to indices of refraction refer to two phases having substantially different indices of refraction, that is the difference in n of greater than 0.02.

15 As used herein, unless otherwise noted, the term “imaging element” refers to embodiments of the present invention.

The layer used for imaging can also be referred to as the “imaging layer”.

20 Imaging Elements

The imaging elements of this invention include two phases, for example a particulate phase dispersed in a continuous polymeric binder in which the two phases have different refractive indices prior to imaging irradiation, or they have the same refractive indices prior to imaging irradiation. Any imaging chemistry can be used for the two phases as long as they will produce the change in refractive indices (matched or mismatched) upon exposure to actinic radiation. In such instances, either or both phases can have a change in index of refraction.

In most embodiments of this invention, the two-phase imaging chemistry used in the imaging elements include sensitizers (defined below) that are capable of absorbing incident actinic radiation that initiates a chemical reaction, for example by one electron oxidation, of a reactant that is dispersed within the continuous polymeric phase. This photochemical reaction causes the

needed substantial change in the index of refraction of particulate material dispersed within the continuous phase.

In other embodiments, exposure by actinic radiation initiates a chemical reaction with a reactant (defined below) to cause a substantial change in the index of refraction without the need for a sensitizer.

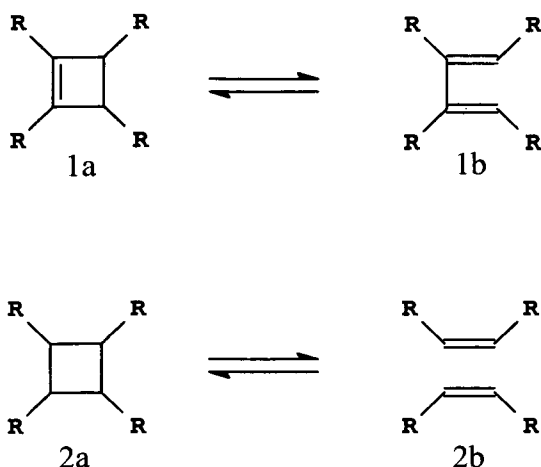
Thus, in some embodiments, the components of the layer used for imaging have essentially the same index of refraction and exposure to actinic radiation causes a difference in index of refraction between said particulate material and the polymeric binder of at least 0.02.

In other embodiments, before exposure to actinic radiation, the difference in index of refraction between the particulate material and the polymeric binder are already different by at least 0.02 and exposure to the actinic radiation reduces the difference so that the indices of refraction are essentially the same.

One embodiment of the invention is illustrated in FIG. 1 in which an imaging element of this invention is imaged with actinic radiation through a mask. The imaging element has a layer containing a particulate material dispersed within a polymer binder that is disposed on a substrate. The particulate material and polymer binder have essentially the same index of refraction prior to exposure but the imaged areas are shown to have a significant difference in indices of refraction.

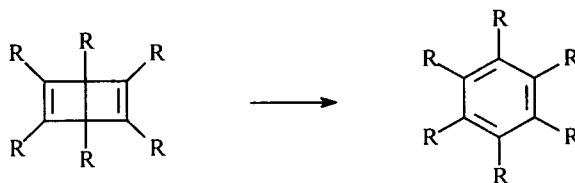
The particulate material containing the reactant is generally present in the imageable element, for example, in an imaging layer, in an amount of from 1 to 50% or typically from 10 to 30%, based on total dry weight.

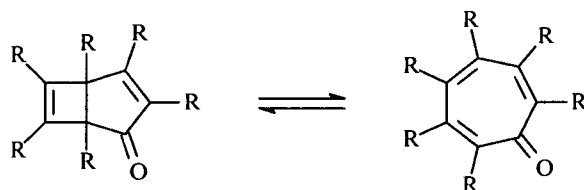
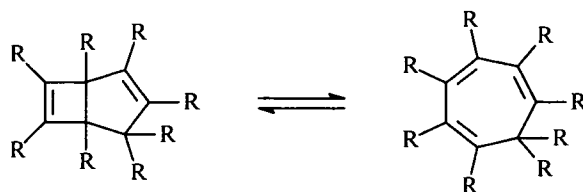
Chemical transformation of the reactant is generally an isomerization including such reactions as cyclizations, cycloadditions, or cycloreversions. General examples of such transformations are the interconversions between 1a and 1b, or 2a and 2b shown as follows:



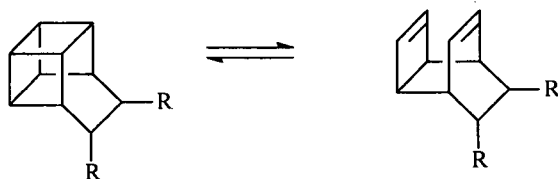
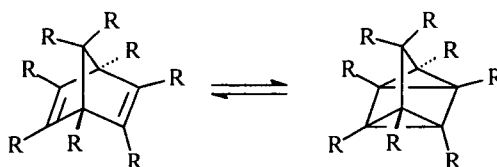
wherein R in the structures can be hydrogen or a substituted or unsubstituted alkyl
 5 or alkoxy groups having 1 to 12 carbon atoms (both linear or branched groups),
 substituted or unsubstituted cycloalkyl groups having 5 to 10 carbon atoms in the
 saturated carbon ring (such as cyclopentyl, cyclohexyl, 4-methylcyclohexyl, and
 cyclooctyl), substituted or unsubstituted aryl groups having 6 to 18 atoms in the
 aromatic ring (such as phenyl, naphthyl, anthryl, or phenanthryl), cyano,
 10 carboxylate, halogen, ketone, an ester, or a substituted or unsubstituted
 heteroaromatic group (such as furyl, thienyl, pyridyl, benzofuryl, and
 benzothieryl). Substituents on the aryl or heteroaryl groups can include but are
 not limited to, alkyl, aryl, alkoxy, aryloxy, thioalkyl, and thioaryl groups. In
 addition, two or more R groups can be joined together to form additional fused
 15 rings.

Examples of 1a/1b reactions carried out in the presence of a
 sensitizer include, but are not limited to:

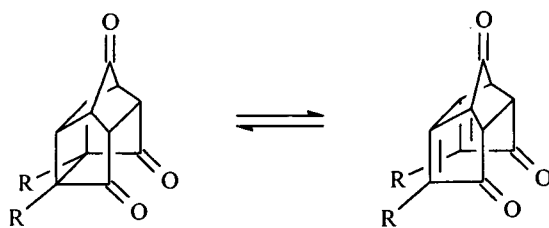




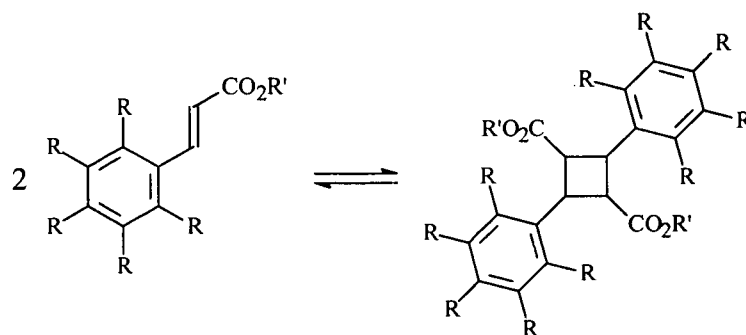
2



5



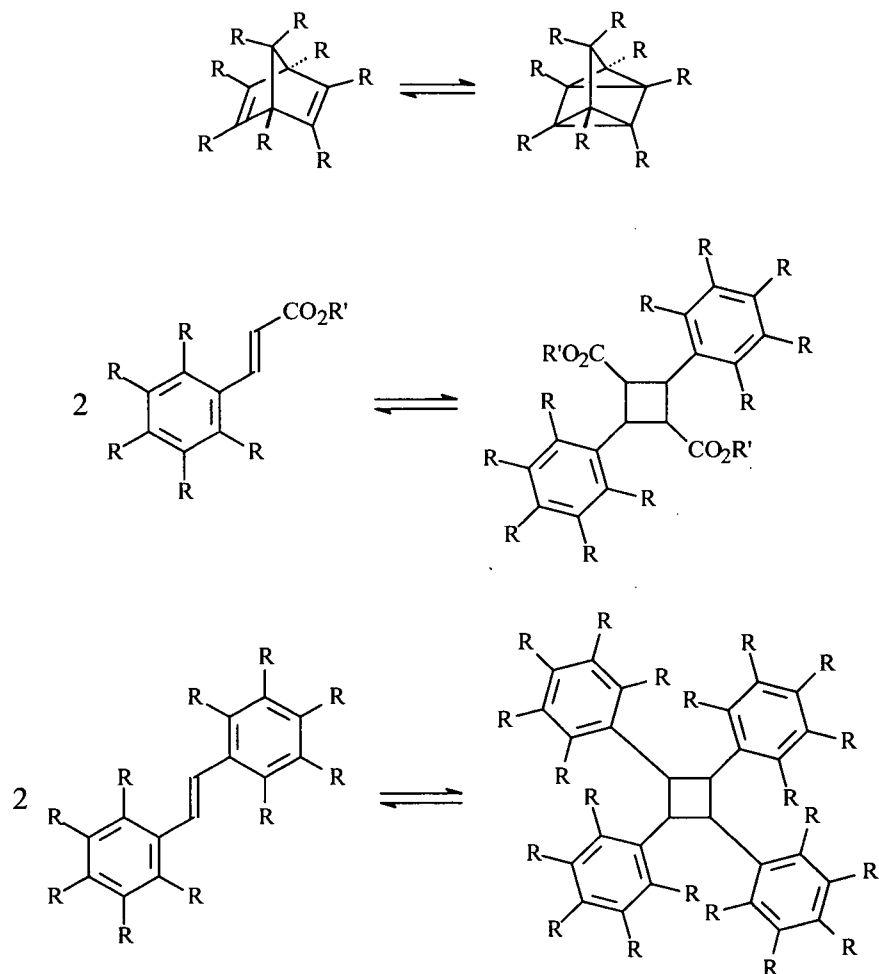
or



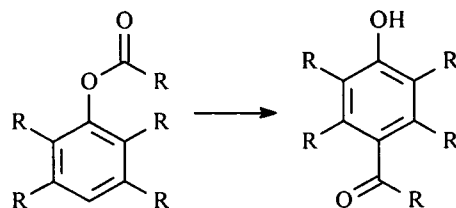
wherein R is as defined above, and

R' represents hydrogen, a substituted or unsubstituted alkyl, substituted or substituted cycloalkyl, or substituted or unsubstituted aromatic or heteroaromatic group, which groups are defined similar to those for R.

5 Reactions that can be carried out without the use of a sensitizer include, but are not limited to:



10 or



wherein R and R' are as defined above.

Useful examples of reactants are described as Compound R-1 through R-13 in U.S. Patent 6,569,600 (noted above) that is cited herein with respect to these compounds and their sources.

In their simplest form, small particles of the reactant (typically 1 to 5 10 μm in diameter) are formed using known dispersion techniques. The particles can be small molecules or polymers including crosslinked polymers that can be suspended in a variety of solvents and other polymer without being dissolved.

In many embodiments, the reactant is selected so that its oxidation potential is less than that of its product, and that a suitably rapid isomerization can 10 occur upon electron transfer to a sensitizer (described below). The compounds listed above possess these characteristics, but other (as yet unidentified) compounds that share the same properties and that would function equally well or better than those listed above may exist.

The sensitizers used in most embodiments initiate the chemical 15 transformation of the reactant. Some sensitizers are capable of oxidizing the reactant to a radical cation after the sensitizer has absorbed actinic radiation (that is, photoinduced electron transfer). Other sensitizers are capable of exciting the reactants to their triplet state.

One class of useful sensitizers that is capable of absorbing an 20 electron from the reactant. Representative compounds of this type and their synthesis are shown in Tables 2 and 3 of U.S. Patent 6,569,600 (noted above) that is also cited herein for the description of these compounds. For example, the compounds listed in Table 2 are useful with hexamethyldewarbenzene as the reactant.

25 U.S. Patent 6,569,600 (Col. 7, line 49 to Col. 8, line 39) also provides further mechanistic definitions of the compounds that may be useful as sensitizers.

For example, useful electron transfer sensitizers for various reactants include cyanoaromatic compounds (such as 1-cyanonaphthalene, 1,4- 30 dicyanonaphthalene, 9,10-dicyanoanthracene, 2,9,10-tricyanoanthracene, and 2,6,9,10-tetracyanoanthracene), aromatic anhydrides or imides (such as 1,8-naphthylene dicarboxylic, 1,4,6,8-naphthalene tetracarboxylic, 3,4-perylene

dicarboxylic, and 3,4,9,10-perylene tetracarboxylic anhydride or imide), condensed pyridinium salts (such as quinolinium, isoquinolinium, phenanthridinium, and acridinium salts), pyrylium salts, thiapyrilium salts, and cyanine dyes. Also useful sensitizers that involve the triplet excited state are
5 carbonyl compounds such as quinones (such as benzo-, naphtha-, anthroquinones) with electron withdrawing substituents (such as chloro and cyano groups), aromatic ketones such as benzophenone, xanthone derivatives, and thioxanthone derivatives. Ketocoumarin derivatives having strong electron withdrawing moieties such as pyridinium can also be used as sensitizers.

10 The various sensitizers shown in Table 3 of U.S. Patent 6,569,600 can have various substituents such as alkyl groups, alkoxy groups, chloro, and phenyl groups to modify various properties such as solubility, absorption spectra, and reduction potential.

In other embodiments, the sensitizers upon absorption of the actinic
15 radiation fragments give an oxidant capable of accepting an electron from the reactant. Examples of such compounds and their synthesis are provided in Table 4 of U.S. Patent 6,569,600 (noted above) that is also cited herein for the description of these compounds. A particular example of this type of sensitizer is N-methoxyphenanthridinium as illustrated in Col. 13, of the noted patent.

20 Useful sensitizers are also described in U.S. Patent Application Publication 2005/0136357 (Farid et al.), for example in Table 2.

One or more sensitizers are present in said layer in an amount of from 0.01 to 10%, or typically from 0.5 to 3%, based on total dry layer weight.

The particulate material (and sensitizer if present) can be dispersed
25 within one or more suitable polymeric binders using a suitable solvent (see below). Examples of suitable polymeric binders include but are not limited to, poly(alkyl methacrylates), poly(alkyl acrylates), polystyrenes, polycarbonate, cellulose acetate, poly(vinyl alcohols), synthetic and naturally-occurring gelatins, and poly(vinyl butyral). For example, a gelatin or poly(vinyl alcohol) is useful, as
30 well as mixtures thereof. The polymeric binder is chosen to be optically transparent in the spectral region where the sensitizer (if present) absorbs. That is, the polymeric binder or mixtures thereof should not have significant absorption at

the excitation wavelengths and should not interfere with the chemical transformation of the reactant. Plasticizers or preservatives may also be dispersed within the polymeric binder. The binder index of refraction should match that of the reactant either before or after exposure to actinic radiation.

5 Thus, the polymeric binder, reactant, and sensitizer (if present) can be formulated into a layer (that is, imaging layer) that is used to form an image. This layer may be self-supporting in the form of a slab or disk, but more likely it is coated or disposed on a support that can be composed of a suitable glass, ceramic, polymer, metal, or paper (such as a resin-coated paper). Useful
10 polymeric supports include polyester, polystyrene, or cellulose acetate films, such as poly(ethylene terephthalate) and poly(ethylene naphthalate) films. The surface of the support may be suitably treated or coated with a subbing material (such as a hydrolyzed vinyl chloride-vinyl acetate copolymer) to improve adhesion to the layer used for imaging.

15 The components described herein can be formulated to form an imaging layer using known dispersion technology (for example, see U.S. Patent 4,833,060 of Nair et al.).

 In general, an imaging layer formulation can be prepared by dispersing a particulate reactant and sensitizer (if used) in a suitable organic
20 solvent to form a solution of from 25 to 95% reactant. In some embodiments, the reactant is in a liquid form and the organic solvent is not necessary, and thus, the sensitizer can be dissolved within the reactant. This reactant solution is mixed with an aqueous surfactant solution (typically 50-90 weight % water), and the resulting dispersion is homogenized to provide reactant particles in the aqueous
25 phase. If an organic solvent was used, it can be removed using known techniques. One or more hydrophilic polymeric binders are then added in an aqueous solution (typically 10 to 50 weight % polymer), generally at a weight ratio of 1:2 to 2:1 of binder solution to reactant solution.

 The layer used for imaging may have a thickness of from 1 μm to 1
30 cm, and typically has a thickness of from 100 to 1000 μm .

The layer used for imaging can be overcoated with a protective layer to provide abrasion resistance, antistatic properties, impermeability to oxygen, and to protection from light (for example with a filter dye).

The following Examples are provided to illustrate the present invention but the invention is not to be interpreted as so limited.

Example 1:

An imaging element of this invention was prepared in which the reactant and polymeric binder had essentially the same index of refraction before exposure to actinic radiation.

The following imaging layer formulation was prepared and coated on a poly(ethylene terephthalate) substrate to provide a dry coating of 40 g/m² and the amounts are the weight in the resulting dry imaging layer:

Tetramethyldimethylesterdewarbenzene as reactant (480 mg, 31.1% weight),
1-methoxyxanthen-9-one as sensitizer (4.8 mg, 0.30% weight),
Oxidized gelatin as binder (1 g, 66.0% weight),
Sodium alkyl naphthalene sulfonate surfactant (40 mg, 2.6 weight %), and
17.4 g of water.

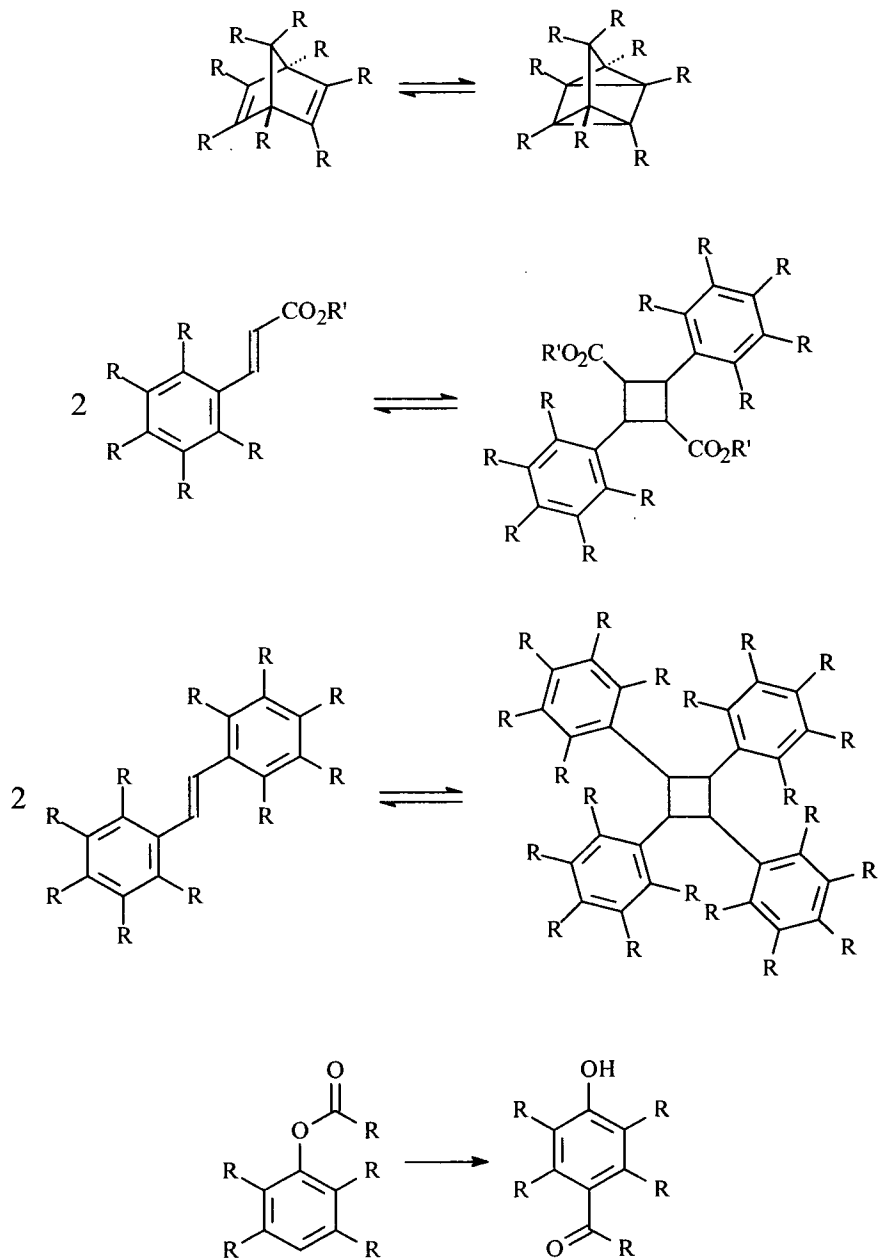
The resulting imaging element was exposed through a mask made from a xerographic transparency using fluorescent lighting under 400 nm wavelength as illustrated in FIG. 1. The exposed regions provided an image as the % light transmission was reduced from 37% to 8% in those regions. This indicates that the exposed regions (image) had a change in the index of refraction due to the reaction of the reactant and sensitizer in the imaging layer. The resulting image is shown in FIG. 2.

CLAIMS:

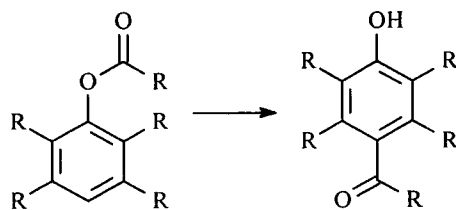
1. An imaging element comprising a layer comprising:
a polymeric binder that is substantially transparent to incident actinic radiation and thus has an index of refraction that is unchangeable as a
5 result of exposure to said incident actinic radiation, said polymeric binder comprising a continuous phase,
a particulate material comprising a reactant, said particulate material being dispersed within said polymeric binder and that:
 - a) has an index of refraction that is substantially the same as that of
10 said polymeric binder before exposure to said incident actinic radiation, and upon exposure to said incident actinic radiation, the index of refraction of said particulate material becomes substantially different from that of said polymeric binder, or
 - b) has an index of refraction that is substantially different from that of
15 said polymeric binder before exposure to said incident actinic radiation, and upon exposure to said incident actinic radiation, the index of refraction of said particulate material becomes substantially the same as that of said polymeric binder,
that is capable of producing an optically detectable image from differential
20 light scattering in said layer.
2. The imaging element of claim 1 wherein said particulate material further comprises a sensitizer that is capable of absorbing said incident actinic radiation and promoting a photochemical reaction with said reactant to
25 cause said substantial change in said index of refraction of said particulate material.
3. The imaging element of claim 1 wherein said reactant can be converted to a product with a substantially different refractive index in a
30 chemical reaction initiated by exposure of said reactant to said actinic radiation.

4. The imaging element of claim 2 wherein said reactant can be converted to a product with a substantially different refractive index in a chemical reaction initiated by exposure of said sensitizer to said actinic radiation.

5. The imaging element of claim 3 wherein said reactant is a capable of undergoing one of the following transformations:



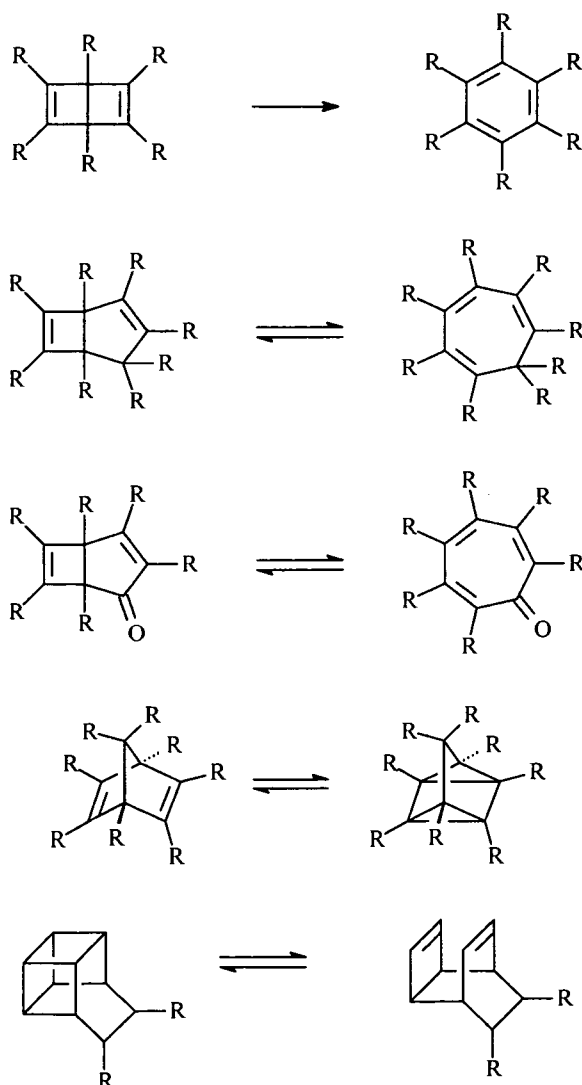
10 or

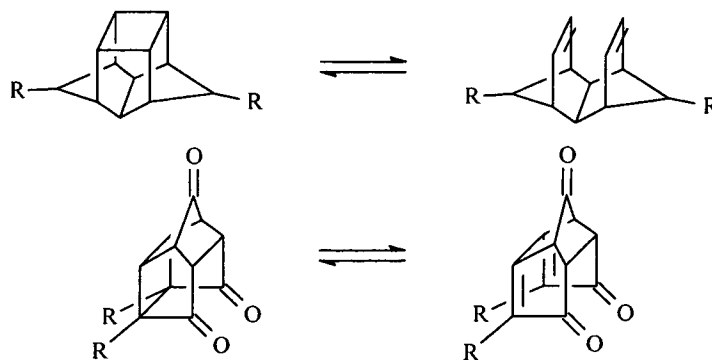


wherein R represents hydrogen, a substituted or unsubstituted alkyl, cycloalkyl, or alkoxy group having from 1 to 12 carbon atoms, a cyano group, a carboxylate group, a halogen, a ketone, an ester, or a substituted or unsubstituted aromatic or heteroaromatic group having from 6 to 18 atoms in the ring, or two or more R groups can be joined together to form an additional ring system, and

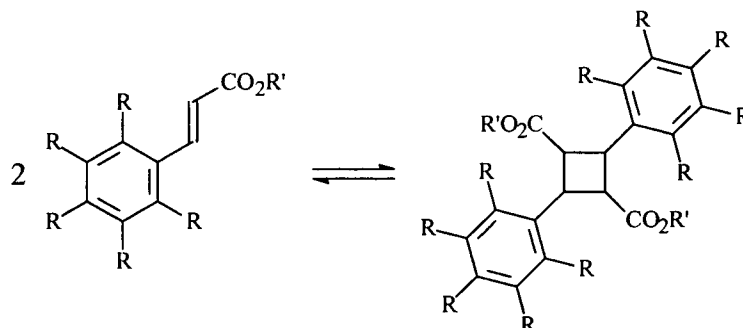
R' represents hydrogen, a substituted or unsubstituted alkyl or cycloalkyl group having from 1 to 12 carbon atoms, or a substituted or unsubstituted aromatic or heteroaromatic group having from 6 to 18 atoms in the ring.

6. The imaging element of claim 4 wherein said reactant is capable of undergoing one of the following transformations:





or



- 5 wherein R represents hydrogen, a substituted or unsubstituted alkyl, cycloalkyl, or alkoxy group, a cyano group, a carboxylate group, a halogen, a ketone, an ester, or a substituted or unsubstituted aromatic or heteroaromatic group, or two or more R groups can be joined together to form an additional ring system, and
- 10 R' represents hydrogen, a substituted or unsubstituted alkyl or cycloalkyl group, or a substituted or unsubstituted aromatic or heteroaromatic group.
7. The imaging element of claim 2 wherein said sensitizer is a
- 15 cyanoaromatic compound, aromatic anhydride or imide, condensed pyridinium salt, a pyrylium salt, a thiapyrylium salt, a cyanine dye, a quinone having electron withdrawing moieties, or an aromatic ketone such as benzophenone, a xanthone derivative, a thioxanthone derivative, or a ketocoumarin derivative.
8. The imaging element of claim 1 wherein said polymeric
- 20 binder is a gelatin or poly(vinyl alcohol).

9. The imaging element of claim 1 wherein said particulate material is present in said layer in an amount of from 1 to 50 % based on total dry layer weight.

5 10. The imaging element of claim 9 wherein said particulate material further comprises a sensitizer that is present in said layer in an amount of from 0.01 to 10%, both based on total dry layer weight.

10 11. The imaging element of claim 1 further having a support having said layer disposed thereon.

12. The imaging element of claim 1 that is capable of producing, upon exposure to actinic radiation, a difference in index of refraction between said particulate material and said polymeric binder of at least 0.02.

15

13. A method of producing an image comprising:
imagewise exposing an imaging element to imaging actinic radiation, said
imaging element comprising a layer comprising:

20 a polymeric binder that is substantially transparent to incident actinic radiation and thus has an index of refraction that is unchangeable as a result of exposure to said incident actinic radiation, said polymeric binder comprising a continuous phase,

a particulate material comprising a reactant, said particulate material being dispersed within said polymeric binder and that:

25 a) has an index of refraction that is substantially the same as that of said polymeric binder before exposure to said incident actinic radiation, and upon exposure to said incident actinic radiation, the index of refraction of said particulate material becomes substantially different from that of said polymeric binder, or

30 b) has an index of refraction that is substantially different from that of said polymeric binder before exposure to said incident actinic radiation, and upon exposure to said incident actinic radiation, the index of refraction of said

particulate material becomes substantially the same as that of said polymeric binder,

to provide exposed and non-exposed regions in said layer so as to provide a difference in index of refraction between said exposed and non-exposed regions.

5

14. The method of claim 13 wherein said particulate material further comprises a sensitizer that is capable of absorbing said incident actinic radiation and promoting a photochemical reaction with said reactant to cause said substantial change in said index of refraction of said particulate material.

10

15. The method of claim 13 wherein said sensitizer is a cyanoaromatic compound, aromatic anhydride or imide, condensed pyridinium salt, a pyrylium salt, a thiapyrylium salt, a cyanine dye, a quinone having electron withdrawing moieties, or an aromatic ketone such as benzophenone, a xanthone derivative, a thioxanthone derivative, or a ketocoumarin derivative.

15

16. The method of claim 13 wherein said polymeric binder is a gelatin or poly(vinyl alcohol).

20

17. The method of claim 13 wherein said particulate material is present in said layer in an amount of from 1 to 50 %, and said sensitizer is present in said layer in an amount of from 0.01 to 10%, both based on total dry layer weight.

25

18. The method of claim 13 wherein said reactant can be converted to a product with a substantially different refractive index in a chemical reaction initiated by exposure of said reactant to said actinic radiation.

30

19. The method of claim 14 wherein said reactant can be converted to a product with a substantially different refractive index in a chemical reaction initiated by exposure of said sensitizer to said actinic radiation.

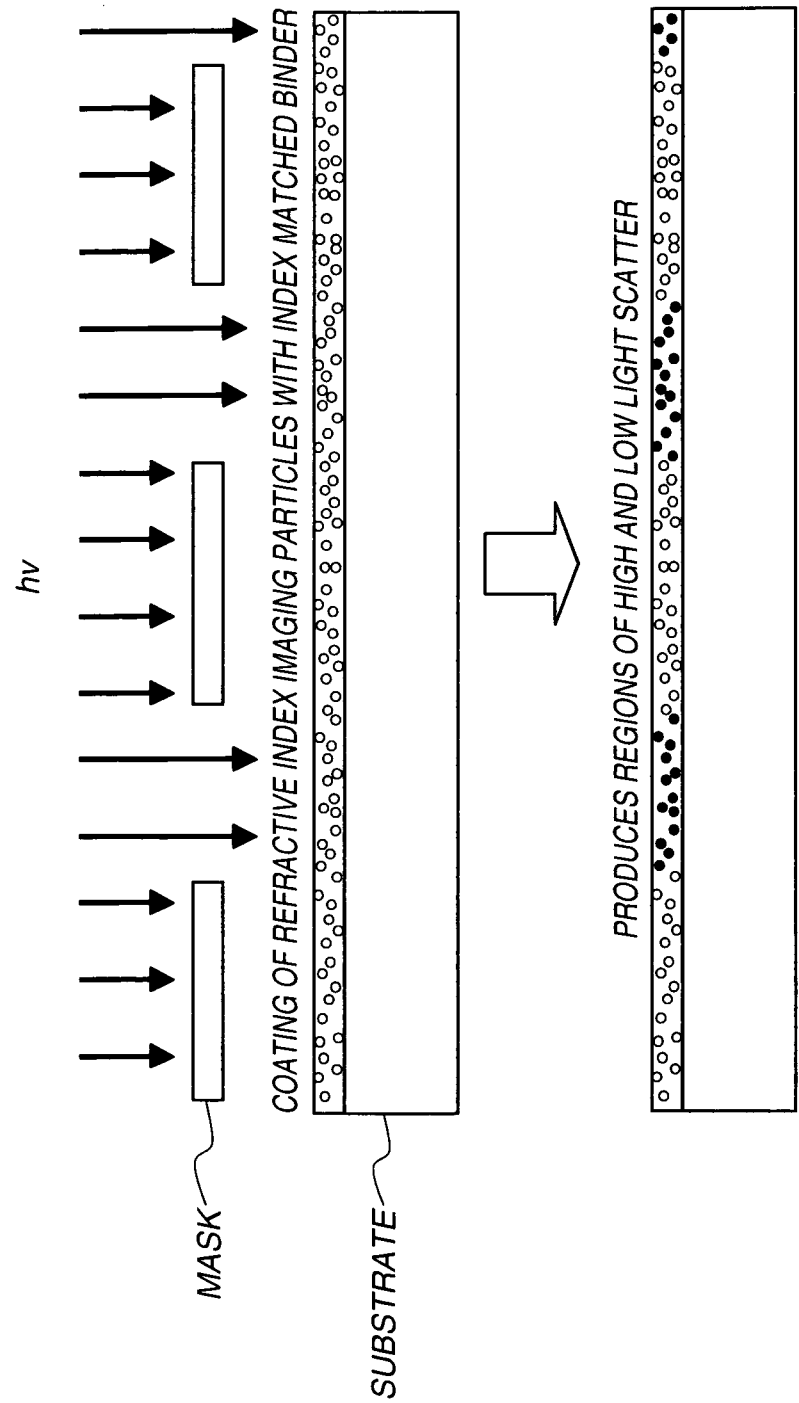


FIG. 1

2/2

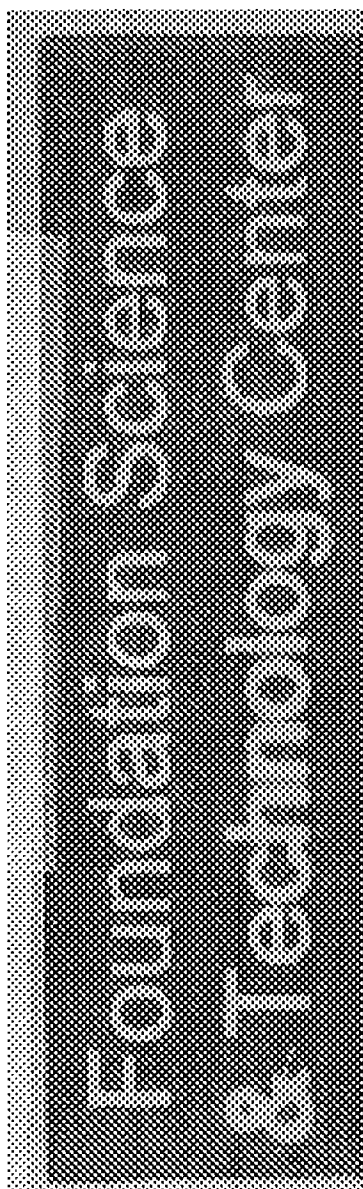


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/004301

A. CLASSIFICATION OF SUBJECT MATTER

INV. G11B7/244
ADD. G11B7/246 G11B7/245 G11B7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G11B G03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/175656 A1 (BAER ERIC [US] ET AL) 9 September 2004 (2004-09-09) claims 1,5,8,10-12	1,3,5,9, 11,13, 17,18
X	WO 2004/084204 A (KONINKL PHILIPS ELECTRONICS NV [NL]; BALISTRERI MARCELLO L M [NL]; MIJ) 30 September 2004 (2004-09-30) page 17, lines 15-18 page 26, lines 1-11	1,13
A	US 2005/136357 A1 (FARID SAMIR Y [US] ET AL) 23 June 2005 (2005-06-23) claims 1,10,26,29,52	1-4,6,7, 13,15, 18,19
	-/--	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

14 October 2009

Date of mailing of the international search report

02/11/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Stabel, Andreas

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/004301

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 2005/010877 A (KONINKL PHILIPS ELECTRONICS NV [NL]; VERSTEGEN EMILE J K [NL]; TOUWSLA) 3 February 2005 (2005-02-03) page 14, line 23 - page 15, line 34; figures 2,5</p> <p>-----</p>	1,13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/004301

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004175656 A1	09-09-2004	NONE	
WO 2004084204 A	30-09-2004	JP 2006522425 T KR 20050115915 A US 2006187806 A1	28-09-2006 08-12-2005 24-08-2006
US 2005136357 A1	23-06-2005	NONE	
WO 2005010877 A	03-02-2005	CA 2533664 A1 JP 2007500409 T KR 20060052900 A MX PA06001052 A US 2006204751 A1	03-02-2005 11-01-2007 19-05-2006 24-04-2006 14-09-2006