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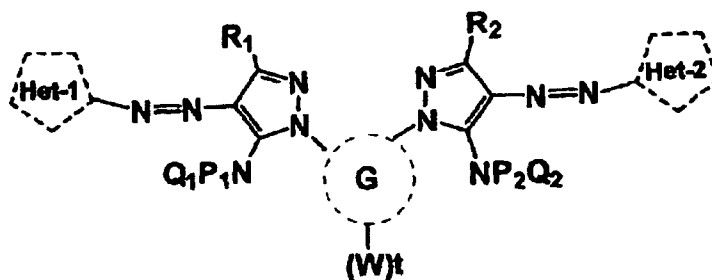
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(54) Title: AZO PIGMENTS, PROCESS FOR PRODUCING THE AZO PIGMENTS, AND PIGMENT DISPERSION, COLORING COMPOSITION AND INK FOR INKJET RECORDING CONTAINING THE PIGMENT



(57) Abstract: An azo pigment represented by the following general formula (1), a tautomer of the azo pigment, and a salt or a hydrate thereof: General formula (1) wherein each of R1, R2, P1, P2, Q1, and Q2 independently represents a hydrogen atom or a substituent, G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group, W represents a substituent capable of binding to the heterocyclic group constituted by G, t represents an integer of from 0 to 4, each of Het-1 and Het-2 independently represents a group selected from specific aromatic heterocyclic groups.

DESCRIPTION

AZO PIGMENTS, PROCESS FOR PRODUCING THE AZO PIGMENTS, AND PIGMENT DISPERSION, COLORING COMPOSITION AND INK FOR INKJET RECORDING CONTAINING THE PIGMENT

Technical Field

The present invention relates to azo pigments and a process for producing them, and a pigment dispersion, coloring composition and ink for inkjet recording containing the pigment.

Background Art

In recent years, as image-recording materials, materials for forming color images have been main and, specifically, recording materials for an ink jet system, recording materials for a thermal transfer system, recording materials for an electrophotographic system, transfer type silver halide light-sensitive materials, printing inks, and recording pens have found widespread use. Also, in photographing devices such as CCDs for photographing equipment, and in LCDs and PDPs for display, color filters are used for recording or reproducing a color image. In these color image recording materials and color filters, colorants (dyes or pigments) of three primary colors of a so-called additive color mixing process or subtractive color mixing process have been used in order to display or record full-color images. In actuality, however, there is no fast colorant having the absorption characteristics capable of realizing a preferred color reproduction region and resisting various use conditions and

environmental conditions. Thus, the improvement thereof has strongly been desired.

In particular, use of recording materials has extended from domestic use to industrial use and, as a result, they are required to have performance at a higher level (regarding hue, coloring strength, and image fastness to light, gas, heat, moisture, and chemicals).

With respect to coloring materials to be used (for example, an ink for inkjet recording), dye inks are required to be changed from water-soluble inks to oil-soluble inks and, in the case where a much higher level of performance is required (from indoor use to outdoor use), the inks are required to be changed from dye inks to pigment inks.

Difference between dyes and pigments in using manner is that, while dyes are used in a state of being dissolved (a state of molecular dispersion) in a medium such as fibers or solvents, pigments are used in a state of solid particles (molecular aggregate) finely dispersed in a medium without being dissolved.

The dyes or pigments to be used for the above-mentioned uses are required to have in common the following properties. That is, they are required to have absorption characteristics favorable in view of color reproduction and have good fastness under the conditions of the environment wherein they are used, for example, fastness against light, heat, and an oxidative gas such as ozone. In addition, in the case where the colorant is a pigment, the pigment is further required to be substantially insoluble in water or in an organic solvent, to have a good fastness to chemicals, and not to lose the preferred absorption characteristics it shows in a molecularly dispersed state even when used as particles. Although the required properties described above can be controlled by adjusting the intensity of intermolecular mutual action, both of them are in a trade-off relation with each other, thus being difficult to allow them to be

compatible with each other.

Besides, in the case of using a pigment as the colorant, the pigment is additionally required to have a particle size and a particle shape necessary for realizing desired transparency or masking properties, to have good fastness under the conditions of the environment wherein they are used, for example, fastness against light, heat, and an oxidative gas such as ozone, to have good fastness to an organic solvent and chemicals such as a sulfurous acid gas, and to be capable of being dispersed in a used medium to a level of fine particles, with the dispersed state being stable. These properties are largely influenced by the particle size, particle shape, and crystallinity as well as the chemical structure thereof, and hence it is of extreme importance to control them (see, for example, JP-A-2004-26930). In particular, there is a strong demand for a pigment which has a good yellow hue and is fast to light, moist heat, and active gases in the environment, especially a pigment which has a high coloring ability and a fastness to light.

That is, in comparison with a dye which is required to have properties as dye molecules, the pigment is required to have more properties, i.e., it is required to satisfy all of the above-mentioned requirements as a solid of an aggregate of a colorant (dispersion of fine particles) as well as the properties as molecules of a coloring material. As a result, a group of compounds which can be used as pigments are extremely limited in comparison with dyes. Even when high-performance dyes are converted to pigments, few of them can satisfy requirement for the properties as a dispersion of fine particles. Thus, such pigments are difficult to develop. This can be confirmed from the fact that the number of pigments registered in Color Index is no more than 1/10 of the number of dyes.

Azo pigments are excellent in hue and coloring ability which are

characteristics of coloring, and hence they have widely been used in printing inks, inks for an ink jet system, and electrophotographic materials. Of the pigments, diarylide pigments are the most typically used yellow azo pigments. Examples of such diarylide pigments include C.I. pigment yellow 12, C.I. pigment yellow 13, and C.I. pigment yellow 17. However, the diarylide pigments are inferior in fastness, particularly light fastness, and hence they are decomposed when prints printed by them are exposed to light, thus being inappropriate for prints which are to be stored for a long time.

In order to remove such defects, there have been disclosed azo pigments having a fastness improved by increasing molecular weight or by introducing a group having a strong intermolecular mutual action (see, for example JP-A-56-38354, US Patent No. 2,936,306, and JP-A-11-100519). However, even the improved pigments, for example, the pigments described in JP-A-2004-26930 have the defect that they have still insufficient light fastness though improved to some extent, and pigments described in, for example, US Patent No. 2,936,306 and JP-A-11-100519 have a greenish hue and a low coloring ability, thus being inferior in coloring characteristics.

Also, JP-A-2003-277662 discloses colorants which have absorption characteristics of excellent color reproducibility and has a sufficient fastness. However, all of the specific compounds described in JP-A-2003-277662 are soluble in water or in an organic solvent, thus being insufficient in fastness to chemicals.

By the way, US Patent No. 7,125,446 describes an example wherein a colorant of dye is dissolved in a water medium to use it as a water-soluble ink for use in inkjet recording. Also, JP-A No. 61-36362 describes examples of anion type monoazo compounds having characteristic light fastness. However, the level of image fastness provided by these examples is not sufficient for satisfying requirements for colorants at

high level, and they fail to provide manners of using pigments.

In the case of expressing a full-color image based on the subtractive color mixing process using three colors of yellow, magenta, and cyan or using four colors further including black, use of a pigment having an inferior fastness as a yellow pigment, gray balance of the prints would be changed with the lapse of time, and use of a pigment having inferior coloring characteristics would reduce color reproducibility upon printing. Thus, in order to obtain prints which can maintain high color reproducibility for a long time, there have been desired a yellow pigment and a pigment dispersion which have both good coloring characteristics and good fastness.

Also, Japanese Patent No.4,073,453 discloses colorants of dyes having absorption characteristics excellent in color reproducibility and having an extremely high level fastness.

However, all of the specific compounds described in Japanese Patent No.4,073,453 have such a high solubility in water or an organic solvent that, when used as pigments, an intended dispersion of pigment fine particles is not obtained, with a colorant solution or emulsion being provided. As a result, it has been difficult to use them as a coloring material containing a pigment dispersion with the purpose of imparting various required performances at high levels.

Disclosure of the Invention

The invention provides azo pigments having excellent coloring characteristics such as coloring ability and hue and having excellent durability such as light fastness and resistance to ozone, a process for producing the pigments, a dispersion of the pigment, a coloring composition, and an ink for ink jet recording.

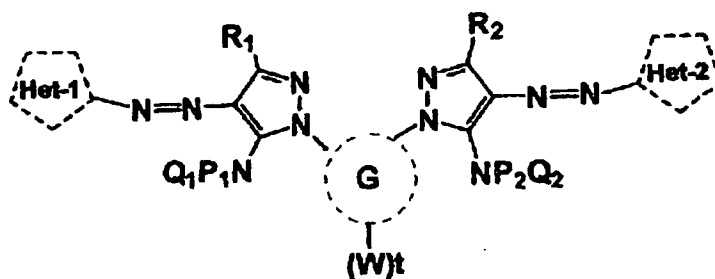
As a result of intensive investigations in consideration of the

above-mentioned circumstances, the inventors have obtained novel azo pigments and have found that they have both excellent coloring characteristics and excellent durability, thus having completed the invention.

That is, the invention is as follows.

<1> An azo pigment represented by the following general formula (1), a tautomer of the azo pigment, and a salt or a hydrate thereof:

General formula (1)



wherein

each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom or a substituent,

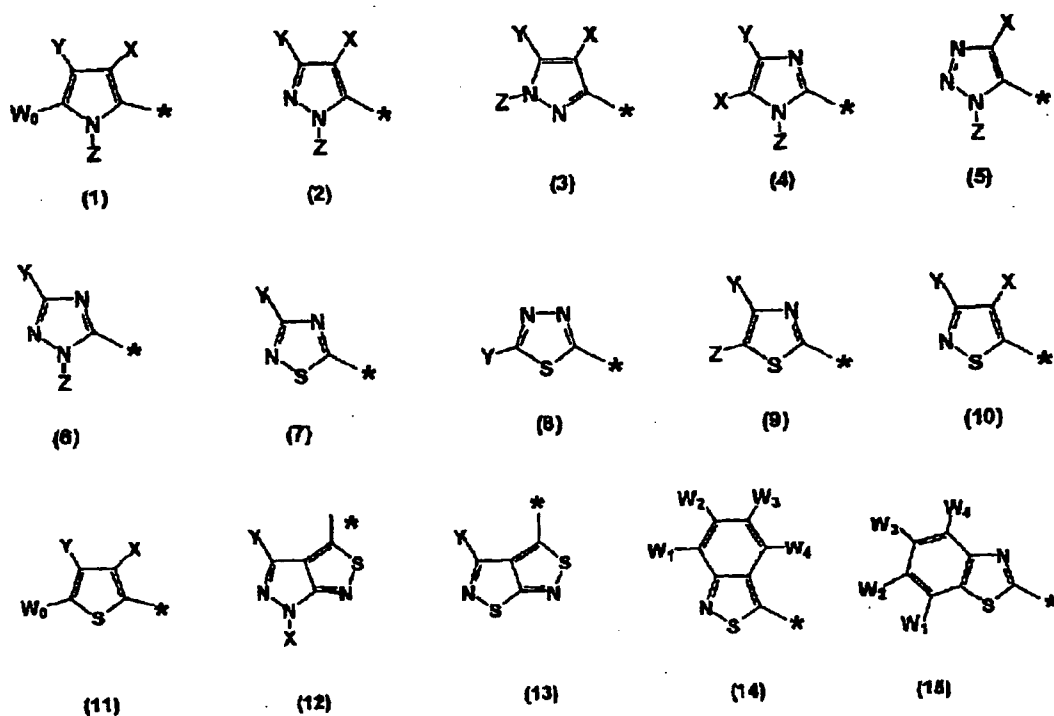
G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G ,

t represents an integer of from 0 to 4,

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the following general formula (2):

General formula (2)



wherein

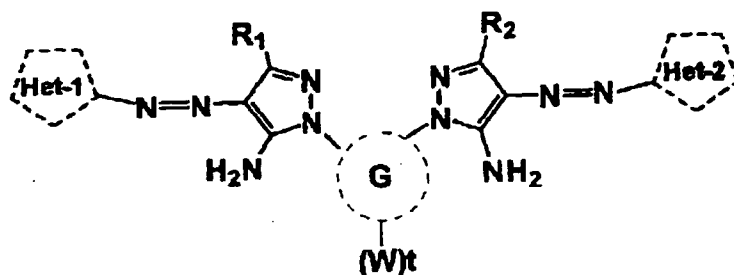
each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the azo linkage in the general formula (1).

<2> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to <1>, wherein

the azo pigment is represented by the following general formula (3):

General formula (3)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G ,

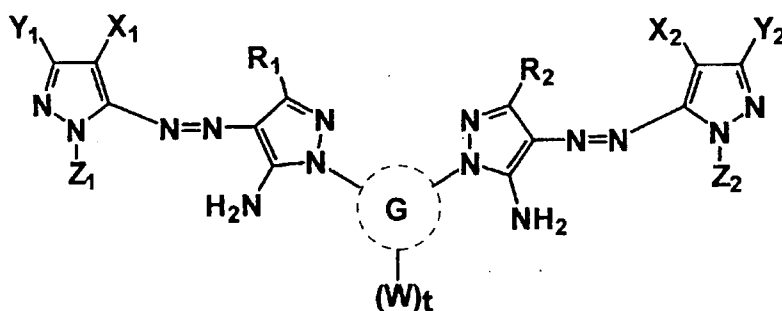
t represents an integer of from 0 to 4,

each of Het-1 and Het-2 independently represents a group selected from aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (3).

<3> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to <1> or <2>, wherein

the azo pigment is represented by the following general formula (4):

General formula (4)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

each of X_1 and X_2 independently represents an electron-withdrawing group having a Hammett's σ_p value of 0.2 or more,

each of Y_1 , Y_2 , Z_1 , and Z_2 independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

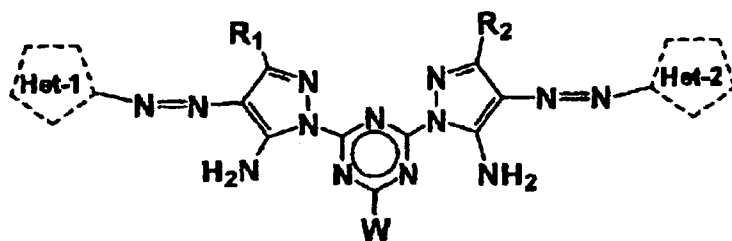
W represents a substituent capable of binding to the heterocyclic group constituted by G, and

t represents an integer of from 0 to 4.

<4> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to <1> or <2>, wherein

the azo pigment is represented by the following general formula (5):

General formula (5)



wherein

each of R₁ and R₂ independently represents a hydrogen atom or a substituent,

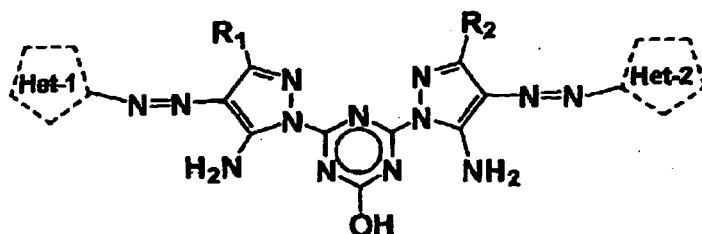
each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (5), and

W represents a substituent on the s-triazinyl group.

<5> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of <1>, <2> and <4>, wherein

the azo pigment is represented by the following general formula (6):

General formula (6)



wherein

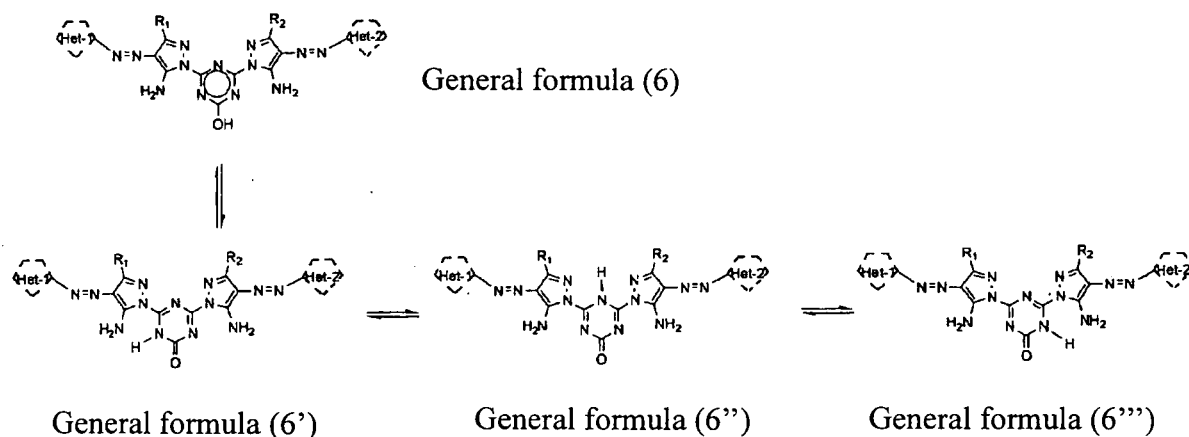
each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

and

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (6).

<6> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of <1>, <2>, <4> and <5>, wherein

the tautomer of the azo pigment is represented by any one of the following general formulae (6') to (6'''):



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

and

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formulae (6') to (6''').

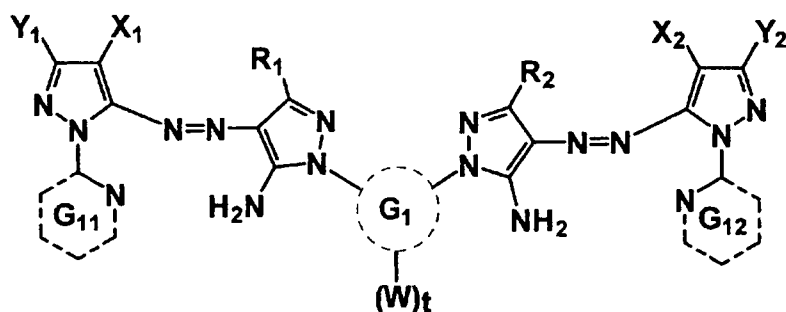
<7> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of <1> to <6>, wherein

the azo pigment has a peak absorption intensity in the range of from 1700 to 1730 cm^{-1} in the IR absorption spectrum which is 1/3 or less of a peak absorption intensity in the range of from 1620 to 1670 cm^{-1} .

<8> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of <1> to <3>, wherein

the azo pigment is represented by the following general formula (7):

General formula (7)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

each of X_1 and X_2 independently represents an electron-withdrawing group having a Hammett's σ_p value of 0.2 or more,

each of Y_1 and Y_2 independently represents a hydrogen atom or a substituent,

G_1 represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G_1 ,

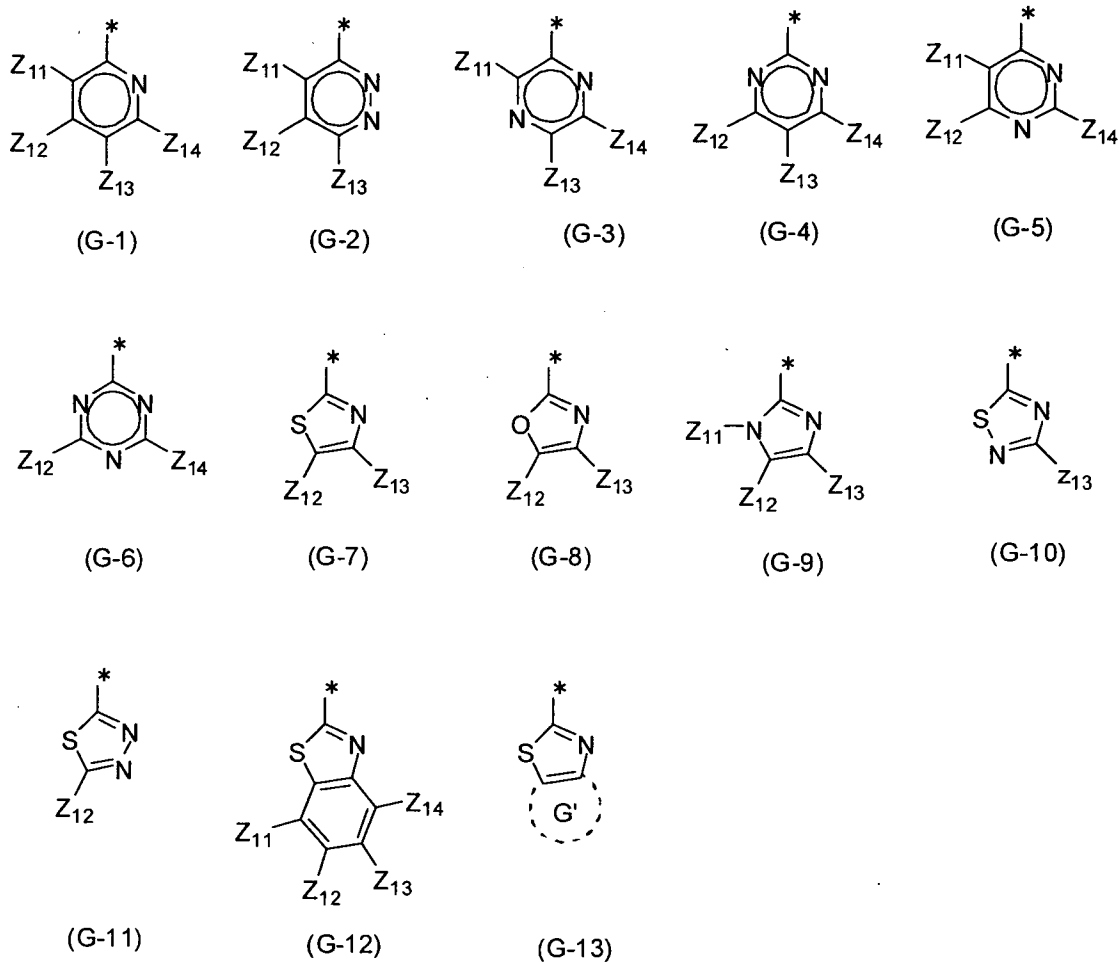
t represents an integer of from 0 to 4,

each of G_{11} and G_{12} independently represents the non-metallic atom groups necessary to complete a 5- to 6-membered heterocyclic group, provided that each of the heterocyclic groups represented by G_{11} and G_{12} may independently be unsubstituted or may have a substituent, and may be a monocyclic ring or may have a condensed ring.

<9> The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to <8>, wherein

at least one of the nitrogen-containing heterocyclic groups respectively represented by G_{11} and G_{12} is represented by any one of (G-1) to (G-13) in the following general formula (8):

General formula (8):



wherein

* in (G-1) to (G-13) shows the point of attachment to the N atom on the pyrazole ring in the general formula (7),

each of Z₁₁ to Z₁₄ represents a substituent capable of binding to the heterocyclic group, and

G' in (G-13) represents the non-metallic atoms necessary to complete a heterocyclic group.

<10> A process for producing the azo pigment described in any one of <1> to <9>,

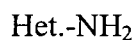
comprising:

preparing a diazonium compound by diazotization of a heterocyclic amine represented by the following general formula (9),

dissolving a compound represented by the following formula (11) in an organic solvent, and

coupling the diazonium compound and the compound represented by the general formula (11) after the dissolution of the compound represented by the general formula (11):

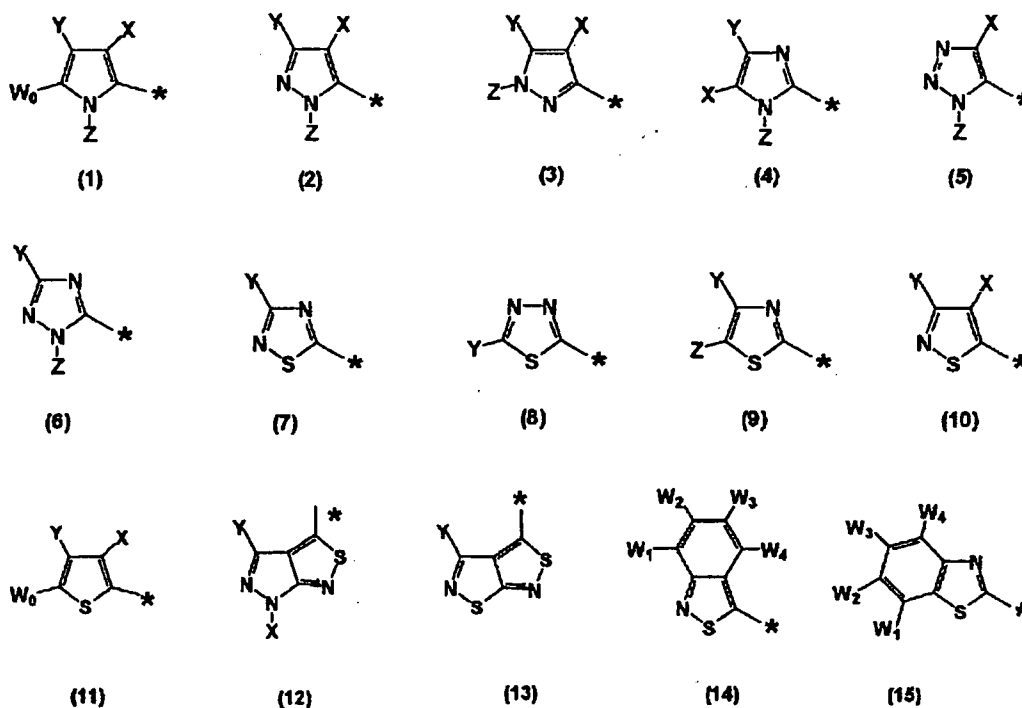
General formula (9)



wherein

Het. represents a heterocyclic group selected from aromatic heterocyclic groups represented by the following general formula (10):

General formula (10)

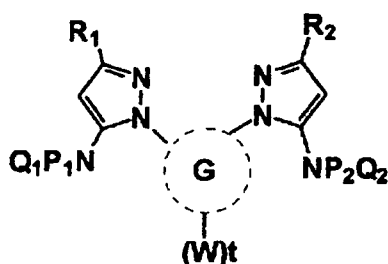


wherein

each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the amino group in the general formula (9):

General formula (11)



wherein

each of R₁, R₂, P₁, P₂, Q₁, and Q₂ independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G, and

t represents an integer of from 0 to 4.

<11> A process for producing the azo pigment described in any one of <1> to <9>, comprising:

preparing a diazonium compound by diazotization of a heterocyclic amine represented by the following general formula (9),

coupling the diazonium compound and a compound represented by the following general formula (11) in the presence of a polar aprotic solvent:

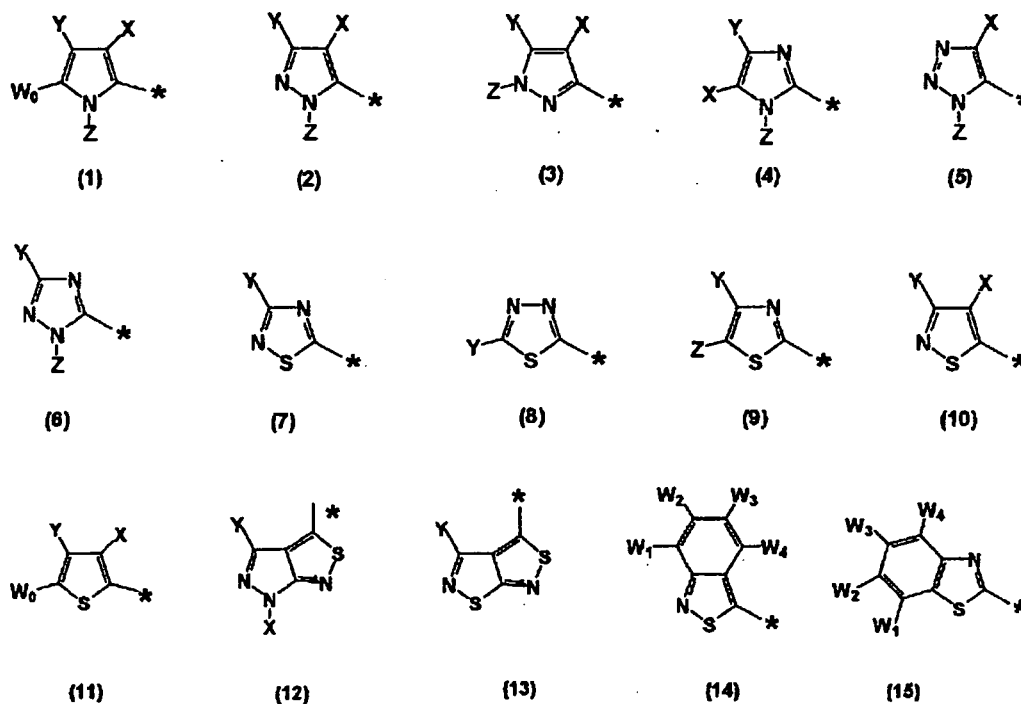
General formula (9)

Het.-NH₂

wherein

Het. represents a heterocyclic group selected from aromatic heterocyclic groups represented by the following general formula (10):

General formula (10)

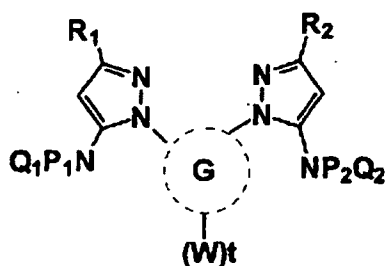


wherein

each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the amino group in the general formula (9):

General formula (11)



wherein

each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G , and

t represents an integer of from 0 to 4.

<12> The azo pigment according to any one of claims 1 to 9, which is obtained by the process described in <10> or <11>.

<13> A pigment dispersion comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of <1> to <9> and <12>.

<14> A coloring composition comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of <1> to <9> and <12>.

<15> An ink for inkjet recording, comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of <1> to <9> and <12>.

Brief Description of the Drawing

Fig. 1 shows the infrared absorption spectrum of the azo pigment (Fig-1) synthesized according to Example 1;

Fig. 2 shows the infrared absorption spectrum of the azo pigment (Fig-2) synthesized according to Example 2;

Fig. 3 shows the infrared absorption spectrum of the azo pigment (Fig-4) synthesized according to Example 3;

Fig. 4 shows the infrared absorption spectrum of the azo pigment (Fig-7) synthesized according to Example 4;

Fig. 5 shows the infrared absorption spectrum of the azo pigment (Fig-27) synthesized according to Example 5;

Fig. 6 shows the infrared absorption spectrum of the azo pigment (Fig-47) synthesized according to Example 6;

Fig. 7 shows the infrared absorption spectrum of the azo pigment (Fig-9) synthesized according to Example 7;

Fig. 8 shows the infrared absorption spectrum of the azo pigment (Fig-11) synthesized according to Example 8;

Fig. 9 shows the infrared absorption spectrum of the azo pigment (Fig-12) synthesized according to Example 9;

Fig. 10 shows the infrared absorption spectrum of the azo pigment (Fig-13) synthesized according to Example 10;

Fig. 11 shows the infrared absorption spectrum of the azo pigment (Fig-16) synthesized according to Example 11;

Fig. 12 shows the infrared absorption spectrum of the azo pigment (Fig-25) synthesized according to Example 12;

Fig. 13 shows the infrared absorption spectrum of the azo pigment (Pig-28) synthesized according to Example 13;

Fig. 14 shows the infrared absorption spectrum of the azo pigment (Pig-29) synthesized according to Example 14;

Fig. 15 shows the infrared absorption spectrum of the azo pigment (Pig-30) synthesized according to Example 15;

Fig. 16 shows the infrared absorption spectrum of the azo pigment (Pig-31) synthesized according to Example 16;

Fig. 17 shows the infrared absorption spectrum of the azo pigment (Pig-32) synthesized according to Example 17;

Fig. 18 shows the infrared absorption spectrum of the azo pigment (Pig-37) synthesized according to Example 18;

Fig. 19 shows the infrared absorption spectrum of the azo pigment (Pig-39) synthesized according to Example 19;

Fig. 20 shows the infrared absorption spectrum of the azo pigment (Pig-41) synthesized according to Example 20;

Fig. 21 shows the infrared absorption spectrum of the azo pigment (Pig-42) synthesized according to Example 21;

Fig. 22 shows the infrared absorption spectrum of the azo pigment (Pig-43) synthesized according to Example 22;

Fig. 23 shows the infrared absorption spectrum of the azo pigment (Pig-44) synthesized according to Example 23;

Fig. 24 shows the infrared absorption spectrum of the azo pigment (Pig-45) synthesized according to Example 24;

Fig. 25 shows the infrared absorption spectrum of the azo pigment (Pig-46)

synthesized according to Example 25;

Fig. 26 shows the infrared absorption spectrum of the azo pigment (Fig-49) synthesized according to Example 26;

Fig. 27 shows the infrared absorption spectrum of the azo pigment (Fig-51) synthesized according to Example 27;

Fig. 28 shows the infrared absorption spectrum of the azo pigment (Fig-52) synthesized according to Example 28;

Fig. 29 shows the infrared absorption spectrum of the azo pigment (Fig-53) synthesized according to Example 29;

Fig. 30 shows the infrared absorption spectrum of the azo pigment (Fig-54) synthesized according to Example 30; and

Fig. 31 shows the infrared absorption spectrum of the azo pigment (Fig-59) synthesized according to Example 31.

Best Mode for Carrying Out the Invention

The invention will be described in detail below.

The Hammett substituent constant σ_p used in this specification will be described here. Hammett's rule is an empirical rule propounded by L. P. Hammett in 1935 in order to quantitatively deal with the influence of a substituent on the reaction and equilibrium of a benzene derivative, and the validity thereof has today been widely recognized. As the substituent constants determined in Hammett's rule, there are the σ_p value and the σ_m value. These constants are described in detail, for example, in Lange's Handbook of Chemistry, the 12th edition, edited by J. A. Dean, 1979 (McGraw-Hill) and Kagaku no Ryoiki (Journal of Japanese Chemistry), an extra issue, 122, 96–103 (1979), Nankodo, although they can be found in many general literatures.

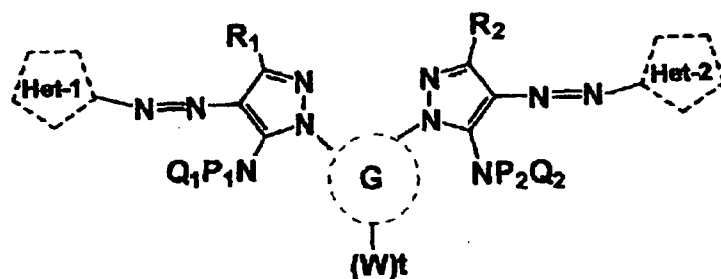
In the invention, each substituent is limited or described by the Hammett substituent constant σ_p . However, this does not mean that the substituent is limited to only a substituent having the constant known in the above-mentioned general literatures. Even when the constant is unknown in literatures, it goes without saying that a substituent having the constant that will be within the range when measured based on Hammett's rule is also included. Further, although the compounds of the invention represented by the general formulae (1) to (12) are not the benzene derivatives, the σ_p value is used as a measure indicating the electronic efficiency of the substituent, independently of the substituted position. In the invention, the σ_p value is used hereinafter in such a sense.

[Azo pigments]

The azo pigments in the invention are represented by the foregoing general formula (1). The compounds represented by the general formula (1) have a low solubility in water, an organic solvent or the like because of the specific structure thereof, and thus they can be used as azo pigments. Pigments are used in a state of solid particles such as molecular aggregates finely dispersed in a solvent, unlike dyes which are used in a state of molecular dispersion dissolved in water, an organic solvent or the like.

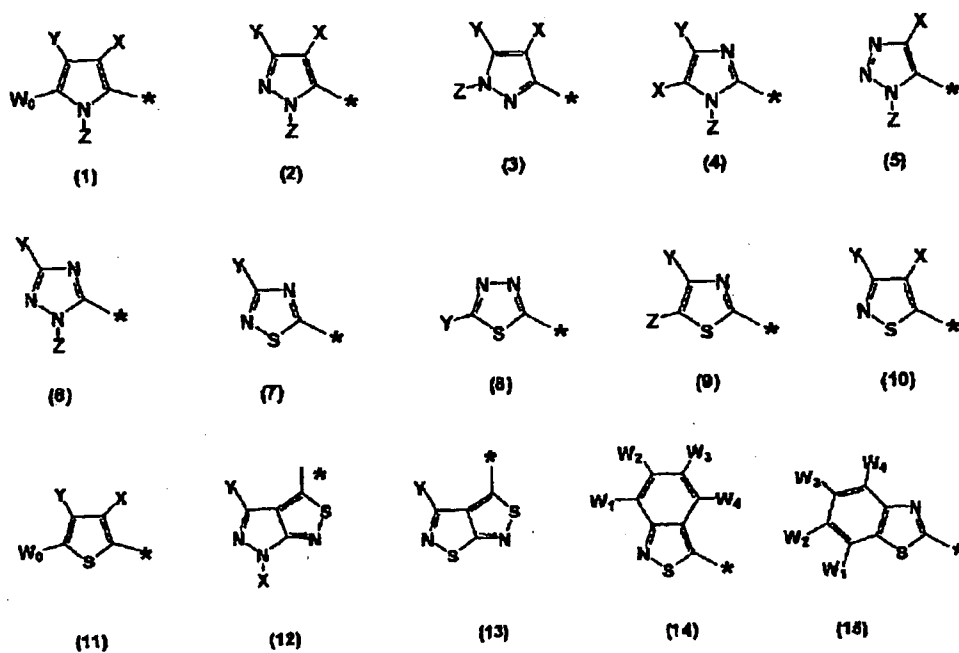
The azo pigments represented by the general formula (1), the tautomers thereof, and the salts or hydrates thereof will be described in detail below.

General formula (1)



(In the general formula (1), each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom or a substituent, G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group, W represents a substituent capable of binding to the heterocyclic group constituted by G , t represents an integer of from 0 to 4, each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the following general formula (2) (wherein * shows the point of attachment to the azo linkage in the general formula (1)):

General formula (2)



(in the general formula (2), each of X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 independently

represents a hydrogen atom or a substituent).

The general formula (1) will be described in more detail below.

In the general formula (1), the heterocyclic group represented by Het-1 or Het-2 represents a group selected from the aromatic heterocyclic groups represented by the above general formula (2), and substituents on the hetero ring may further bind to each other to form a condensed ring. The asterisk * shows the point of attachment to the azo linkage in the general formula (1).

As examples of the heterocyclic group, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are more preferred, (2), (5), (6), (7), and (10) are particularly preferred, (2) and (7) are still more preferred, and (2) is most preferred.

X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the general formula (2) independently represents a hydrogen atom or a substituent.

Examples of the substituent represented by X, Y, Z, W₀, W₁, W₂, W₃, or W₄ include a straight or branched alkyl group containing from 1 to 12 carbon atoms, a straight or branched aralkyl group containing from 7 to 18 carbon atoms, a straight or branched alkenyl group containing from 2 to 12 carbon atoms, a straight or branched alkynyl group containing from 2 to 12 carbon atoms, a straight or branched cycloalkyl group containing from 3 to 12 carbon atoms, a straight or branched cycloalkenyl group containing from 3 to 12 carbon atoms (for example, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, t-butyl, 2-ethylhexyl, 2-methylsulfonyl ethyl, 3-phenoxypropyl, trifluoromethyl or cyclopentyl), a halogen atom (for example, a chlorine atom or a bromine atom), an aryl group (for example, phenyl, 4-t-butylphenyl or 2,4-di-t-amylphenyl), a heterocyclic group (for example, imidazolynyl, pyrazolynyl, triazolynyl, 2-furyl, 2-thienyl, 2-pyrimidyl or 2-benzothiazolynyl), a cyano group, a

hydroxyl group, a nitro group, a carboxy group, an amino group, an alkyloxy group (for example, methoxy, ethoxy, 2-methoxyethoxy or 2-methylsulfonylethoxy), an aryloxy group (for example, phenoxy, 2-methylphenoxy, 4-t-butylphenoxy, 3-nitrophenoxy, 3-t-butyloxycarbonylphenoxy or 3-methoxycarbonylphenyloxy), an acylamino group (for example, acetamido, benzoamido or 4-(3-t-butyl-4-hydroxyphenoxy)butanamido), an alkylamino group (for example, methylamino, butylamino, diethylamino or methylbutylamino), an arylamino group (for example, phenylamino or 2-chloroanilino), an ureido group (for example, phenylureido, methylureido or N,N-dibutylureido), a sulfamoylamino group (for example, N,N-dipropylsulfamoylamino), an alkylthio group (for example, methylthio, octylthio or 2-phenoxyethylthio), an arylthio group (for example, phenylthio, 2-butoxy-5-t-octylphenylthio or 2-carboxyphenylthio), an alkyloxycarbonylamino group (for example, methoxycarbonylamino), an alkylsulfonylamino group and an arylsulfonylamino group (for example, methylsulfonylamino, phenylsulfonylamino or p-toluenesulfonylamino), a carbamoyl group (for example, N-ethylcarbamoyl or N,N-dibutylcarbamoyl), a sulfamoyl group (for example, N-ethylsulfamoyl, N,N-dipropylsulfamoyl or N-phenylsulfamoyl), a sulfonyl group (for example, methylsulfonyl, octylsulfonyl, phenylsulfonyl or p-toluenesulfonyl), an alkyloxycarbonyl group (for example, methoxycarbonyl or butyloxycarbonyl), a heterocyclic oxy group (for example, 1-phenyltetrazol-5-oxy or 2-tetrahydropyranyloxy), an azo group (for example, phenylazo, 4-methoxyphenylazo, 4-pivaloylaminophenylazo or 2-hydroxy-4-propanoylphenylazo), an acyloxy group (for example, acetoxy), a carbamoyloxy group (for example, n-methylcarbamoyloxy or N-phenylcarbamoyloxy), a silyloxy group (for example, trimethylsilyloxy or dibutylmethylsilyloxy), an aryloxycarbonylamino group (for example,

phenoxy-carbonylamino), an imido group (for example, N-succinimido or N-phthalimido), a heterocyclic thio group (for example, 2-benzothiazolylthio, 2,4-di-phenoxy-1,3,5-triazol-6-thio or 2-pyridylthio), a sulfinyl group (for example, 3-phenoxypropylsulfinyl), a phosphonyl group (for example, phenoxyphosphonyl, octyloxyphosphonyl or phenylsulfonyl), an aryloxy-carbonyl group (for example, phenoxy-carbonyl), an acyl group (for example, acetyl, 3-phenylpropanoyl or benzoyl), and an ionic hydrophilic group (for example, a carboxyl group, a sulfo group, a phosphono group or a quaternary ammonium group).

In the case where the azo pigment of the invention contains the ionic hydrophilic group as a substituent, the pigment is preferably a salt with a polyvalent metal cation (for example, magnesium, calcium or barium), and is particularly preferably a lake pigment.

In the general formula (2), preferred examples of each of the substituents of X and W_0 are independently electron-withdrawing groups, particularly electron-withdrawing groups having a Hammett substituent constant σ_p value of 0.20 or more, more preferably electron-withdrawing groups having a Hammett substituent constant σ_p value of 0.30 or more, with 1.0 being the upper limit.

Specific examples of the electron-withdrawing group having a σ_p value of 0.20 or more include an acyl group, an acyloxy group, a carbamoyl group, an alkyloxy-carbonyl group, an aryloxy-carbonyl group, a cyano group, a nitro group, a dialkylphosphono group, a diarylphosphono group, a diarylphosphinyl group, an alkylsulfinyl group, an arylsulfinyl group, an alkylsulfonyl group, an arylsulfonyl group, a sulfonyloxy group, an acylthio group, a sulfamoyl group, a thiocyanato group, a thiocarbonyl group, a halogenated alkyl group, a halogenated alkoxy group, a halogenated aryloxy group, a halogenated alkylamino group, a halogenated alkylthio

group, an aryl group substituted by other electron-withdrawing group having a σ_p value of 0.20 or more, a heterocyclic group, a halogen atom, an azo group or a selenocyanato group.

As preferred examples of each of the substituents of X and W_0 , there are independently illustrated an acyl group containing from 2 to 12 carbon atoms, anacyloxy group containing from 2 to 12 carbon atoms, a carbamoyl group containing from 1 to 12 carbon atoms, an alkyloxycarbonyl group containing from 2 to 12 carbon atoms, an aryloxycarbonyl group containing from 7 to 18 carbon atoms, a cyano group, a nitro group, an alkylsulfinyl group containing from 1 to 12 carbon atoms, an arylsulfinyl group containing from 6 to 18 carbon atoms, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, a sulfamoyl group containing from 0 to 12 carbon atoms, a halogenated alkyl group containing from 1 to 12 carbon atoms, a halogenated alkyloxy group containing from 1 to 12 carbon atoms, a halogenated alkylthio group containing from 1 to 12 carbon atoms, a halogenated aryloxy group containing from 7 to 18 carbon atoms, an aryl group containing from 7 to 18 carbon atoms and being substituted by two or more other electron-withdrawing groups having a σ_p value of 0.20 or more, and a 5- to 8-membered heterocyclic group containing a nitrogen atom, an oxygen atom or a sulfur atom and containing from 1 to 18 carbon atoms.

More preferred are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms and a sulfamoyl group containing from 0 to 12 carbon atoms. Particularly preferred are a cyano group, an alkylsulfonyl group containing from 1 to 8 carbon atoms, an arylsulfonyl group containing from 6 to 12 carbon atoms, and a sulfamoyl group containing from 0 to 8 carbon atoms. Among them, a cyano group, a

methanesulfonyl group, a phenylsulfonyl group and a sulfamoyl group are preferred, a cyano group and a methanesulfonyl group are still more preferred, and a cyano group is the most preferred.

Preferred examples of Z in the general formula (2) are a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted alkylsulfonyl group, a substituted or unsubstituted arylsulfonyl group, and an acyl group. Particularly preferred substituents are a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocyclic group, a substituted or unsubstituted alkylsulfonyl group, a substituted or unsubstituted arylsulfonyl group, and an acyl group. Of these, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are particularly preferred, a substituted or unsubstituted heterocyclic group is especially preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is the most preferred. As examples of the substituent, there can be illustrated the same ones that are illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2).

As preferred examples of Y and W₁ to W₄ in the general formula (2), there are independently illustrated a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, and a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of these, a hydrogen atom and a substituted or unsubstituted, straight or branched alkyl

group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, and a hydrogen atom is the most preferred.

Preferred examples of R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W in the general formula (1) are described in detail below.

In the case where plural W s exist, each of them independently represents a substituent. Each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom or a substituent.

In the case where each of R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W represents a monovalent substituent, examples of each of the monovalent substituents independently include a halogen atom, an alkyl group, a cycloalkyl group, an aralkyl group, an alkenyl group, an alkynyl group, an aryl group, a heterocyclic group, a cyano group, a hydroxyl group, a nitro group, an alkoxy group, an aryloxy group, a silyloxy group, a heterocyclic oxy group, an acyloxy group, a carbamoyloxy group, an alkoxycarbonyloxy group, an aryloxycarbonyloxy group, an amino group (an alkylamino group or an arylamino group), an acylamino group (an amido group), an aminocarbonylamino group (a ureido group), an alkoxycarbonylamino group, an aryloxycarbonylamino group, a sulfamoylamino group, an alkylsulfonylamino group, an arylsulfonylamino group, an alkylthio group, an arylthio group, a heterocyclic thio group, a sulfamoyl group, an alkylsulfinyl group, an arylsulfinyl group, an alkylsulfonyl group, an arylsulfonyl group, an acyl group, an aryloxycarbonyl group, an alkoxycarbonyl group, a carbamoyl group, a phosphino group, a phosphinyl group, a phosphinyloxy group, a phosphinylamino group, a silyl group, an azo group, and an imido group, each of which may further have a substituent.

Particularly preferred examples of each of W s are independently a halogen

atom, an alkyl group, an aryl group, a heterocyclic group, a cyano group, a hydroxyl group, an alkoxy group, an amido group, a ureido group, an alkylsulfonylamino group, an arylsulfonylamino group, a sulfamoyl group, an alkylsulfonyl group, an arylsulfonyl group, a carbamoyl group, and an alkoxycarbonyl group. Of these, a halogen atom, an alkyl group, an aryl group, a cyano group, a hydroxyl group, an alkylsulfonyl group, an arylsulfonyl group, a heterocyclic group, and an alkoxycarbonyl group are more preferred, and an alkyl group, an aryl group, a hydroxyl group, and an alkoxycarbonyl group are the most preferred.

Particularly preferred examples of each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 are independently a hydrogen atom, a halogen atom, an alkyl group, an aryl group, a heterocyclic group, a cyano group, a hydroxyl group, an alkoxy group, an amido group, a ureido group, an alkylsulfonylamino group, an arylsulfonylamino group, a sulfamoyl group, an alkylsulfonyl group, an arylsulfonyl group, a carbamoyl group, and an alkoxycarbonyl group. Of these, a hydrogen atom, a halogen atom, an alkyl group, an aryl group, a cyano group, a hydroxyl group, an alkylsulfonyl group, an arylsulfonyl group, a heterocyclic group, and an alkoxycarbonyl group are particularly preferred, and a hydrogen atom, an alkyl group, an aryl group, a hydroxyl group, and an alkoxycarbonyl group are the most preferred.

R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W will be described in more detail below.

The halogen atom represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W represents a chlorine atom, a bromine atom or an iodine atom. Of these, a halogen atom or a bromine atom is preferred, with a chlorine atom being particularly preferred.

The alkyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W includes a substituted or unsubstituted alkyl group. The substituted or unsubstituted alkyl group is preferably an alkyl group containing from 1 to 30 carbon atoms. As examples of

the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Among them, a hydroxyl group, an alkoxy group, a cyano group, a halogen atom, a sulfo group (optionally in the salt form thereof), and a carboxyl group (optionally in the salt form thereof) are preferred. Examples of the alkyl group include methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, s-butyl, t-butyl, n-octyl, eicosyl, 2-chloroethyl, hydroxyethyl, cyanoethyl, and 4-sulfobutyl.

The cycloalkyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a substituted or unsubstituted cycloalkyl group. The substituted or unsubstituted cycloalkyl group is preferably a cycloalkyl group containing from 5 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the cycloalkyl group include cyclohexyl, cyclopentyl, and 4-n-dodecylcyclohexyl.

The aralkyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a substituted or unsubstituted aralkyl group. The substituted or unsubstituted aralkyl group is preferably an aralkyl group containing from 7 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aralkyl group include benzyl and 2-phenethyl.

The alkenyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a straight, branched or cyclic, substituted or unsubstituted alkenyl group. Preferably, there can be illustrated a substituted or unsubstituted alkenyl group containing from 2 to 30 carbon atoms, for example, vinyl, allyl, prenyl, geranyl, oleyl, 2-cyclopenten-1-yl, and 2-cyclohexen-1-yl.

The alkynyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a substituted or unsubstituted alkynyl group containing from 2 to 30 carbon atoms, for example, ethynyl and propargyl.

The aryl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a substituted or unsubstituted aryl group containing from 6 to 30 carbon atoms, for example, phenyl, p-tolyl, naphthyl, m-chlorophenyl, and o-hexadecanoylamino-phenyl. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2).

The heterocyclic group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is a monovalent group formed by removing one hydrogen atom from a 5- or 6-membered, substituted or unsubstituted, aromatic or non-aromatic heterocyclic compound, which may further be condensed with other ring. More preferably, the hetero ring is a 5- or 6-membered aromatic heterocyclic group containing from 3 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). To illustrate the heterocyclic group without restricting the substitution position, there can be illustrated pyridyl, pyrazinyl, pyridazinyl, pyrimidinyl, triazinyl, quinolinyl, isoquinolinyl, quinazolinyl, cinnolinyl, phthalazinyl, quinoxalinyl, pyrrolyl, indolyl, furyl, benzofuryl, thienyl, benzothienyl, pyrazolyl, imidazolyl, benzimidazolyl, triazolyl, oxazolyl, benzoxazolyl, thiazolyl, benzothiazolyl, isothiazolyl, benzoisothiazolyl, thiadiazolyl, isoxazolyl, benzisoxazolyl, pyrrolidinyl, piperidyl, piperazinyl, imidazolyl, and thiazolyl.

Further, a pyridyl group, a pyrimidinyl group, a pyridazinyl group, and a triazinyl group are preferred. Of these, a pyridyl group, a pyrimidinyl group, and a

triazinyl group are preferred, and a 2-pyridyl group, 2,4-pyrimidinyl group, and an s-triazinyl group are the most preferred.

The alkoxy group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W includes a substituted or unsubstituted alkoxy group. The substituted or unsubstituted alkoxy group is preferably an alkoxy group containing from 1 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the alkoxy group include methoxy, ethoxy, isopropoxy, n-octyloxy, methoxyethoxy, hydroxyethoxy, and 3-carboxypropoxy.

The aryloxy group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted aryloxy group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aryloxy group include phenoxy, 2-methylphenoxy, 4-t-butylphenoxy, 3-nitrophenoxy, and 2-tetradecanoylaminophenoxy.

The silyloxy group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a silyloxy group containing from 3 to 20 carbon atoms, and examples thereof include trimethylsilyloxy and t-butyldimethylsilyloxy.

The heterocyclic oxy group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted heterocyclic oxy group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the heterocyclic oxy group include 1-phenyltetrazol-5-oxy and 2-tetrahydropyranyloxy.

The acyloxy group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a formyloxy group, a substituted or unsubstituted alkylcarbonyloxy group containing from 2 to 30 carbon atoms, or a substituted or unsubstituted arylcarbonyloxy group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the acyloxy group include formyloxy, acetyloxy, pivaloyloxy, stearoyloxy, benzoyloxy, and p-methoxyphenylcarbonyloxy.

The carbamoyloxy group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted carbamoyloxy group containing from 1 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the carbamoyloxy group include N,N-dimethylcarbamoyloxy, N,N-diethylcarbamoyloxy, morpholinocarbonyloxy, N,N-di-n-octylaminocarbonyloxy, and N-n-octylcarbamoyloxy.

The alkoxycarbonyloxy group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted alkoxycarbonyloxy group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the alkoxycarbonyloxy group include methoxycarbonyloxy, ethoxycarbonyloxy, t-butoxycarbonyloxy, and n-octylcarbonyloxy.

The aryloxycarbonyloxy group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted aryloxycarbonyloxy group containing from 7 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same

substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aryloxycarbonyloxy group include phenoxycarbonyloxy, p-methoxyphenoxycarbonyloxy, and p-n-hexadecyloxyphenoxycarbonyloxy.

The amino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted alkylamino group containing from 1 to 30 carbon atoms or a substituted or unsubstituted arylamino group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the amino group include amino, methylamino, dimethylamino, aniline, N-methylanilino, diphenylamino, hydroxyethylamino, carboxyethylamino, sulfoethylamino, and 3,5-dicarboxyanilino.

The acylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a formylamino group, a substituted or unsubstituted alkylcarbonylamino group containing from 1 to 30 carbon atoms, or a substituted or unsubstituted arylcarbonylamino group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the acylamino group include formylamino, acetylamino, pivaloylamino, lauroylamino, benzoylamino, and 3,4,5-tri-n-octyloxyphenylcarbonylamino.

The aminocarbonylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted aminocarbonylamino group containing from 1 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aminocarbonylamino

group include carbamoylamino, N,N-dimethylaminocarbonylamino, N,N-diethylaminocarbonylamino, and morpholinocarbonylamino.

The alkoxycarbonylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted alkoxycarbonylamino group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the alkoxycarbonylamino group include methoxycarbonylamino, ethoxycarbonylamino, t-butoxycarbonylamino, n-octadecyloxycarbonylamino, and N-methyl-methoxycarbonylamino.

The aryloxycarbonylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted aryloxycarbonylamino group containing from 7 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aryloxycarbonylamino group include phenoxycarbonylamino, p-chlorophenoxycarbonylamino, and m-n-octylphenoxycarbonylamino.

The sulfamoylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted sulfamoylamino group containing from 0 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the sulfamoylamino group include sulfamoylamino, N,N-dimethylaminosulfonylamino, and N-n-octylaminosulfonylamino.

The alkyl or arylsulfonylamino group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted alkylsulfonylamino group containing

from 1 to 30 carbon atoms or a substituted or unsubstituted arylsulfonylamino group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the alkylsulfonylamino group and the arylsulfonylamino group include methylsulfonylamino, butylsulfonylamino, phenylsulfonylamino, 2,3,5-trichlorophenylsulfonylamino, and p-methylphenylsulfonylamino.

The alkylthio group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted alkylthio group containing from 1 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the alkylthio group include methylthio, ethylthio, and n-hexadecylthio.

The arylthio group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted arylthio group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the arylthio group include phenylthio, p-chlorophenylthio, and m-methoxyphenylthio.

The heterocyclic thio group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted heterocyclic thio group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the heterocyclic thio group include 2-benzothiazolylthio and 1-phenyltetrazol-5-ylthio.

The sulfamoyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted sulfamoyl group containing from 0 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the sulfamoyl group include N-ethylsulfamoyl, N-(3-dodecyloxypropyl)sulfamoyl, N,N-dimethylsulfamoyl, N-acetylsulfamoyl, N-benzoylsulfamoyl, and N-(N'-phenylcarbamoyl)sulfamoyl).

The alkyl or arylsulfinyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted alkylsulfinyl group containing from 1 to 30 carbon atoms or a substituted or unsubstituted arylsulfinyl group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the alkyl and arylsulfinyl group include methylsulfinyl, ethylsulfinyl, phenylsulfinyl, and p-methylphenylsulfinyl.

The alkyl or arylsulfonyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted alkylsulfonyl group containing from 1 to 30 carbon atoms or a substituted or unsubstituted arylsulfonyl group containing from 6 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the alkyl and arylsulfonyl group include methylsulfonyl, ethylsulfonyl, phenylsulfonyl, and p-toluenesulfonyl.

The acyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a formyl group, a substituted or unsubstituted alkylcarbonyl group containing from 2 to 30 carbon atoms, a substituted or unsubstituted arylcarbonyl group containing from 7 to 30 carbon atoms, or a heterocyclic carbonyl group containing from 4 to 30 carbon

atoms wherein the hetero ring binds to the carbonyl group through a carbon atom. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the acyl group include acetyl, pivaloyl, 2-chloroacetyl, stearoyl, benzoyl, p-n-octyloxyphenylcarbonyl, 2-pyridylcarbonyl, and 2-furylcarbonyl.

The aryloxy carbonyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted aryloxy carbonyl group containing from 7 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the aryloxy carbonyl group include phenoxy carbonyl, o-chlorophenoxy carbonyl, m-nitrophenoxy carbonyl, and p-t-butylphenoxy carbonyl.

The alkoxy carbonyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted alkoxy carbonyl group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the alkoxy carbonyl group include methoxy carbonyl, ethoxy carbonyl, and t-butoxy carbonyl, n-octadecyloxy carbonyl.

The carbamoyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted carbamoyl group containing from 1 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the carbamoyl group include carbamoyl, N-methylcarbamoyl, N,N-dimethylcarbamoyl, N,N-di-n-octylcarbamoyl,

and N-(methylsulfonyl)carbamoyl.

The phosphino group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted phosphino group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the phosphino group include dimethylphosphino, diphenylphosphino, and methylphenylphosphino.

The phosphinyl group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted phosphinyl group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the phosphinyl group include phosphinyl, dioctyloxyphosphinyl, and diethoxyphosphinyl.

The phosphinyloxy group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted phosphinyloxy group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the phosphinyloxy group include diphenoxyphosphinyloxy and dioctyloxyphosphinyloxy.

The phosphinylamino group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W is preferably a substituted or unsubstituted phosphinylamino group containing from 2 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2). Examples of the phosphinylamino group include dimethoxyphosphinylamino and dimethylaminophosphinylamino.

The silyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W is preferably a substituted or unsubstituted silyl group containing from 3 to 30 carbon atoms. As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2). Examples of the silyl group include trimethylsilyl, t-butyldimethylsilyl, and phenyldimethylsilyl.

Examples of the azo group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include phenylazo, 4-methoxyphenylazo, 4-pivaloylaminophenylazo, and 2-hydroxy-4-propanoylphenylazo.

Examples of the imido group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include N-succinimido and N-phthalimido.

The heterocyclic thio group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include a heterocyclic thio group having a substituent and an unsubstituted heterocyclic thio group. The heterocyclic thio group preferably has a 5- or 6-membered heterocyclic group. Examples of the substituent include ionic hydrophilic groups. Examples of the heterocyclic thio group include a 2-pyridylthio group.

The sulfinyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include an alkylsulfinyl group and an arylsulfinyl group. Examples of the sulfinyl group include a 3-sulfopropylsulfinyl group and a 3-carboxypropylsulfinyl group.

The phosphoryl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include a phosphoryl group having a substituent and an unsubstituted phosphoryl group. Examples of the phosphoryl group include a phenoxyphosphoryl group and a phenylphosphoryl group.

The acyl group represented by R₁, R₂, P₁, P₂, Q₁, Q₂, and W include an acyl

group having a substituent and an unsubstituted acyl group. As the acyl group, an acyl group containing from 1 to 12 carbon atoms excluding the substituent is preferred. Examples of the acyl group include an ionic hydrophilic group. Examples of the acyl group include an acetyl group and a benzoyl group.

The ionic hydrophilic group represented by R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W include a sulfo group, a carboxyl group, a phosphono group, and a quaternary ammonium group. As the ionic hydrophilic group, a carboxyl group and a sulfo group are preferred. The carboxyl group and the sulfo group may be in the salts form thereof. Examples of the counter ion forming the salt include an ammonium ion, an alkali metal ion (for example, calcium ion or barium ion), and an organic cation (for example, tetramethylguanidium ion).

In the case where each of R_1 , R_2 , P_1 , P_2 , Q_1 , Q_2 , and W represents a divalent group, the divalent group is preferably an alkylene group (for example, methylene, ethylene, propylene, butylene or pentylene), an alkenyl group (for example, ethenylene or propenylene), an alkynylene group (for example, ethynylene or propynylene), an arylene group (for example, phenylene or naphthylene), a divalent heterocyclic group (for example, a 6-chloro-1,3,5-triazine-2,4-diyl group, a pyrimidine-2,4-diyl group, a pyrimidine-4,6-diyl group, a quinoxaline-2,3-diyl group, a pyridazine-3,6-diyl group, -O-, -CO-, -NR'- (wherein R' represents a hydrogen atom, an alkyl group or an aryl group), -S-, -SO₂-, -SO-, or a combination thereof (for example, -NHCH₂CH₂NH- or -NHCONH-).

The alkylene group, alkenylene group, alkynylene group, arylene group, divalent heterocyclic group, and the alkyl or aryl group of R' may have a substituent.

As examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X , Y , Z , W_0 , W_1 , W_2 , W_3 , and W_4 in the

foregoing general formula (2).

The alkyl group and the aryl group of R' described above are the same as the substituent examples having been illustrated with respect to the case where each of R₁, R₂, P₁, P₂, Q₁, Q₂, and W represents an alkyl group or an aryl group.

More preferably, the divalent group is an alkylene group containing 10 or less carbon atoms, an alkenylene group containing 10 or less carbon atoms, an alkynylene group containing 10 or less carbon atoms, an arylene group containing from 6 to 10 carbon atoms, a divalent heterocyclic group, -S-, -SO-, -SO₂- or a combination thereof (for example, -SCH₂CH₂S- or -SCH₂CH₂CH₂S-).

The divalent linking group contains a total of preferably from 0 to 50 carbon atoms, more preferably from 0 to 30 carbon atoms, most preferably from 0 to 10 carbon atoms.

In the case where each of R₁, R₂, P₁, P₂, Q₁, Q₂, and W represents a trivalent group, the trivalent group is preferably a trivalent hydrocarbon group, a trivalent heterocyclic group, >N- or a combination thereof with a divalent group (for example, >NCH₂CH₂NH- or >NCONH-).

The trivalent linking group contains a total of preferably from 0 to 50 carbon atoms, more preferably from 0 to 30 carbon atoms, most preferably from 0 to 10 carbon atoms.

In the general formula (1), t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.

Preferred examples of the 5- to 6-membered heterocyclic group constituted by G in the general formula (1) are 5- or 6-membered, substituted or unsubstituted, aromatic or non-aromatic heterocyclic groups, which may be further condensed with other ring. More preferred are 5- or 6-membered aromatic heterocyclic groups

containing from 3 to 30 carbon atoms.

To illustrate the heterocyclic group represented by G without restricting substitution positions, there can be illustrated pyridine, pyrazine, pyridazine, pyrimidine, triazine, quinoline, isoquinoline, quinazoline, cinnoline, phthalazine, quinoxaline, pyrrole, indole, furan, benzofuran, thiophene, benzothiophene, pyrazole, imidazole, benzimidazole, triazole, oxazole, benzoxazole, thiazole, benzothiazole, isothiazole, benzoisothiazole, thiadiazole, isoxazole, benzisoxazole, pyrrolidine, piperidine, piperazine, imidazolidine, thiazoline, and sulfolane.

More preferred are a pyridine ring, a pyrazine ring, a pyridazine ring, a pyrimidine ring, and a triazine ring. Of them, an s-triazine ring, a pyrimidine ring, a pyridazine ring, and a pyrazine ring are preferred, with a 2,3-pyridazine ring, a 2,4-pyrimidine ring, a 2,5-pyrazine ring, a 2,6-pyrimidine ring, and an s-triazine ring being most preferred.

In the case where the heterocyclic group constituted by G is a group which can further have a substituent, as examples of the substituent, there can be illustrated the same substituents as have been illustrated with respect to X, Y, Z, W₀, W₁, W₂, W₃, and W₄ in the foregoing general formula (2).

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (1), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the

invention represented by the general formula (1) contain the following (a) to (k).

- (a) G is preferably a 5- or 6-membered, nitrogen-containing heterocyclic group and, to illustrate without restricting the substitution positions, an s-triazine ring, a pyrimidine ring, a pyridazine ring, a pyrazine ring, a pyridine ring, an imidazole ring, a pyrazole ring, and a pyrrole ring are preferred. Of these, an s-triazine ring, a pyrimidine ring, a pyridazine ring, and a pyrazine ring are preferred, with a 2,3-pyridazine ring, a 2,4-pyrimidine ring, a 2,5-pyrazine ring, a 2,6-pyrimidine ring, and an s-triazine ring being most preferred..
- (b) W is preferably a hydroxyl group, a cyano group, a substituted or unsubstituted carbamoyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group, a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio group are particularly preferred, with a hydroxyl group and an amino group being most preferred.
- (c) t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.
- (d) Preferably, each of R₁ and R₂ is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are preferred, with a methyl group and a t-butyl group being most preferred.

- (e) Preferably, each of P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted acyl group, a substituted or unsubstituted alkylsulfonyl group, or a substituted or unsubstituted arylsulfonyl group. Particularly preferred are a hydrogen atom, a substituted or unsubstituted alkyl group, and a substituted or unsubstituted acyl group. Of them, a hydrogen atom is particularly preferred.
- (f) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.
- (g) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.
- (h) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.
- (i) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a

substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

(j) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

(k) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

The azo pigments represented by the foregoing general formula (1) are preferably those azo pigments which are represented by the following general formula (3).

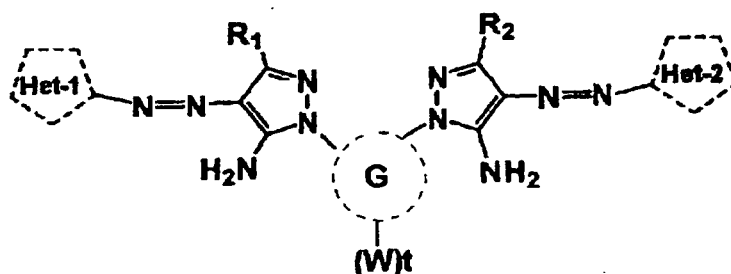
Azo pigments represented by the general formula (3), the tautomers thereof, and the salts or hydrates thereof will be described below.

Of the azo pigments represented by the foregoing general formula (1), those

azo pigments which are represented by the following general formula (3) are preferred.

Azo pigments represented by the general formula (3), the tautomers thereof, and the salts or hydrates thereof will be described below.

General formula (3)



In the general formula (3), each of R_1 , R_2 , G , W , t , Het-1, and Het-2 is independently the same as R_1 , R_2 , G , W , t , Het-1, and Het-2 in the general formula (3). The asterisk * shows the point of attachment to the azo linkage in the general formula (3).

R_1 , R_2 , G , W , t , Het-1, and Het-2 will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the foregoing general formula (1), and preferred examples thereof are also the same as described there.

Examples of G are the same as those of G in the foregoing general formula (1), and preferred examples thereof are also the same as described there.

Examples of the substituent W are the same as those of W in the foregoing general formula (1), and preferred examples thereof are also the same as described there.

Examples of t is the same as those of t in the foregoing general formula (1), and preferred examples thereof are also the same as described there.

Examples of each of the heterocyclic groups represented by Het-1 and Het-2

are independently the same as those of each of Het-1 and Het-2 in the foregoing general formula (1), and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (3), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formula (3) contain the following (a) to (j).

(a) G is preferably a 5- or 6-membered, nitrogen-containing heterocyclic group and, to illustrate without restricting the substitution positions, an s-triazine ring, a pyrimidine ring, a pyridazine ring, a pyrazine ring, a pyridine ring, an imidazole ring, a pyrazole ring, and a pyrrole ring are preferred. Of these, an s-triazine ring, a pyrimidine ring, a pyridazine ring, and a pyrazine ring are preferred, with a 2,3-pyridazine ring, a 2,4-pyrimidine ring, a 2,5-pyrazine ring, a 2,6-pyrimidine ring, and an s-triazine ring being most preferred.

(b) W is preferably a hydroxyl group, a cyano group, a substituted or unsubstituted carbamoyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group, a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio group are

particularly preferred, with a hydrogen atom, a hydroxyl group, and an amino group being most preferred.

(c) t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.

(d) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are preferred, with a methyl group and a t-butyl group being most preferred.

(e) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.

(f) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(g) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a

hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(h) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

(i) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

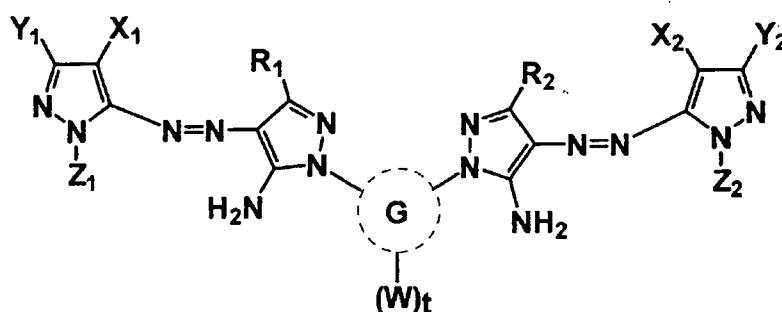
(j) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

Of the azo pigments represented by the foregoing general formulae (1) and (3),

those azo pigments which are represented by the following general formula (4) are preferred.

The azo pigments represented by the following general formula (4), the tautomers thereof, and the salts or hydrates thereof will be described in detail below.

General formula (4)



Examples of each of the substituents R_1 , R_2 , G , W , and t are independently the same as those of each of R_1 , R_2 , G , W , and t in the foregoing general formula (3). Each of X_1 and X_2 independently represents an electron-withdrawing group having a Hammett's σ_p value of 0.2 or more. Each of Y_1 , Y_2 , Z_1 , and Z_2 independently represents a hydrogen atom or a substituent.

R_1 , R_2 , G , W , t , Y_1 , Y_2 , Z_1 , and Z_2 will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

Examples of G are the same as those of G in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

Examples of the substituent W are the same as those of W in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

Examples of t is the same as those of t in the foregoing general formula (3),

and preferred examples thereof are also the same as described there.

Examples of each of the substituents of X_1 and X_2 are independently the same as those of X in the foregoing general formula (2).

Examples of each of the substituents of Y_1 and Y_2 are independently the same as those of Y in the foregoing general formula (2).

Examples of each of the substituents of Z_1 and Z_2 are independently the same as those of Z in the foregoing general formula (2).

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (4), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formula (4) contain the following (a) to (g).

(a) G is preferably a 5- or 6-membered, nitrogen-containing heterocyclic group and, to illustrate without restricting the substitution positions, an s-triazine ring, a pyrimidine ring, a pyridazine ring, a pyrazine ring, a pyridine ring, an imidazole ring, a pyrazole ring, and a pyrrole ring are preferred. Of these, an s-triazine ring, a pyrimidine ring, a pyridazine ring, and a pyrazine ring are preferred, with a 2,3-pyridazine ring, a 2,4-pyrimidine ring, a 2,5-pyrazine ring, a 2,6-pyrimidine ring, and an s-triazine ring being most preferred.

(b) W is preferably a hydroxyl group, a cyano group, a substituted or unsubstituted carbamoyl group, a substituted or unsubstituted amino group, a

substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group, a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio group are particularly preferred, with a hydroxyl group and an amino group being most preferred.

(c) t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.

(d) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are preferred, with a methyl group and a t-butyl group being most preferred.

(e) Particularly preferably, each of X_1 and X_2 is independently a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(f) Particularly preferably, each of Y_1 and Y_2 is independently a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched

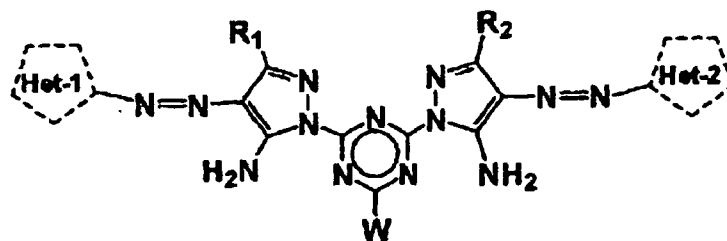
alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(g) Particularly preferably, each of Z_1 and Z_2 is independently a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is more preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

Of the azo pigments represented by the foregoing general formulae (1) and (3), those azo pigments which are represented by the following general formula (5) are preferred.

The azo pigments represented by the following general formula (5), the tautomers thereof, and the salts or hydrates thereof will be described in detail below.

General formula (5)



In the general formula (5), each of R_1 , R_2 , Het-1, and Het-2 is independently the same as R_1 , R_2 , Het-1, and Het-2 in the general formula (3). The asterisk * shows the point of attachment to the azo linkage in the general formula (5).

R_1 , R_2 , W, Het-1, and Het-2 will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

Examples of the substituent W are the same as those of W in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

Examples of each of the heterocyclic groups represented by Het-1 and Het-2 are independently the same as those of each of Het-1 and Het-2 in the foregoing general formula (3), and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (5), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formula (5) contain the following (a) to (i).

(a) W is preferably a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group, a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio

group are particularly preferred, with a hydroxyl group and an amino group being most preferred.

(b) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are preferred, with a methyl group and a t-butyl group being most preferred.

(c) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.

(d) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(e) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1

to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(f) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is particularly preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

(g) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

(h) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

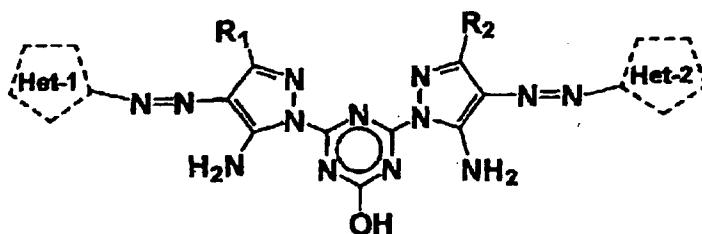
(i) As to pigment mother nucleus, those azo pigments are preferred wherein the main component of mother nucleus is an azo pigment mother nucleus among an azo pigment nucleus and a hydrazone pigment nucleus. Of them, those pigments are

most preferred which have the azo pigment mother nucleus and are of a single crystal form.

Of the azo pigments represented by the foregoing general formula (5), those azo pigments which are represented by the following general formula (6) are preferred.

The azo pigments represented by the following general formula (6), the tautomers thereof, and the salts or hydrates thereof will be described in detail below.

General formula (6)



In the general formula (6), each of R_1 and R_2 independently represents a hydrogen atom or a monovalent substituent, and each of Het-1 and Het-2 is independently the same as Het-1 and Het-2 in the above general formula (5). The asterisk * shows the point of attachment to the azo linkage in the general formula (6).

R_1 , R_2 , Het-1, and Het-2 will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the above general formula (6), and preferred examples thereof are also the same as described there.

Examples of each of the heterocyclic groups represented by Het-1 and Het-2 are independently the same as those of each of Het-1 and Het-2 in the above general formula (6), and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (6), those compounds are preferred wherein at least one of the various substituents is the preferred group having been

described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formula (6) contain the following (a) to (g).

(a) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are more preferred, with a methyl group and a t-butyl group being most preferred.

(b) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.

(c) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(d) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl

group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(e) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is particularly preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

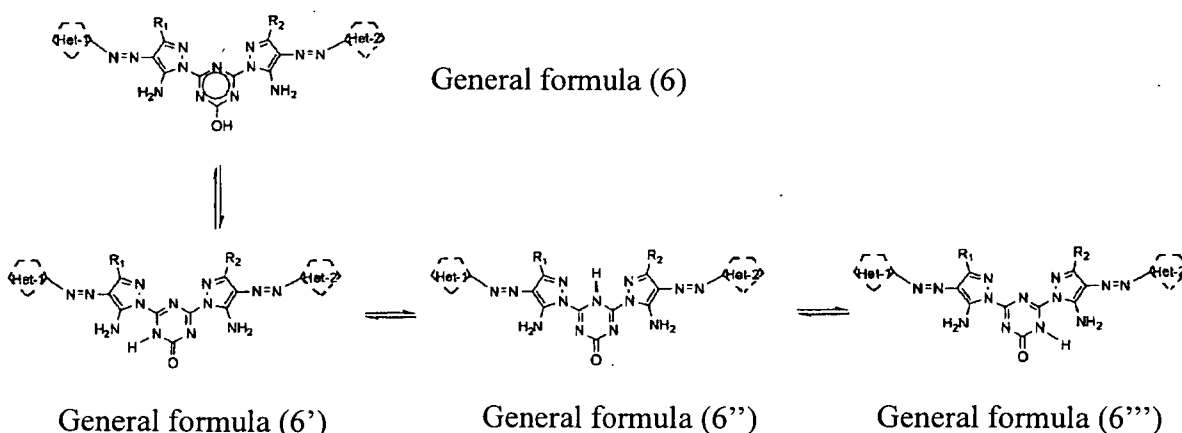
(f) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

(g) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing

from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

The invention also includes in its scope tautomers of the azo pigments represented by the general formulae (1), (3), (4), and (6). Although the general formulae (1), (3), (4), and (6) are shown in the form of limited structure among several tautomer forms which are possible in view of chemical structure, the azo pigments may be tautomers of other structure than the shown one, and may be used as a mixture containing plural tautomers. For example, with the pigment represented by the general formula (6), azo-hydrazone tautomers represented by the following general formulae (6') to (6''') can be considered.

The general formulae (6') to (6''') will be described in detail below.



In the general formulae (6') to (6'''), each of R_1 and R_2 independently represents a hydrogen atom or a monovalent substituent, each of Het-1 and Het-2 independently is independently the same as Het-1 and Het-2 in the foregoing general formula (5), and the asterisk * shows the point of attachment to the azo linkage in the general formula (6).

R_1 , R_2 , Het-1, and Het-2 will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the above general formula (5), and preferred examples

thereof are also the same as described there.

Examples of each of the heterocyclic groups represented by Het-1 and Het-2 are independently the same as those of each of Het-1 and Het-2 in the above general formula (5), and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formulae (6') to (6'''), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formulae (6') to (6''') contain the following (a) to (g).

(a) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are more preferred, with a methyl group and a t-butyl group being most preferred.

(b) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are

more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.

(c) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(d) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(e) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is particularly preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

(f) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano

group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

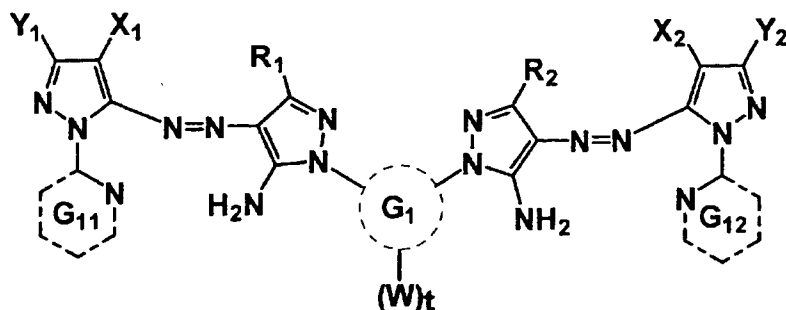
(g) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

The azo pigment of the general formula (6) may be used as a mixture containing, for example, the tautomers thereof represented by the general formulae (6') to (6'''). It is preferred, however, that the azo pigment represented by the general formula (6) constitutes a major component.

Of the azo pigments represented by the foregoing general formula (4), those azo pigments which are represented by the following general formula (7) are preferred.

The azo pigments represented by the following general formula (7), the tautomers thereof, and the salts or hydrates thereof will be described in detail below.

General formula (7)



In the general formula (7), each of R_1 , R_2 , X_1 , X_2 , Y_1 , and Y_2 is independently the same as R_1 , R_2 , X_1 , X_2 , Y_1 , and Y_2 in the general formula (4), G_1 represents the

non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group, W represents a substituent capable of binding to the heterocyclic group constituted by G_1 , t represents an integer of from 0 to 4, each of G_{11} and G_{12} independently represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group, each of the heterocyclic groups constituted by G_{11} and G_{12} may independently be unsubstituted or may have a substituent, and each of the heterocyclic groups may be a monocyclic ring or may have a condensed ring.

R_1 , R_2 , G_1 , W, t, X_1 , X_2 , Y_1 , Y_2 , G_{11} , and G_{12} will be described in more detail below.

Examples of each of the substituents R_1 and R_2 are independently the same as those of each of R_1 and R_2 in the foregoing general formula (4).

Examples of G_1 are the same as those of G in the foregoing general formula (4), and preferred examples thereof are also the same as described there.

Examples of the substituent W are the same as those of W in the foregoing general formula (4), and preferred examples thereof are also the same as described there.

Examples of t is the same as those of t in the foregoing general formula (4), and preferred examples thereof are also the same as described there.

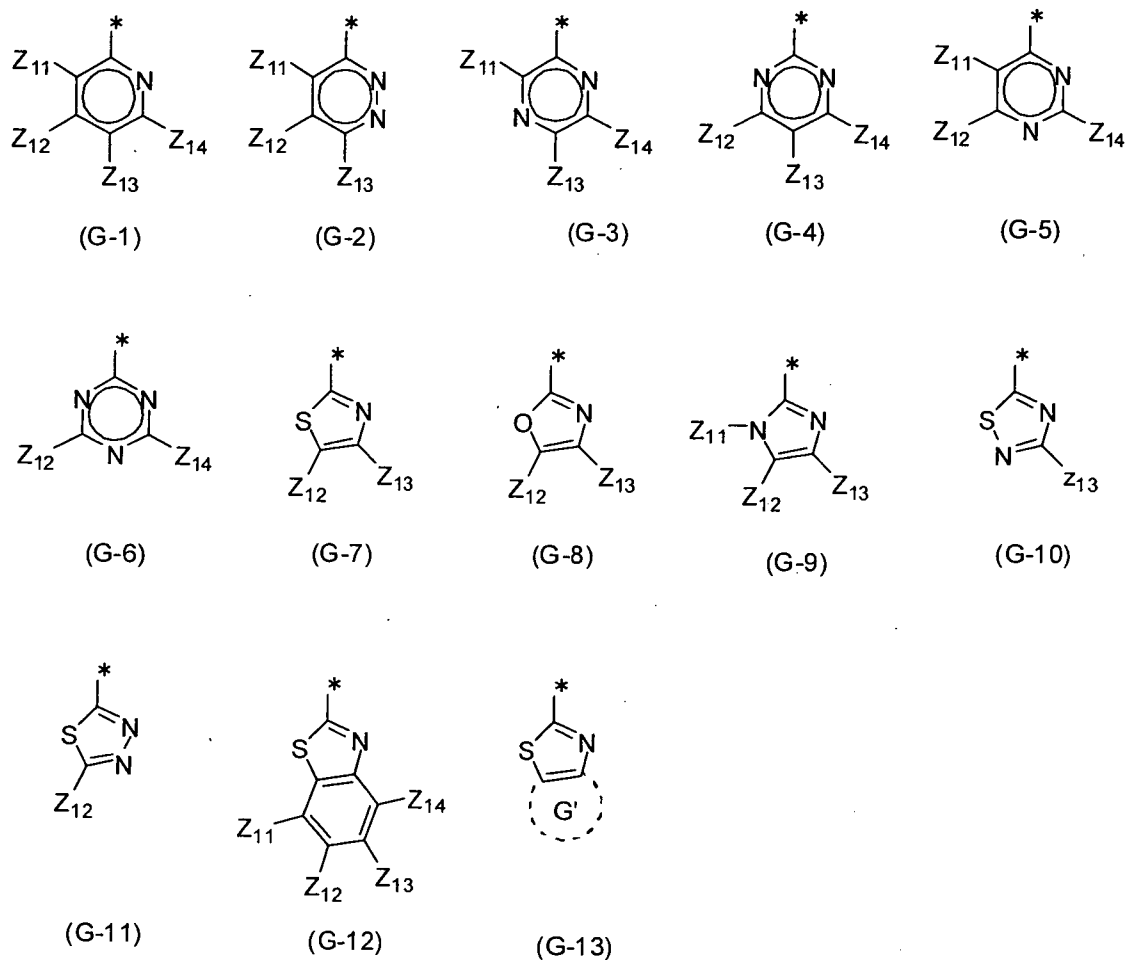
Examples of each of the substituents of X_1 and X_2 are independently the same as those of X_1 and X_2 in the foregoing general formula (4), and preferred examples thereof are also the same as described there.

Examples of each of the substituents of Y_1 and Y_2 are independently the same as those of Y_1 and Y_2 in the foregoing general formula (4), and preferred examples thereof are also the same as described there.

At least one of the nitrogen-containing heterocyclic groups respectively

represented by G_{11} and G_{12} is preferably represented by any one of (G-1) to (G-13) in the following general formula (8).

General formula (8)



In the above general formula (8), * in (G-1) to (G-13) shows the point of attachment to the N atom on the pyrazole ring represented in the above general formula (7), each of Z_{11} to Z_{14} represents a substituent capable of binding to the heterocyclic group, and G' in (G-13) represents the non-metallic atoms necessary to complete a heterocyclic group.

Each of Z_{11} , Z_{12} , Z_{13} , and Z_{14} in (G-1) to (G-13) in the general formula (8) is a hydrogen atom or is the same as the substituent represented by X, Y, Z, W_0 , W_1 , W_2 , W_3 , and W_4 in the foregoing general formula (2), and preferred examples thereof are

also the same as described there.

Examples of the heterocyclic group represented by G' in (G-13) in the general formula (8) are the same as the preferred examples of the 5- to 6-membered heterocyclic group constituted by G₁ in the general formula (7) as long as they can form a condensed ring, and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the pigment of the invention represented by the general formula (7), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the groups in the azo pigments of the invention represented by the general formula (7) contain the following (a) to (g).

(a) G₁₁ is preferably a 5- or 6-membered, nitrogen-containing heterocyclic group and, to illustrate without restricting the substitution positions, an s-triazinyl group, a pyrimidinyl group, a pyridazinyl group, a pyrazyl group, a pyridyl group, an imidazolyl group, a pyrazolyl group, and a pyrrolyl group are preferred. Of these, an s-triazinyl group, a pyrimidinyl group, a pyridazinyl group, and a pyrazinyl group are preferred, with a 2,3-pyridazyl group, a 2,4-pyrimidinyl group, a 2,5-pyrazyl group, a 2,6-pyrimidinyl group, and an s-triazinyl group being most preferred.

(b) W is preferably a hydroxyl group, a cyano group, a substituted or unsubstituted carbamoyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group,

a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio group are particularly preferred, with a hydroxyl group and an amino group being most preferred.

(c) t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.

(d) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are more preferred, with a methyl group and a t-butyl group being most preferred.

(e) Particularly preferably, each of X_1 and X_2 is independently a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(f) Particularly preferably, each of Y_1 and Y_2 is independently a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a

hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(g) Particularly preferably, each of G_{11} and G_{12} is independently (G-1), (G-2), (G-3), (G-4), (G-5), (G-6), (G-7), (G-9), (G-10), and (G-11) in the general formula (8). Of them, (G-1), (G-2), (G-3), (G-4), (G-5), and (G-6) are particularly preferred, (G-1), (G-3), (G-4), (G-5), and (G-6) are more preferred, and (G-1), (G-4), and (G-6) are most preferred.

With the azo pigments represented by the foregoing general formulae (1), (3), (4), (5), (6), and (7), azo-hydrazone tautomers thereof can be considered.

Also, in the invention, the azo pigments represented by the general formula (1) preferably have a substituent forming an intramolecular hydrogen bond or an intramolecular cross-linked hydrogen bond. It is preferable to have a substituent forming one or more intramolecular hydrogen bonds, more preferable to have a substituent forming two or more intramolecular hydrogen bonds, still more preferable to have a substituent forming one or more intramolecular hydrogen bonds and one or more intramolecular cross-linked hydrogen bonds, and especially preferable to have a substituent forming two or more intramolecular hydrogen bonds and one or more intramolecular cross-linked hydrogen bonds.

Of the azo pigments represented by the foregoing general formulae (1), (3), (4), (5), (6), and (7), azo pigments represented by the following general formulae (7-1), (7-2) and (7-3) can be illustrated as examples of particularly preferred azo pigments.

As a reason why this structure is preferred, there can be illustrated the fact that, as is shown by the general formula (7-1), the nitrogen atoms constituting the hetero rings contained in the azo pigment structure, hydrogen atoms of the amino group, and hetero atoms (nitrogen atom of the azo group or its tautomer of hydrazone

group and oxygen atom of the carbonyl group or a nitrogen atom of the amino group) tend to easily form at least one or more intramolecular hydrogen bond.

More preferably, as is shown by the following general formula (7-2), the nitrogen atoms constituting the hetero rings contained in the azo pigment structure, hydrogen atoms of the amino group, and hetero atoms (nitrogen atom of the azo group or its tautomer of hydrazone group and oxygen atom of the carbonyl group or a nitrogen atom of the amino group) tend to easily form at least two or more intramolecular hydrogen bonds.

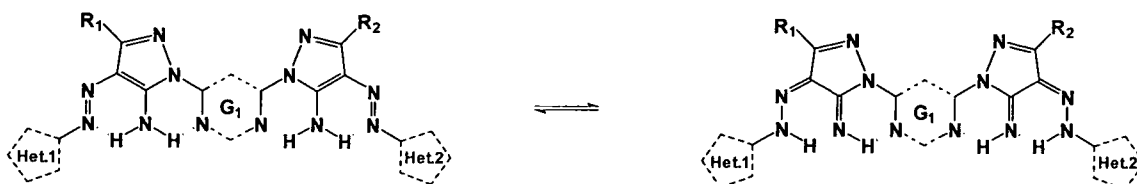
Particularly preferably, as is shown by the following general formula (7-3), the nitrogen atoms constituting the hetero rings contained in the azo pigment structure, hydrogen atoms of the amino group, and hetero atoms (nitrogen atom of the azo group or its tautomer of hydrazone group and oxygen atom of the carbonyl group or a nitrogen atom of the amino group) tend to easily form at least two or more intramolecular hydrogen bond and, in addition, tend to easily form at least one or more intramolecular cross-linked hydrogen bonds.

As a result, flatness of the molecule is enhanced, the intramolecular and intermolecular mutual action is improved, crystallinity of the azo pigment represented by the general formula (7-1), further the general formula (7-2) and, particularly, the general formula (7-3) is enhanced (higher structure of the pigment becoming liable to be easily formed), and hence performances required as pigments, i.e., light fastness, heat stability, moist heat stability, water resistance, gas resistance, and/or solvent resistance, can markedly be improved, thus such pigments being most preferred examples.

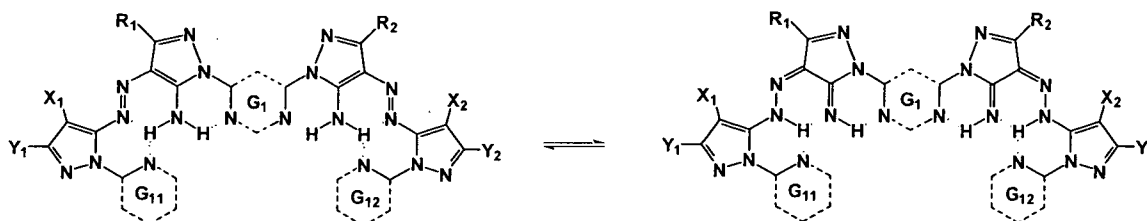
General formula (7-1)



General formula (7-2)



General formula (7-3)



In the general formulae (7-1) to (7-3), R_1 , R_2 , G_1 , Het-1 and Het-2 are respectively the same as R_1 , R_2 , G_1 , Het-1 and Het-2 in the above general formula (1), and G_{11} , G_{12} , X_1 , X_2 , Y_1 and Y_2 are respectively the same as G_{11} , G_{12} , X_1 , X_2 , Y_1 and Y_2 in the general formula (7).

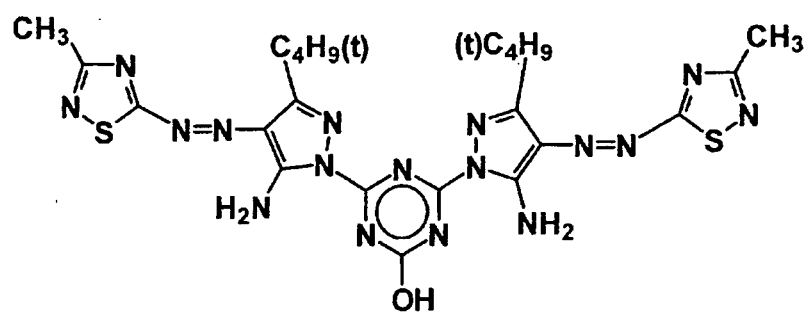
In view of dispersibility of pigments, with the azo pigments represented by the foregoing general formulae (1), (3), (4), (5), (6), and (7), a peak absorption intensity in the range of from 1700 to 1730 cm^{-1} in the IR absorption spectrum is preferably 1/3 or less of a peak absorption intensity in the range of from 1620 to 1670 cm^{-1} . More preferably, λ_{max} exists between 400 and 480 nm, and, most preferably, the above-mentioned absorption intensity ratio is 1/5 or less.

Specific examples of the azo pigments (illustrative azo pigments Fig-1 to

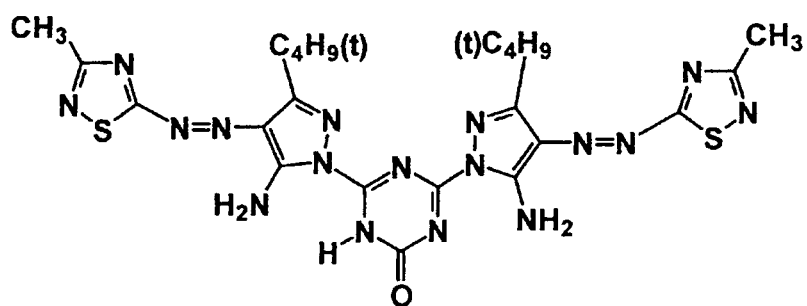
Pig-80) represented by the general formulae (1), (3), (4), (5), (6), and (7) will be shown below which, however, do not limit azo pigments to be used in the invention.

Also, each of the following structures of the specific examples is shown in the limited structural formula selected from several tautomers possible in view of chemical structure. However, needless to say, the pigments may be in other tautomer structures than the described ones.

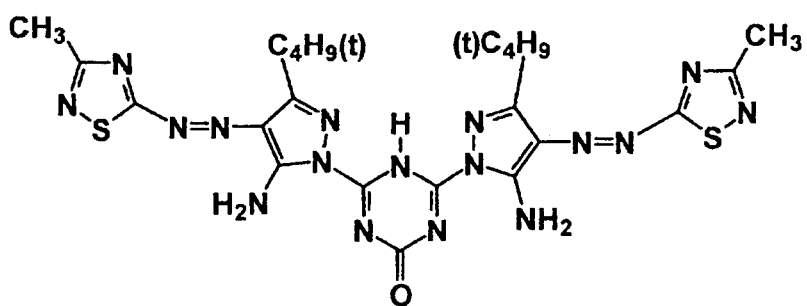
(P i g - 1)



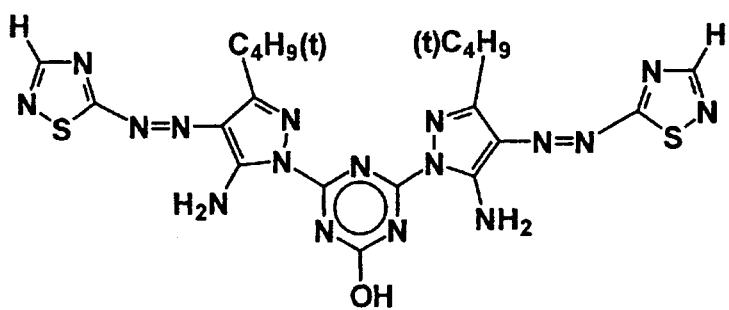
(P i g - 2)



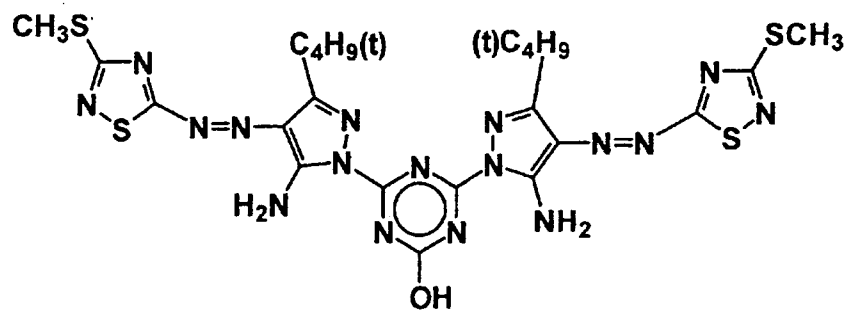
(P i g - 3)



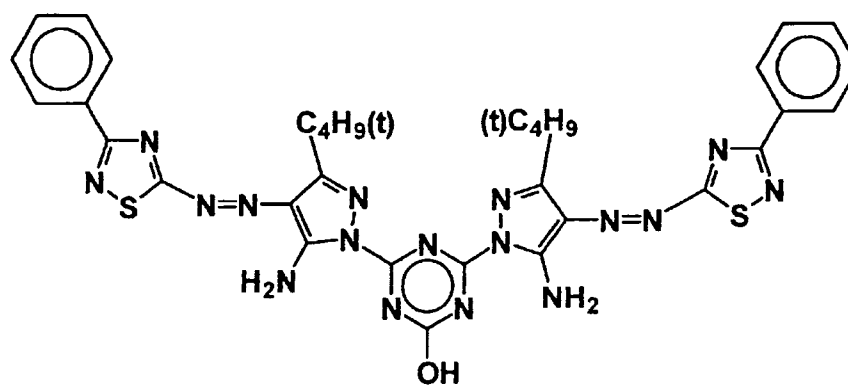
(P i g - 4)



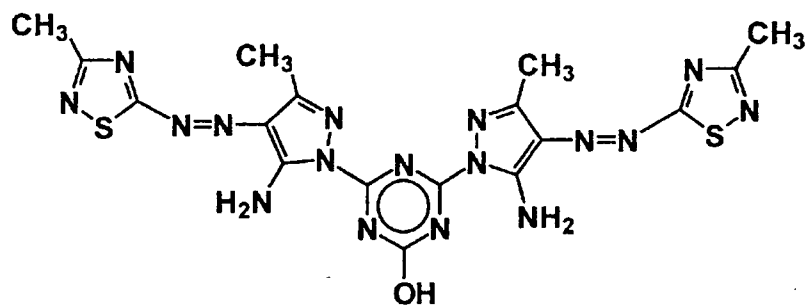
(P i g - 5)



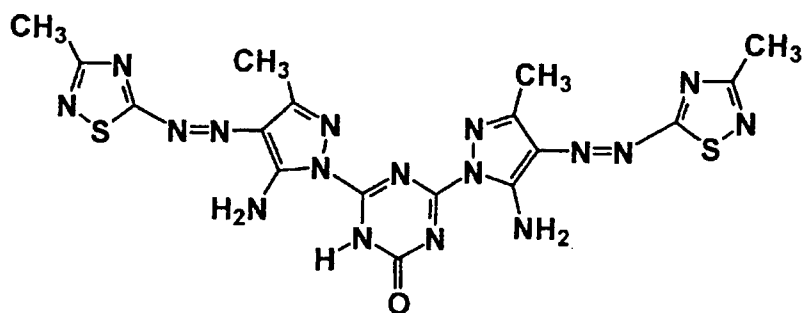
(P i g - 6)



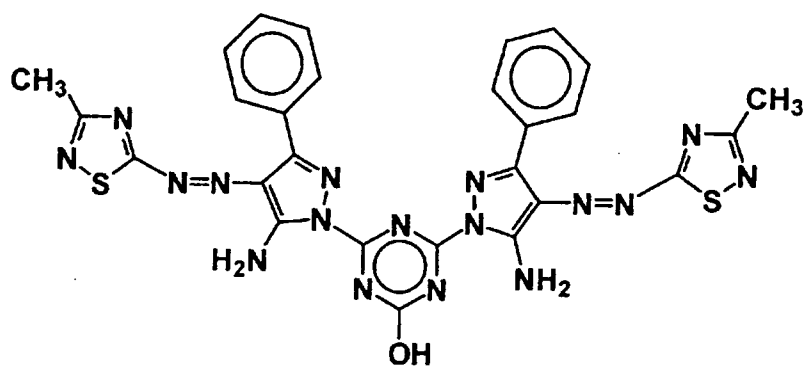
(P i g - 7)



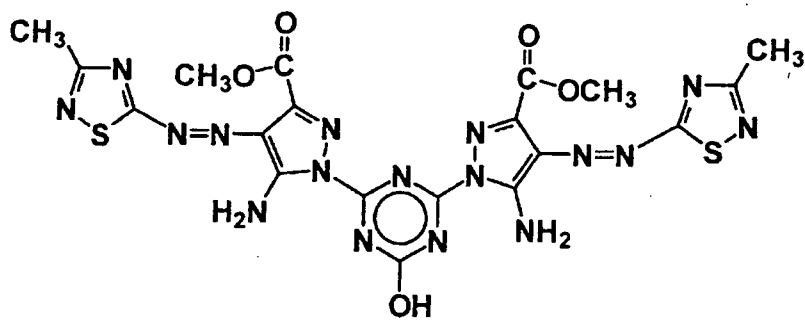
(P i g - 8)



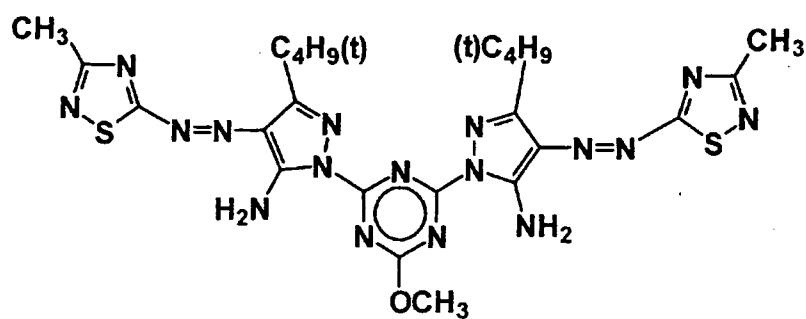
(P i g - 9)



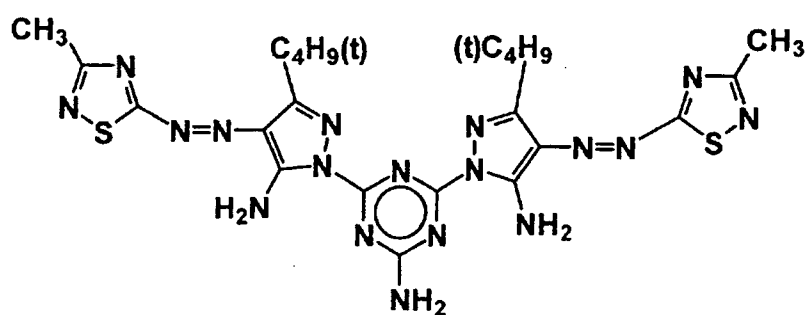
(P i g - 1 0)



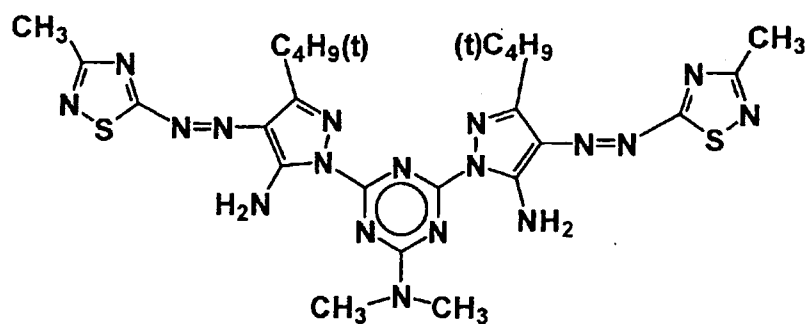
(P i g - 1 1)



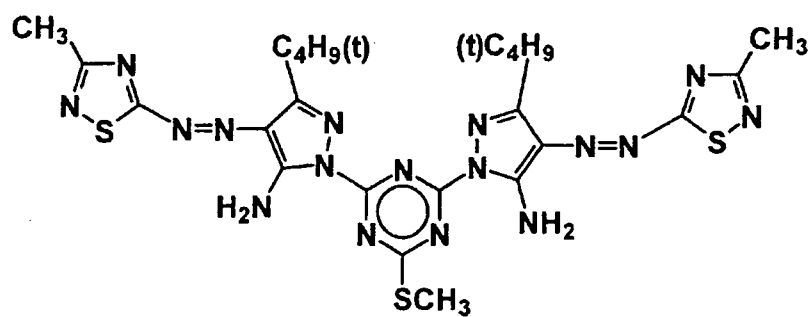
(P i g - 1 2)



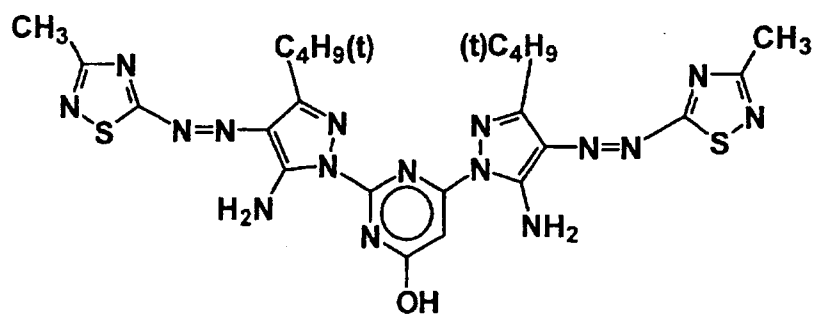
(P i g - 1 3)



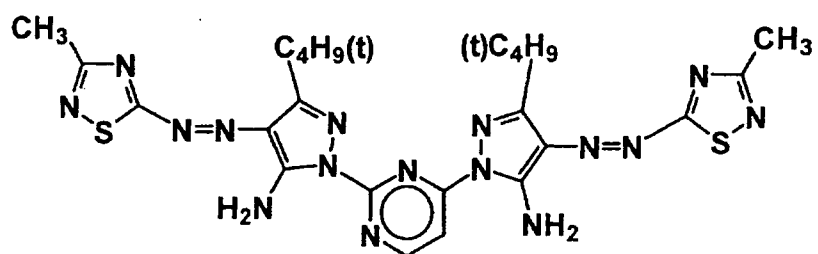
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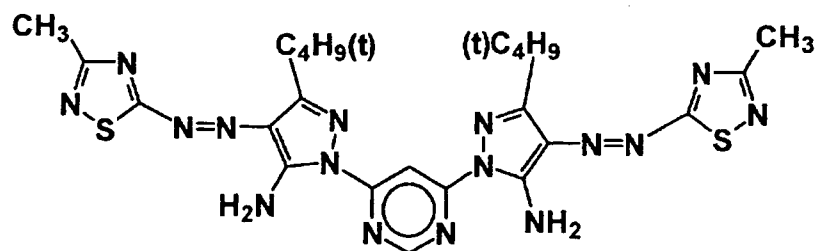
(P i g - 1 5)



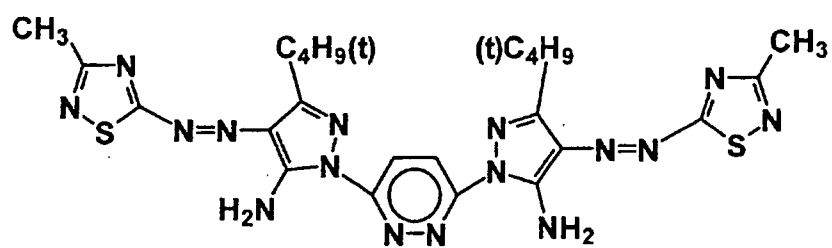
(P i g - 1 6)



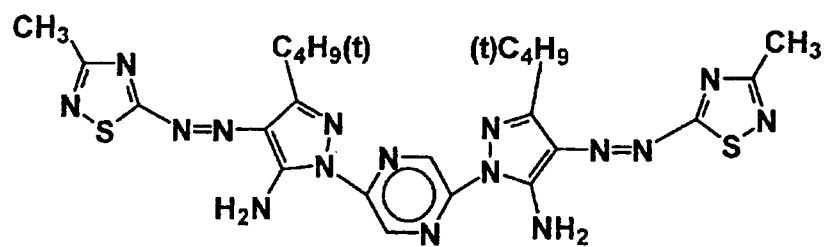
(P i g - 1 7)



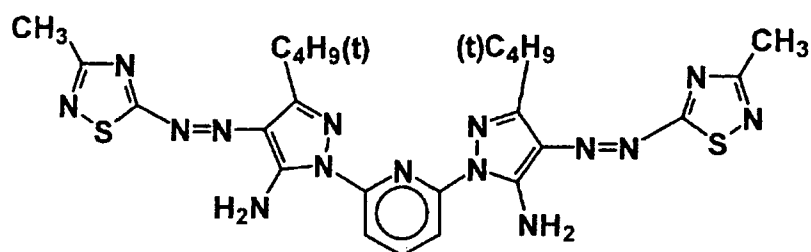
(P i g - 1 8)



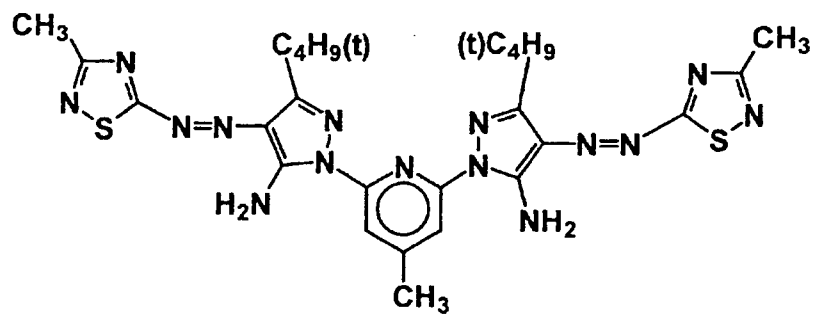
(P i g - 1 9)



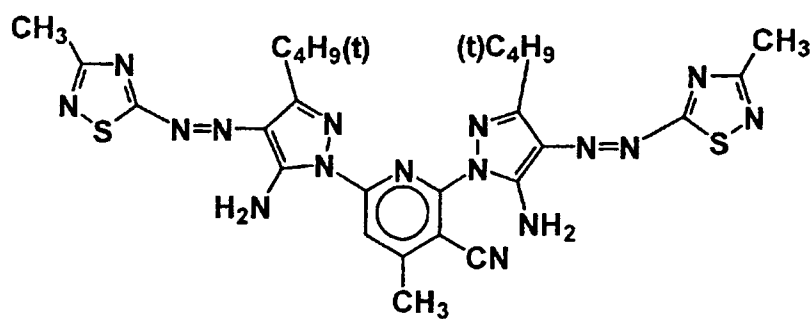
(P i g - 2 0)



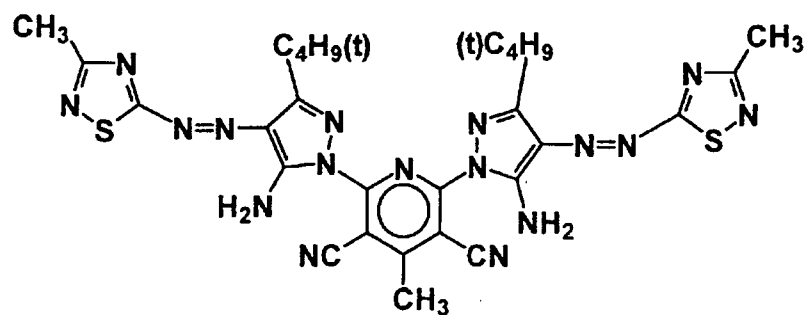
(P i g - 2 1)



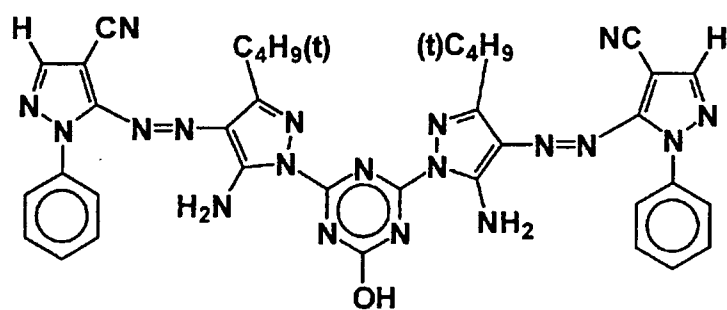
(P i g - 2 2)



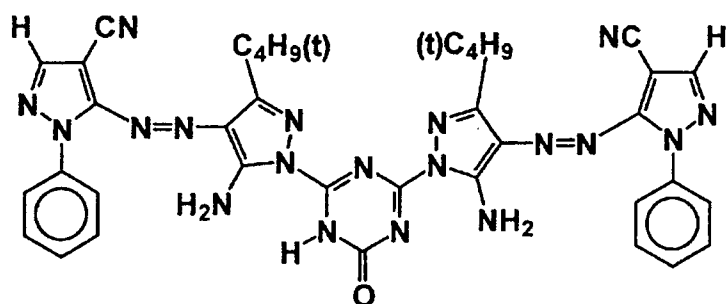
(P i g - 2 3)



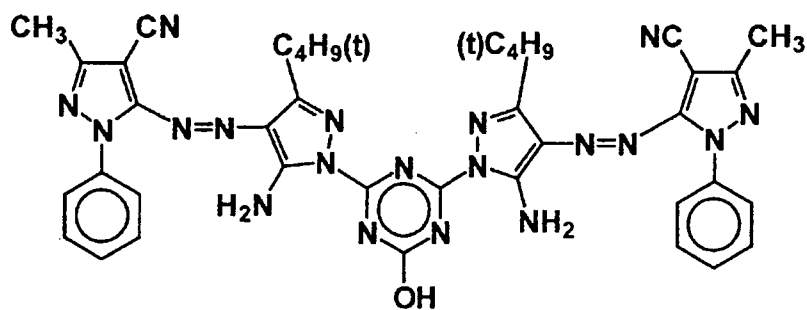
(P i g - 2 4)



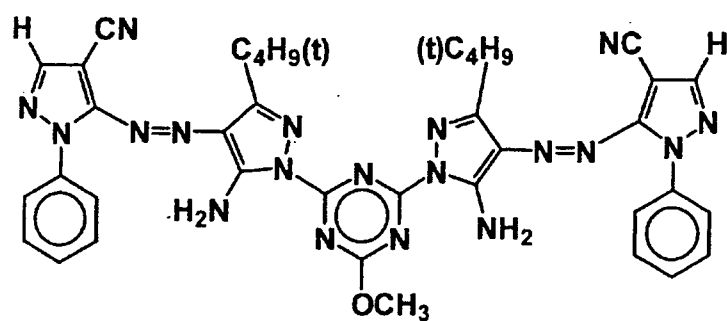
(P i g - 2 5)



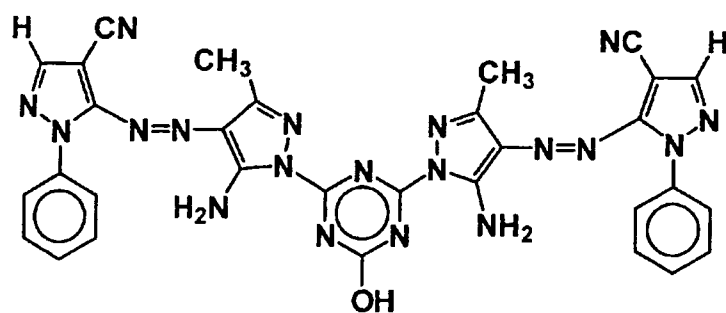
(P i g - 2 6)



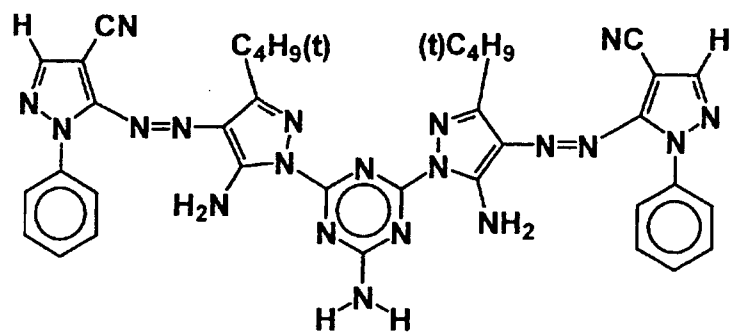
(Fig-27)



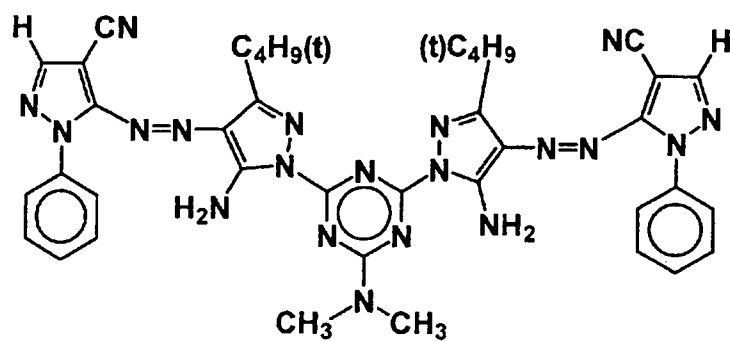
(Fig-28)



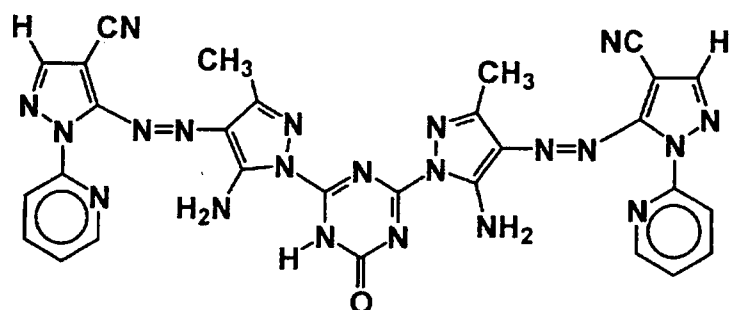
(Fig-29)



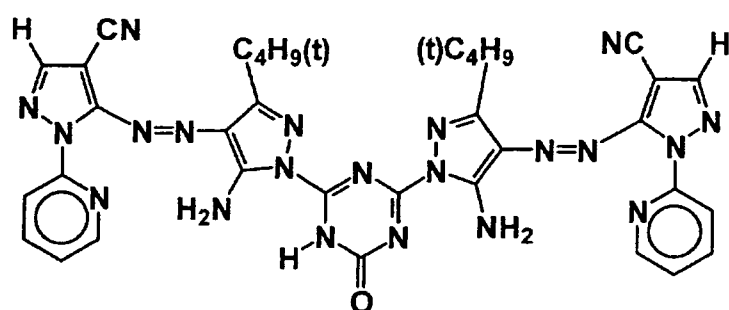
(Fig-30)



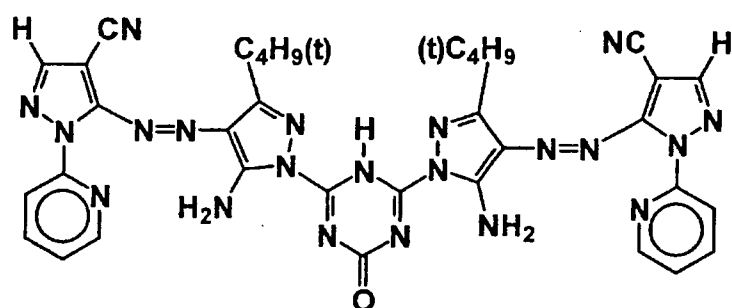
(P i g - 3 1)



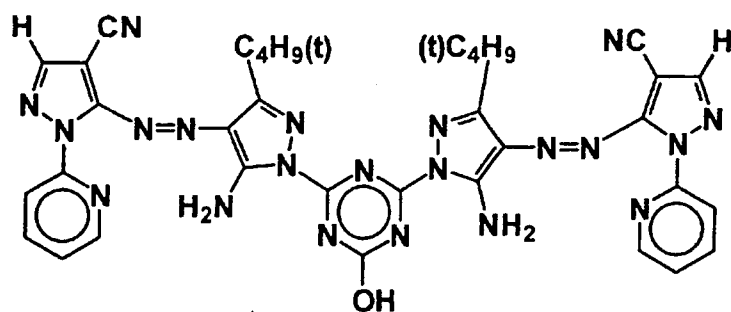
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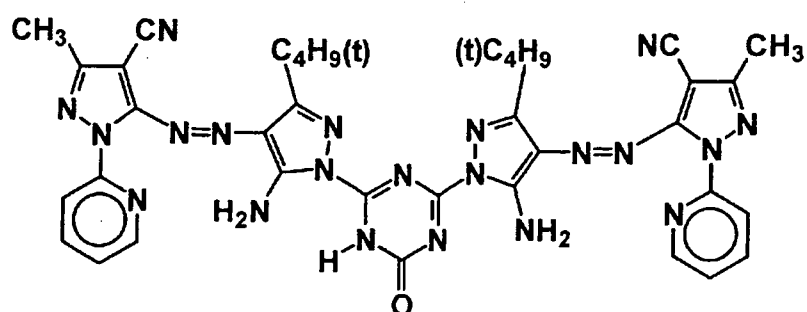
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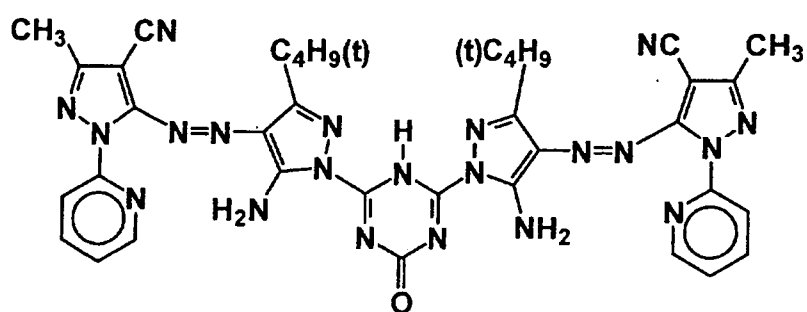
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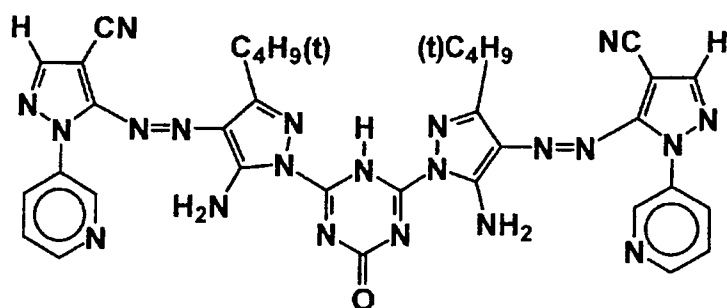
(P i g - 3 5)



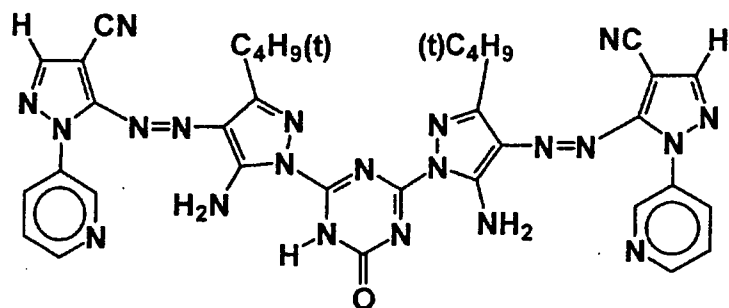
(P i g - 3 6)



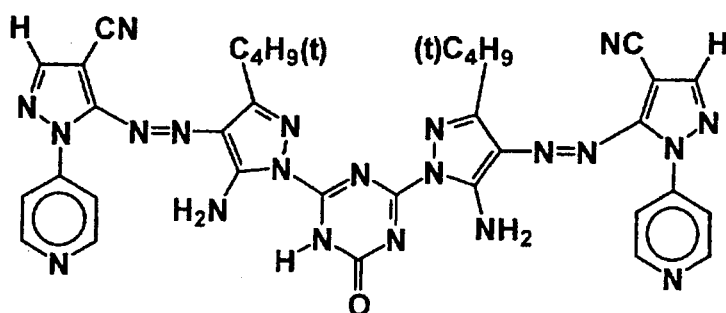
(P i g - 3 7)



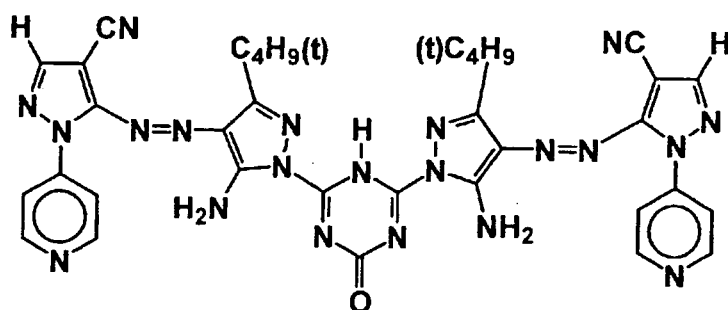
(P i g - 3 8)



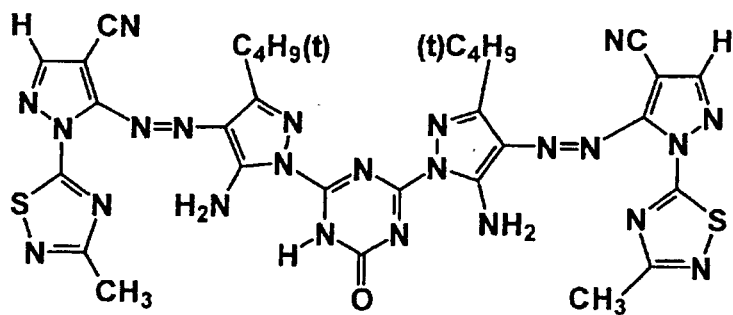
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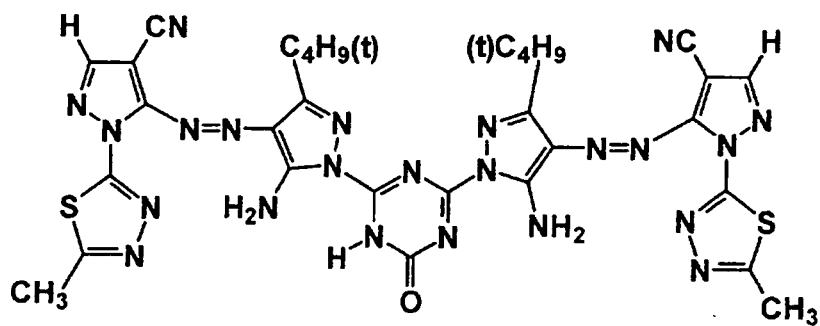
(P i g - 4 0)



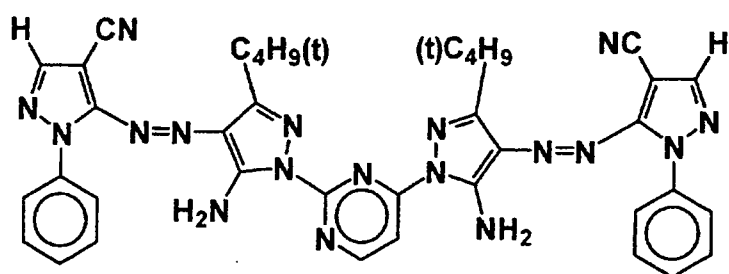
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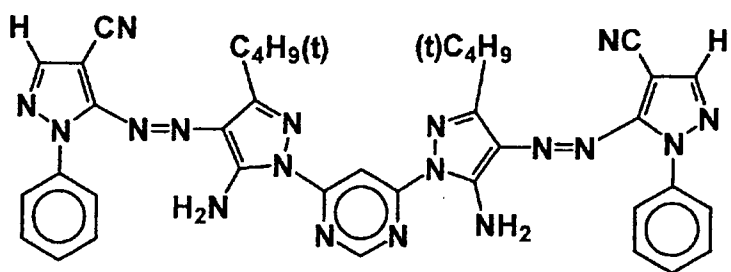
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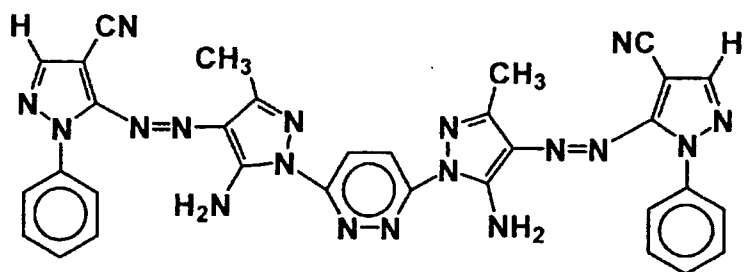
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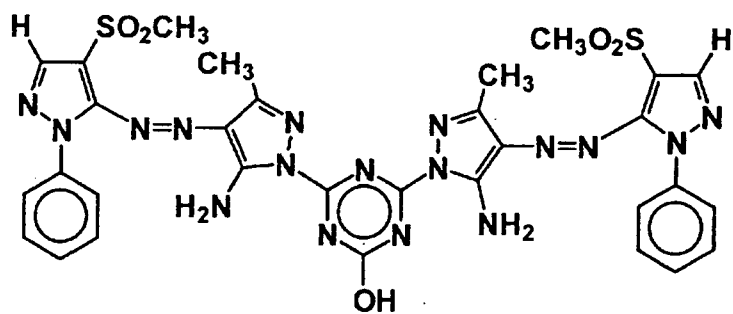
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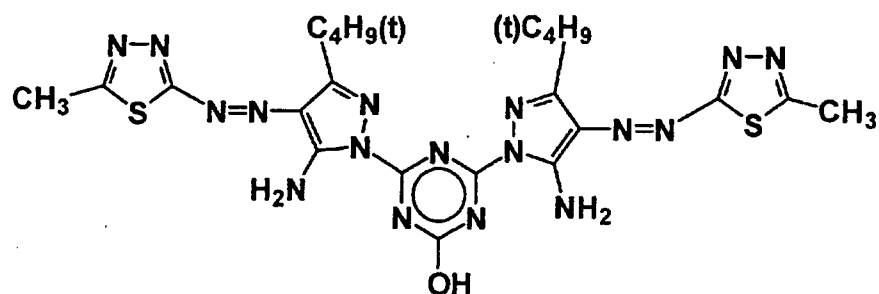
(P i g - 4 5)



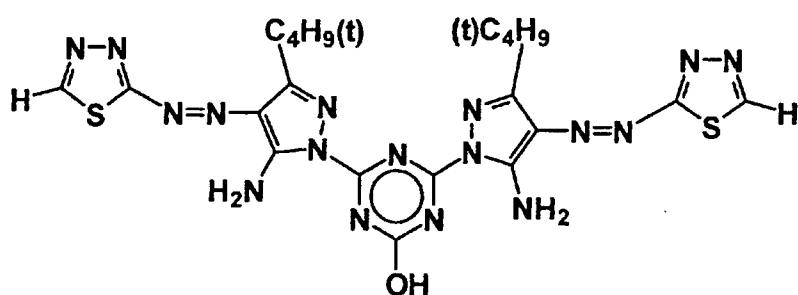
(P i g - 4 6)



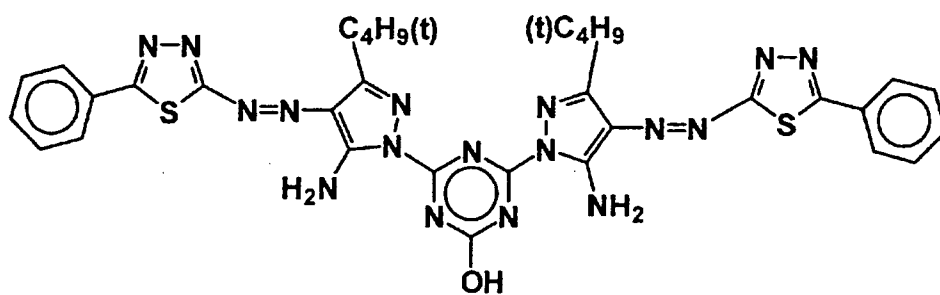
(P i g - 4 7)



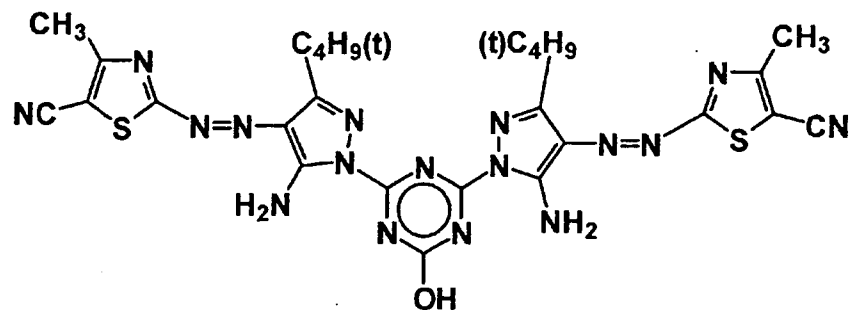
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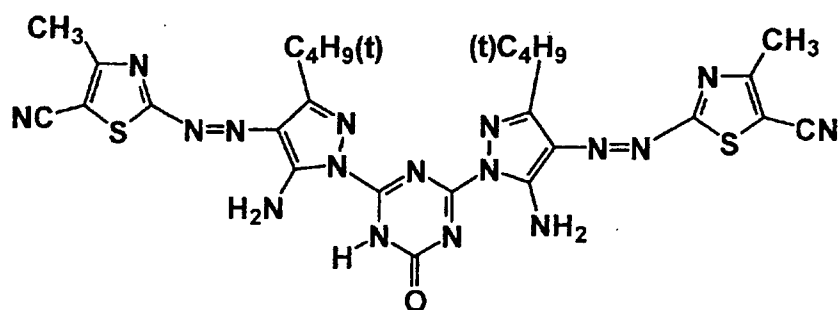
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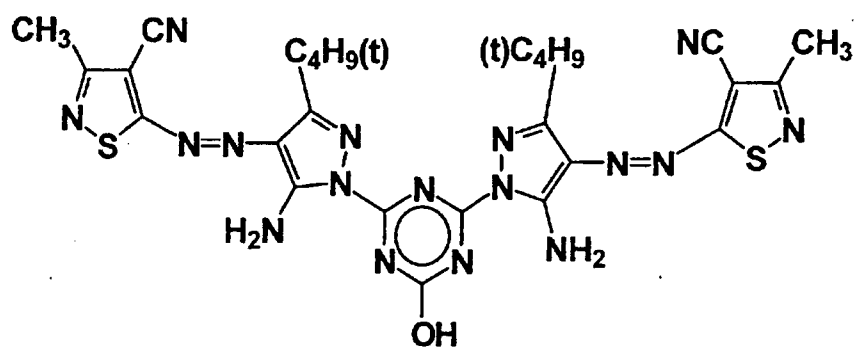
(P i g - 5 0)



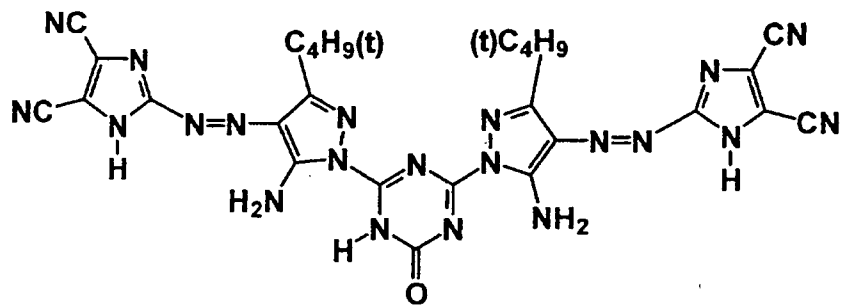
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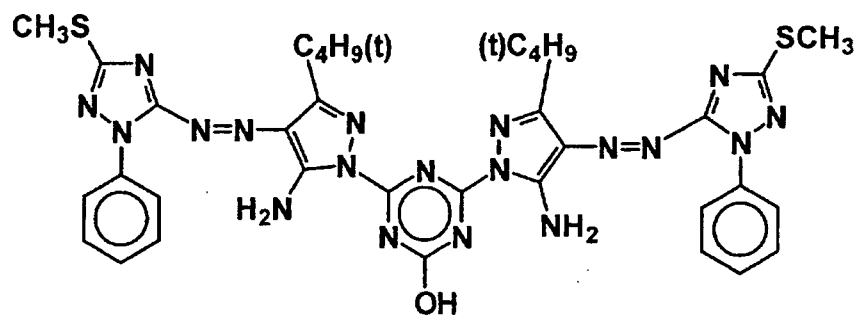
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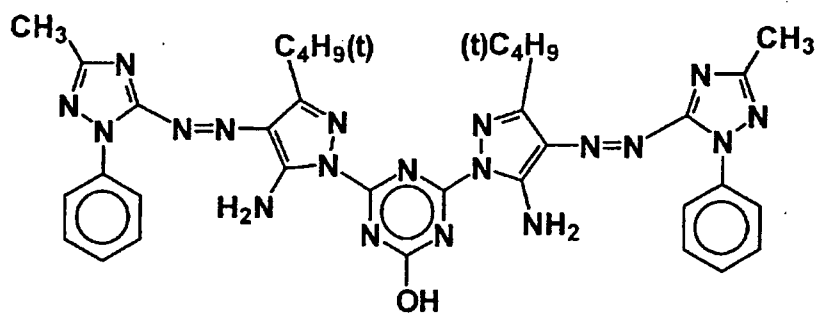
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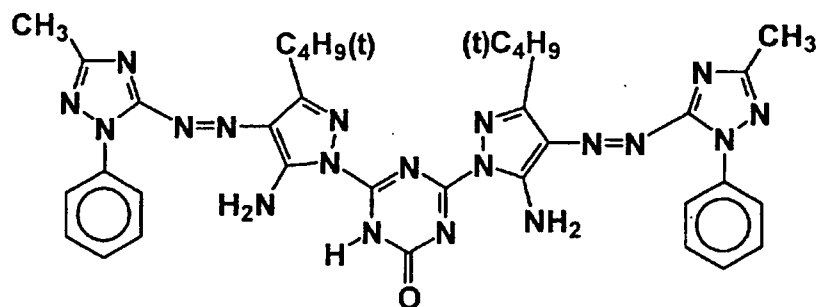
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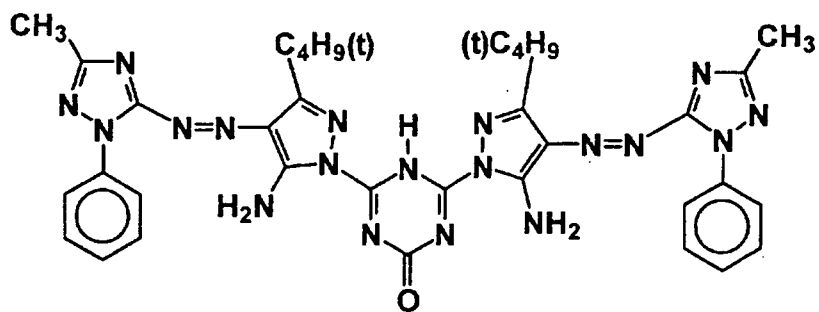
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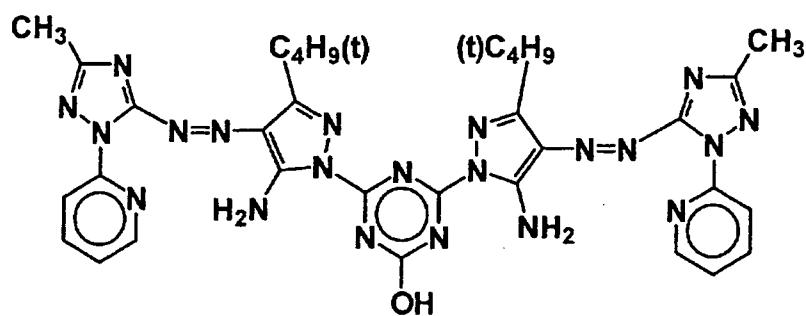
(P i g - 5 6)



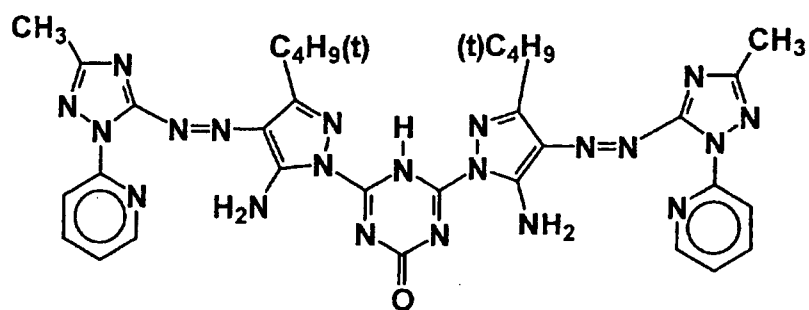
(P i g - 5 7)



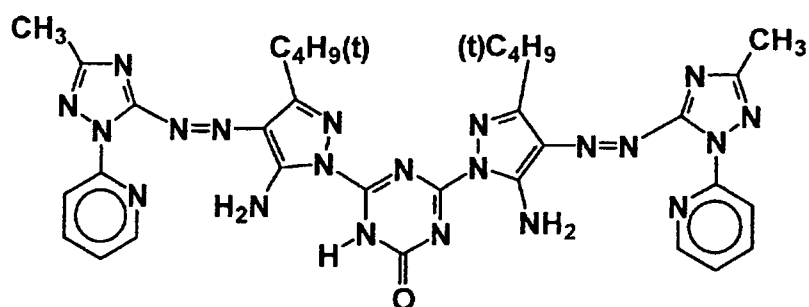
(P i g - 5 8)



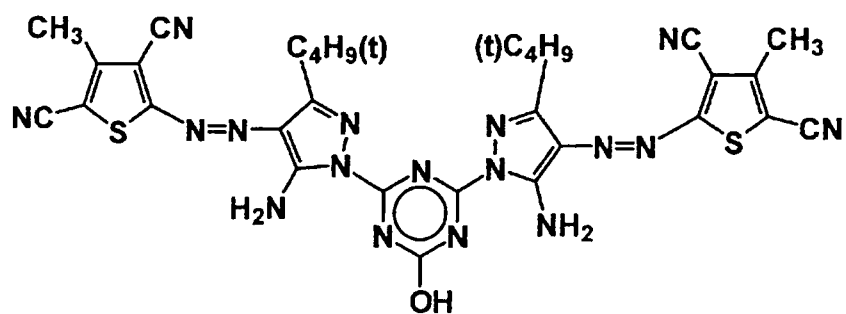
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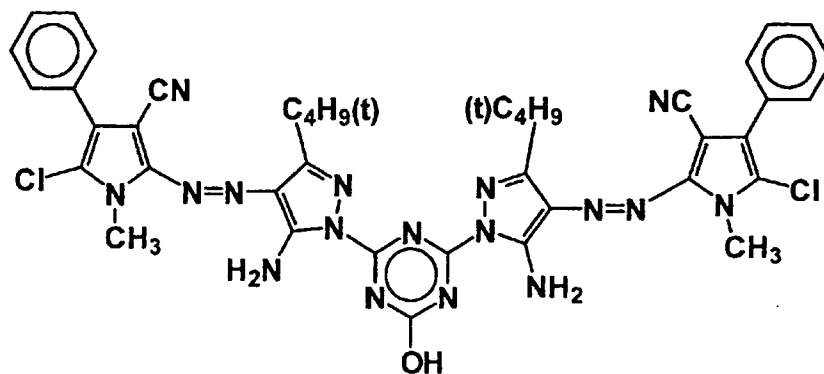
(P i g - 6 0)



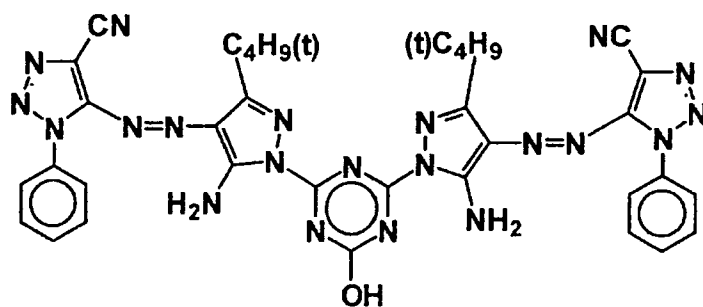
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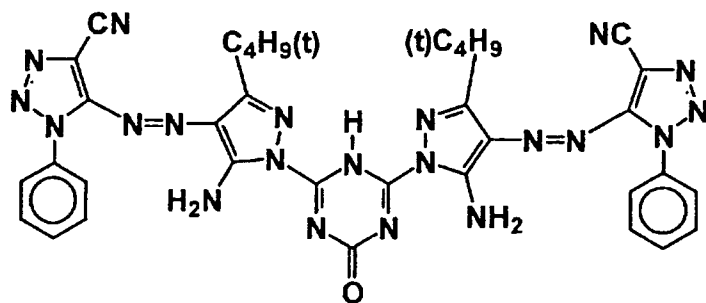
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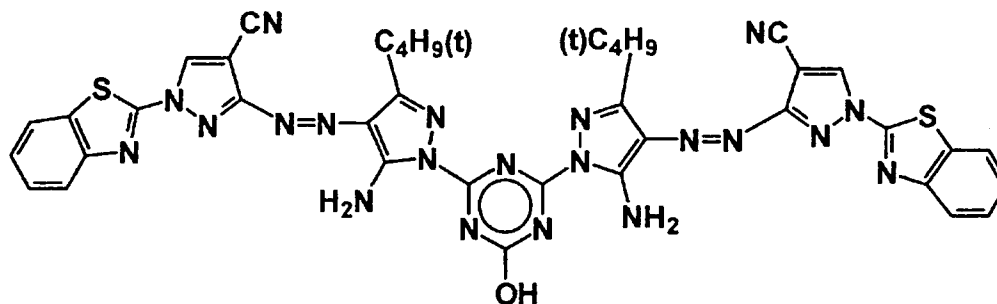
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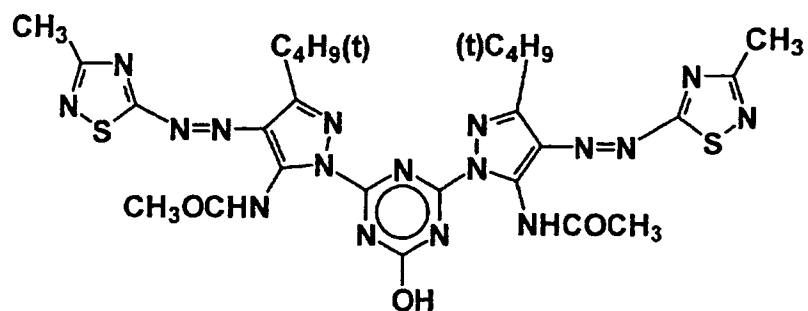
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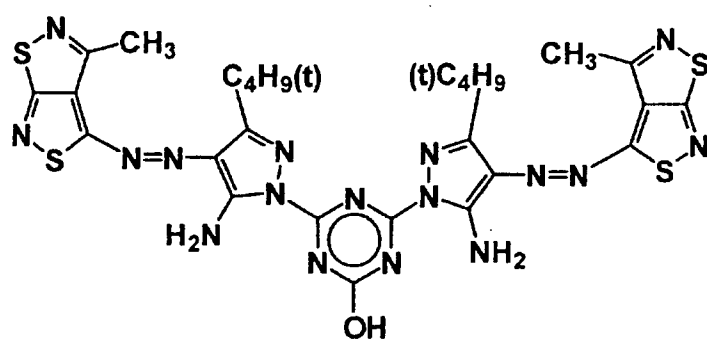
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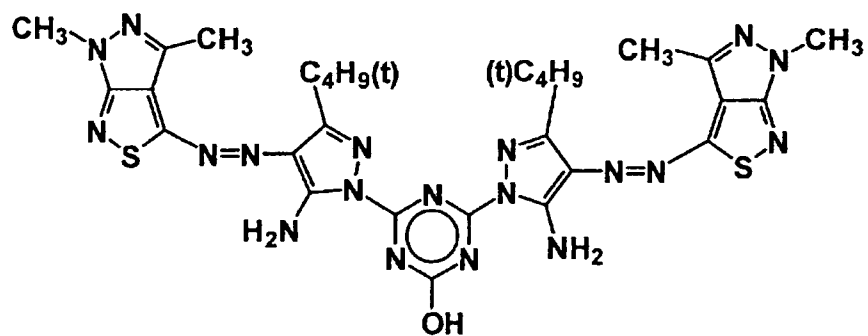
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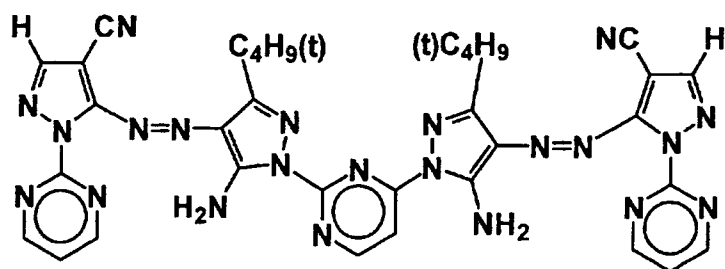
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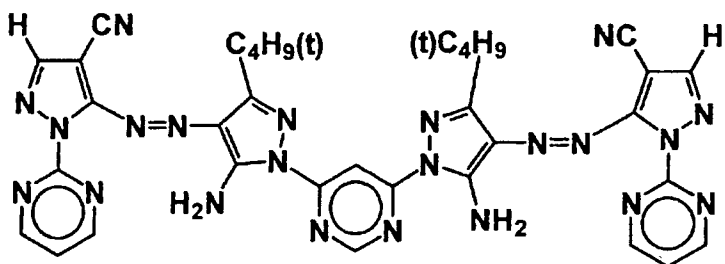
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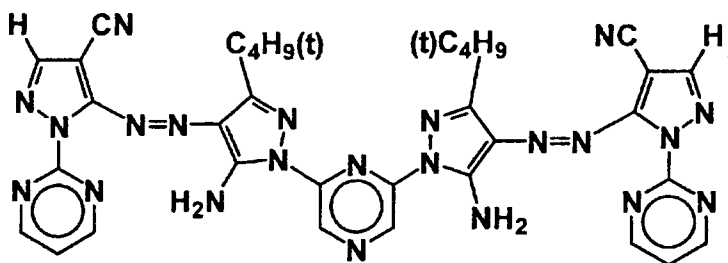
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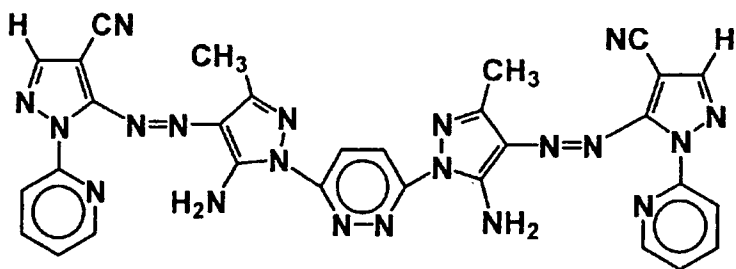
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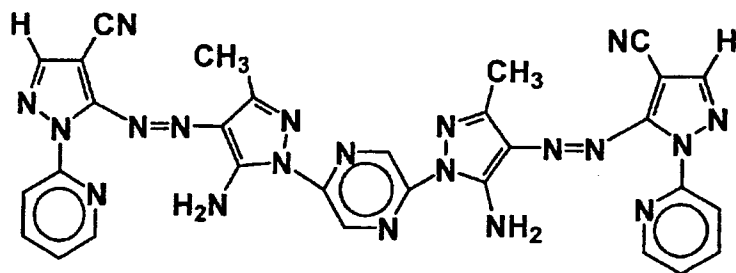
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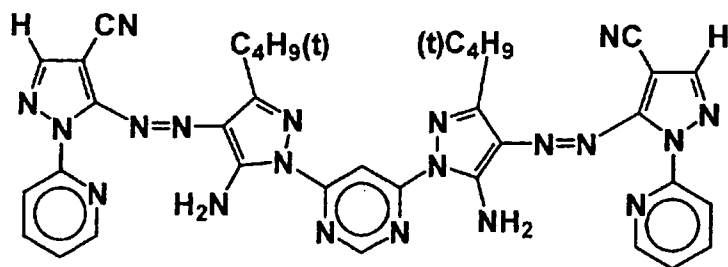
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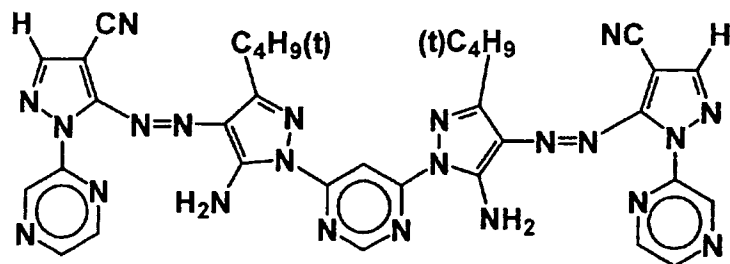
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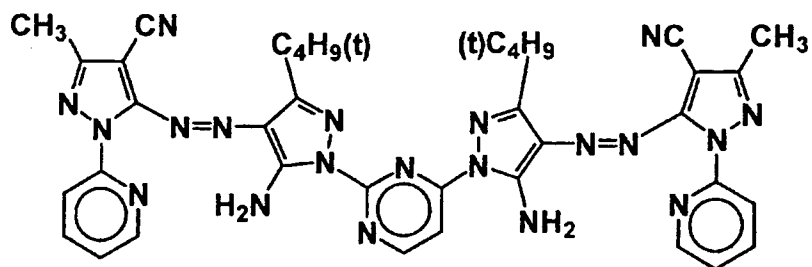
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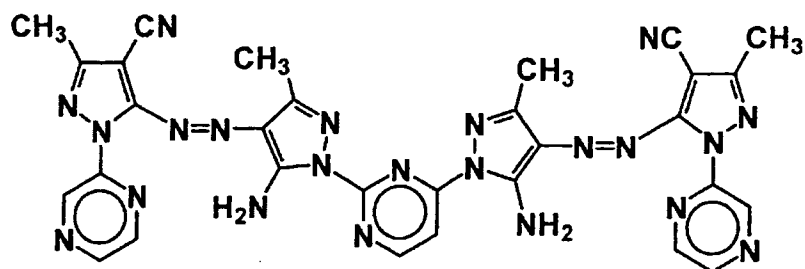
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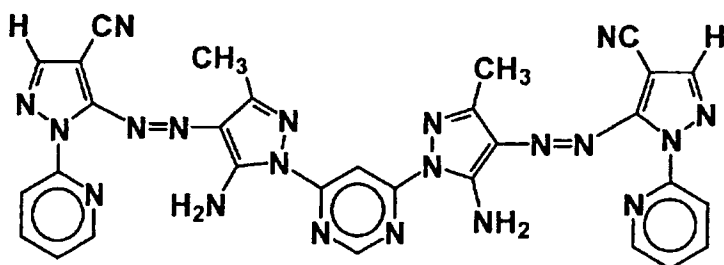
(P i g - 7 6)



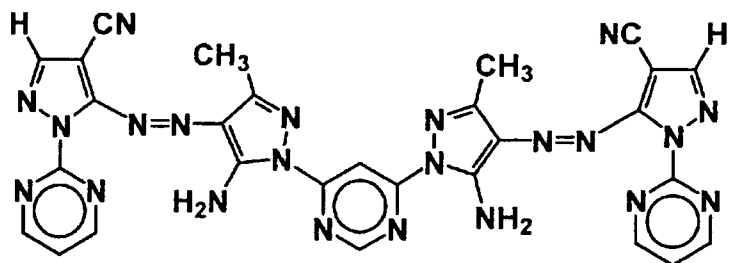
(P i g - 7 7)



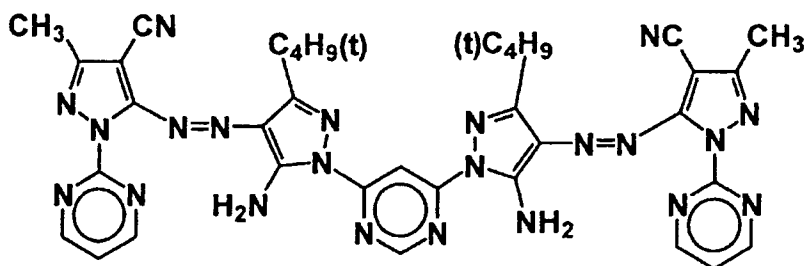
(P i g - 7 8)



(P i g - 7 9)



(P i g - 8 0)



The pigments of the invention represented by the general formulae (1), (3), and (4) to (7) may be in the form of the general formulae (1), (3), and (4) to (7) or may be the tautomers thereof, and may be of any crystal forms called polymorphic forms.

Polymorphism means that crystals having the same chemical composition can

be different from each other in the conformation of building block (molecules or ions) in the crystal. Chemical and physical properties of the pigments are decided by the crystal structure, and polymorphic forms of the same pigment can be discriminated from each other by rheology, color, and other color characteristics. Also, different polymorphic forms can be confirmed by X-Ray Diffraction (results of powder X-ray diffractometry) or by X-Ray Analysis (results of X-ray analysis of crystal structure).

In the case where the pigments of the invention represented by the general formulae (1), (3), and (4) to (7) exhibit polymorphism, they may be in any polymorphic forms and may be a mixture of two or more polymorphic forms.

With those which have acid groups among the azo pigments of the invention represented by the general formulae (1), (3), and (4) to (7), part or all of the acid groups may be in a salt form, or the pigment may be a mixture of a salt type pigment and a free acid type pigment. Examples of the salt type include salts of an alkali metal such as Na, Li or K, salts of ammonium optionally substituted by an alkyl group or a hydroxyalkyl group, and salts of an organic amine. Examples of the organic amine include a lower alkyl amine, a hydroxyl-substituted lower alkyl amine, a carboxy-substituted lower alkyl amine, and a polyamine having from 2 to 10 alkyleneimine units containing from 2 to 4 carbon atoms. With these salt type pigments, they are not necessarily limited to one as to kind, but may be in a mixture of two or more thereof.

Further, as to the structure of the pigment to be used in the invention, in the case where plural acid groups exist in one molecule, the plural acid groups may be of a salt type or an acid type, and may be different from each other.

The azo pigments represented by the general formulae (1), (3), and (4) to (7) may be hydrates which contain water molecules within the crystal.

With the azo pigments of the invention represented, for example, by the general formula (6), various tautomers and/or polymorphic forms exist, and the azo pigments of different forms show, for example, different absorption patterns of IR absorption spectrum.

To illustrate this, two absorption patterns of IR absorption spectrum with dye 2 are shown in Figs. 1 and 2.

Absorption intensity in the range of from 1700 to 1730 cm^{-1} is largely different between the absorption pattern of Fig. 1 and the absorption pattern of Fig. 2.

Hereinafter, crystals showing no absorption in the range between 1700 and 1730 cm^{-1} are referred to as type α , and crystals showing a strong absorption in the range between 1700 and 1730 cm^{-1} are referred to as type β .

Both of a pigment dispersion prepared by using an α -type azo pigment and a pigment dispersion prepared by using a β -type azo pigment are included in the pigment dispersion of the invention. However, a pigment dispersion prepared by using the α -type azo pigment shows better dispersibility, thus being preferred.

The azo pigments represented by the general formula (1) can be produced according to the following process. That is, a heterocyclic amine represented by the following general formula (9) is diazotized;

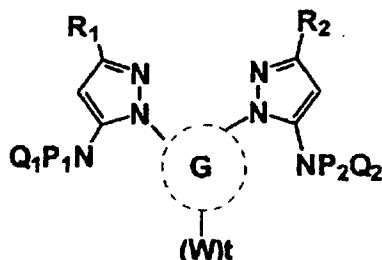
General formula (9):



wherein Het is the same as the heterocyclic group selected from the aromatic heterocyclic groups represented by the general formula (10), and * shows the point of attachment to the amino group in the general formula (9), and subsequently the resulting diazonium is coupled with a compound represented by the following general formula (11) to thereby produce an azo pigment represented by

the general formula (1);

General formula (11):



wherein each of R₁, R₂, P₁, P₂, Q₁, and Q₂ independently represents a hydrogen atom or a monovalent substituent, G represents the non-metallic atoms necessary to complete a 5- or 6-membered heterocyclic group, W represents a substituent capable of binding to the heterocyclic group constituted by G, and t represents an integer of from 0 to 4.

In the general formula (9), Het is the same as Het-1 and Het-2 in the general formula (1), and preferred examples thereof are also the same as described there. The asterisk * shows the point of attachment to the amino group in the general formula (9).

In the general formula (11), R₁, R₂, P₁, P₂, Q₁, and Q₂ are the same as R₁, R₂, P₁, P₂, Q₁, and Q₂ in the general formula (1), and preferred examples thereof are also the same as described there.

Examples of the substituent of G are the same as those of G in the general formula (1), and preferred examples thereof are also the same as described there.

Examples of the substituent W are the same as those of W in the general formula (1), and preferred examples thereof are also the same as described there.

Examples of t are the same as those of t in the general formula (1), and preferred examples thereof are also the same as described there.

With respect to a preferred combination of the substituents in the

intermediates of the pigment of the invention represented by the general formulae (9) and (11), those compounds are preferred wherein at least one of the various substituents is the preferred group having been described hereinbefore, those compounds are more preferred wherein more of the various substituents are the preferred groups having been described hereinbefore, and those compounds are most preferred wherein all of the substituents are the preferred groups having been described hereinbefore.

Particularly preferred combinations of the intermediates for the azo pigments of the invention, represented by the general formulae (9) and (11), contain the following (a) to (k).

(a) G is preferably a 5- or 6-membered, nitrogen-containing heterocyclic group and, to illustrate without restricting the substitution positions, an s-triazine ring, a pyrimidine ring, a pyridazine ring, a pyrazine ring, a pyridine ring, an imidazole ring, a pyrazole ring, and a pyrrole ring are preferred. Of these, an s-triazine ring, a pyrimidine ring, a pyridazine ring, and a pyrazine ring are preferred, with a 2,3-pyridazine ring, a 2,4-pyrimidine ring, a 2,5-pyrazine ring, a 2,6-pyrimidine ring, and an s-triazine ring being most preferred.

(b) W is preferably a hydroxyl group, a cyano group, a substituted or unsubstituted carbamoyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, a substituted or unsubstituted aryloxy group, a substituted or unsubstituted alkylthio group, or a substituted or unsubstituted arylthio group, and a hydroxyl group, a substituted or unsubstituted amino group, a substituted or unsubstituted alkoxy group, and a substituted or unsubstituted alkylthio group are particularly preferred, with a hydrogen atom, a hydroxyl group, and an amino group being most preferred.

- (c) t represents an integer of from 0 to 4, preferably from 0 to 2, more preferably 1 or 2, most preferably 1.
- (d) Preferably, each of R_1 and R_2 is independently a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms is preferred, and a methyl group and a sec- or tert-alkyl group are preferred, with a methyl group and a t-butyl group being most preferred.
- (e) Preferably, each of P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted acyl group, a substituted or unsubstituted alkylsulfonyl group, or a substituted or unsubstituted arylsulfonyl group. Particularly preferred are a hydrogen atom, a substituted or unsubstituted alkyl group, and a substituted or unsubstituted acyl group. Of them, a hydrogen atom is particularly preferred.
- (f) Preferably, each of Het-1 and Het-2 is independently selected from the aromatic heterocyclic groups (1) to (15) represented by the foregoing general formula (2). Of them, (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11) are preferred, (2), (5), (6), (7), (8), (9), and (10) are particularly preferred, (2), (5), (6), (7), and (10) are more preferred, and (2) and (7) are still more preferred, with (2) being most preferred.
- (g) Particularly preferred examples of X are a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, and a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group and an alkylsulfonyl group containing from 1 to 12 carbon atoms are preferred, and a cyano group is most preferred.

(h) Y is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing a total of from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, and a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are particularly preferred, with a hydrogen atom being most preferred.

(i) Z is preferably a hydrogen atom, a substituted or unsubstituted alkyl group, a substituted or unsubstituted cycloalkyl group, a substituted or unsubstituted alkenyl group, a substituted or unsubstituted alkynyl group, a substituted or unsubstituted aralkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted heterocyclic group. Of them, a substituted or unsubstituted aryl group and a substituted or unsubstituted heterocyclic group are preferred, a substituted or unsubstituted heterocyclic group is particularly preferred, and a substituted or unsubstituted, nitrogen-containing heterocyclic group is most preferred.

(j) W_0 is particularly preferably a cyano group, an alkylsulfonyl group containing from 1 to 12 carbon atoms, an arylsulfonyl group containing from 6 to 18 carbon atoms, or a sulfamoyl group containing from 0 to 12 carbon atoms. Of them, a cyano group, a methanesulfonyl group, and a phenylsulfonyl group are preferred, with a cyano group being most preferred.

(k) Each of W_1 to W_4 is preferably a hydrogen atom, a substituted or unsubstituted alkyl group containing a total of from 1 to 12 carbon atoms, a substituted or unsubstituted aryl group containing from 6 to 18 carbon atoms, or a substituted or unsubstituted heterocyclic group containing a total of from 4 to 12 carbon atoms. Of

them, a hydrogen atom and a straight or branched alkyl group containing a total of from 1 to 8 carbon atoms are preferred, a hydrogen atom and an alkyl group containing from 1 to 8 carbon atoms are more preferred, and a hydrogen atom is most preferred.

Synthesis of the azo pigments of the invention will be described in detail below.

The azo pigments of the invention can be synthesized, for example, by coupling reaction between a diazonium salt, prepared by diazotization of a diazo component of the general formula (9) in a conventionally known manner, and a coupling component of the general formula (11).

Preparation of the diazonium salt and the coupling reaction can be conducted in a conventional manner.

In preparing the diazonium salt of the general formula (9), there can be applied a conventional process for synthesizing a diazonium salt of the general formula (9), for example, by using a nitrosonium ion source, for example, nitrous acid, nitrous acid salt or nitrosylsulfuric acid in a reaction medium containing an acid (for example, hydrochloric acid, sulfuric acid, phosphoric acid, acetic acid, propionic acid, methanesulfonic acid or trifluoromethanesulfonic acid).

As more preferred examples of the acid, there can be illustrated acetic acid, propionic acid, methanesulfonic acid, phosphoric acid, and sulfuric acid, which may be used alone or in combination thereof. Of these, a system containing phosphoric acid or a combination of acetic acid and sulfuric acid is particularly preferred.

As the reaction medium (solvent), organic acids and inorganic acids are preferred to use. In particular, phosphoric acid, sulfuric acid, acetic acid, propionic acid, and methanesulfonic acid are preferred. Of them, acetic acid and/or propionic acid is preferred.

As to a preferred example of the nitrosonium ion source, use of nitrosylsulfuric acid in a reaction medium containing the above-mentioned preferred acid enables one to prepare the diazonium salt with stability and efficiency.

The amount of the solvent to be used for the diazo component of the general formula (9) is preferably a 0.5- to 50-fold amount by weight, more preferably a 1- to 20-fold amount by weight, particularly preferably a 3- to 10-fold amount, based on the diazo component.

In the invention, the diazo component of the general formula (9) may be dispersed in the solvent, or may be in a state of solution depending upon kind of the diazo component.

The amount of nitrosonium ion source to be used is preferably from 0.95 to 5.0 equivalents, more preferably from 1.00 to 3.00 equivalents, particularly preferably from 1.00 to 1.10, based on the diazo component.

The reaction temperature is preferably from -15°C to 30°C, more preferably from -10°C to 10°C, still more preferably from -5°C to 5°C. In case when the temperature is lower than -10°C, the reaction rate becomes so small that the synthesis takes a seriously prolonged period, thus such temperature not being economical. Also, in case when the synthesis is conducted at a high temperature exceeding 30°C, amounts of by-products are increased, thus such temperature not being preferred.

The reaction time is preferably from 30 minutes to 300 minutes, more preferably from 30 minutes to 200 minutes, still more preferably from 30 minutes to 150 minutes.

The coupling reaction can be performed in an acidic to basic reaction medium. With the azo pigments of the invention, the coupling reaction is preferably performed in an acidic to neutral reaction medium. In particular, when the coupling reaction is

performed in an acidic reaction medium, the diazonium salt can be converted to the azo pigment effectively with suppressing decomposition of the diazonium salt.

As preferred examples of the reaction medium (solvent), organic acids, inorganic acids, and organic solvents may be used, with organic solvents being particularly preferred. Those solvents are preferred which do not cause liquid separation phenomenon upon reaction but provide a uniform solution. Examples thereof include alcoholic organic solvents such as methanol, ethanol, propanol, isopropanol, butanol, t-butyl alcohol, and amyl alcohol; ketone series organic solvents such as acetone and methyl ethyl ketone; diol series organic solvents such as ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, and 1,3-propanediol; ether series organic solvents such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and ethylene glycol diethyl ether; tetrahydrofuran; dioxane; and acetonitrile. These solvents may be used as a mixed solution of two or more thereof.

Preferred are organic solvents having a polar parameter (ET) of 40 or more. Of them, glycol series solvents having two or more hydroxyl groups in the solvent molecule and alcoholic solvents containing 3 or less carbon atoms, preferably 2 or less carbon atoms (for example, methanol and ethylene glycol) are preferred. Mixed solvents of these solvents are also included.

The amount of the solvent to be used is preferably a 1- to 100-fold amount by weight, more preferably a 1- to 50-fold amount by weight, still more preferably a 2- to 10-fold amount by weight, based on the coupling component represented by the general formula (11).

In the invention, the coupling component of the general formula (7) may be dispersed in the solvent, or may be in a state of solution depending upon kind of the

coupling component.

The coupling component is to be used in such amount that the amount of the diazo component per azo-coupling position becomes preferably from 0.95 to 5.0 equivalents, more preferably from 1.00 to 3.00 equivalents, particularly preferably from 1.00 to 1.50 equivalents.

The reaction temperature is preferably from -30°C to 30°C, more preferably from -15°C to 10°C, still more preferably from -10°C to 5°C. In case when the temperature is lower than -30°C, the reaction rate becomes so small that the synthesis takes a seriously prolonged period, thus such temperature not being economical. Also, in case when the synthesis is conducted at a high temperature exceeding 30°C, amounts of by-products are increased, thus such temperature not being preferred.

The reaction time is preferably from 30 minutes to 300 minutes, more preferably from 30 minutes to 200 minutes, still more preferably from 30 minutes to 150 minutes.

In the process of synthesizing the azo pigment of the invention, the product (crude azo pigment) obtained by these reactions can be used after subjecting the product to ordinary after-treatments of organic synthesis reactions and subsequent purification or without purification.

That is, the product liberated from the reaction system can be used without further purification or after purification procedures of recrystallization, salt formation, and the like, which may be conducted alone or in combination thereof.

It is also possible to remove, after completion of the reaction, the reaction solvent by distillation or, without distillation, pour the reaction product into water or ice-water, collect the liberated product after or without neutralization, or extract the neutralized or non-neutralized reaction solution with an organic solvent/an aqueous

solution, and conduct purification procedures of recrystallization, crystallization, salt formation, and the like, which procedures may be conducted alone or in combination of two or more thereof, thus obtaining a product for use.

The process for synthesizing the azo pigment of the invention will be described in more detail below.

The process for synthesizing the azo pigment of the invention is characterized by conducting the coupling reaction between the diazonium compound prepared by diazotization of the heterocyclic amine represented by the general formula (9) and the compound represented by the general formula (11) after dissolving the compound of the general formula (11) in an organic solvent.

The diazotization reaction of the heterocyclic amine represented by the general formula (9) can be conducted, for example, by reacting it with a reagent such as sodium nitrite or nitrosylsulfonic acid in an acidic solvent such as sulfuric acid, phosphoric acid or acetic acid at a temperature of 15°C or less for about 10 minutes to about 6 hours. The coupling reaction is preferably conducted by reacting the diazonium salt obtained by the above-mentioned process with the compound represented by the general formula (11) at 40°C or less, preferably 15°C or less, for about 10 minutes to about 12 hours.

The tautomerism and the polymorphism can be controlled through production conditions upon the coupling reaction. As a process for producing more preferred α -form crystals, for example, the process of the invention is preferred wherein the compound represented by the general formula (11) is once dissolved in an organic solvent, and then the coupling reaction is conducted. As the organic solvent which can be used in this reaction, there are illustrated, for example, alcohol solvents. Preferred examples of the alcohol solvents include methanol, ethanol, isopropanol,

ethylene glycol, and diethylene glycol. Of these, methanol is particularly preferred.

Another process for producing the azo pigment of the invention is characterized in that, in the coupling reaction between the diazonium compound prepared by diazotization of the heterocyclic amine represented by the general formula (9) and the compound represented by the general formula (11), the coupling reaction is conducted in the presence of a polar aprotic solvent.

The α -form crystals can also be effectively produced by the process of conducting the coupling reaction in the presence of the polar aprotic solvent. Examples of the polar aprotic solvent include N,N-dimethylformamide, N,N-dimethylacetamide, N-methyl-2-pyrrolidone, dimethylsulfoxide, tetramethylurea, and a mixed solvent thereof. In the case of using these solvents, the compound of the general formula (11) may or may not be completely dissolved.

The compounds represented by the general formulae (1), (3), and (4) to (7) are obtained as crude azo pigments by the above-mentioned production processes. In the case of using them as the pigments of the invention, they are preferably subjected to after-treatment. As methods of the after-treatment, there are illustrated, for example, a pigment particle-controlling step such as milling treatment (e.g., solvent-salt milling, salt milling, dry milling, solvent milling or acid pasting) or solvent heating treatment; and a surface-treating step using, for example, a resin, a surfactant or a dispersing agent.

The compounds of the invention represented by the general formulae (1), (3), and (4) to (7) are preferably subjected to the solvent heating treatment and/or the solvent-salt milling as the after-treatment.

As a solvent to be used in the solvent heating treatment, there are illustrated, for example, water, aromatic hydrocarbon series solvents such as toluene and xylene;

halogenated hydrocarbon series solvents such as chlorobenzene and o-dichlorobenzene; alcoholic solvents such as isopropanol and isobutanol; polar aprotic organic solvents such as N,N-dimethylformamide, N,N-dimethylacetamide, and N-methyl-2-pyrrolidone; glacial acetic acid; pyridine; and a mixture thereof. An inorganic or organic acid or base may further be added to the above-described solvents. The temperature of the solvent heating treatment varies depending upon the desired primary particle size of the pigment, but is preferably from 40 to 150°C, more preferably from 60 to 100°C. The treating time is preferably from 30 minutes to 24 hours.

As the solvent-salt milling, there is illustrated the procedure wherein a crude azo pigment, an inorganic salt, and an organic solvent which does not dissolve them are placed in a kneader, and knead-milling of the mixture is conducted therein. As the inorganic salt, water-soluble inorganic salts can preferably be used. For example, inorganic salts such as sodium chloride, potassium chloride, and sodium sulfate are preferably used. Also, it is more preferred to use inorganic salts having an average particle size of from 0.5 to 50 μm . The amount of the inorganic salt to be used is preferably a 3- to 20-fold amount by weight, more preferably a 5- to 15-fold amount by weight, based on the crude pigment. As the organic solvent, water-soluble organic solvents can preferably be used and, since the solvent becomes easily vaporize due to an increase in temperature upon kneading, high-boiling solvents are preferred in view of safety. Examples of such organic solvents include diethylene glycol, glycerin, ethylene glycol, propylene glycol, liquid polyethylene glycol, liquid polypropylene glycol, 2-(methoxymethoxy)ethanol, 2-butoxyethanol, 2-(isopentyloxy)ethanol, 2-(hexyloxy)ethanol, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, triethylene glycol, triethylene

glycol monomethyl ether, 1-methoxy-2-propanol, 1-ethoxy-2-propanol, dipropylene glycol, dipropylene glycol monomethyl ether, dipropylene glycol monomethyl ether, dipropylene glycol, and a mixture thereof. The amount of the water-soluble organic solvent to be used is preferably a 0.1- to 5-fold amount based on the crude azo pigment. The kneading temperature is preferably from 20 to 130°C, particularly preferably from 40 to 110°C. As a kneader, there can be used, for example, a kneader and a mix muller.

[Pigment dispersion]

The pigment dispersion of the invention is characterized in that it contains at least one of the azo pigments represented by the general formulae (1), (3), and (4) to (7). Thus, there can be obtained a pigment dispersion having excellent coloring characteristics, durability, and dispersion stability.

The pigment dispersion of the invention may be aqueous or non-aqueous, but is preferably an aqueous pigment dispersion. As the aqueous liquid for dispersing the pigment in the aqueous pigment dispersion of the invention, a mixture containing water as a major component and, as needed, a hydrophilic organic solvent can be used. Examples of the hydrophilic organic solvent include alcohols such as methanol, ethanol, propanol, isopropanol, butanol, isobutanol, sec-butanol, t-butanol, pentanol, hexanol, cyclohexanol, and benzyl alcohol; polyhydric alcohols such as ethylene glycol, diethylene glycol, triethylene glycol, polyethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, butylenes glycol, hexanediol, pentanediol, glycerin, hexanetriol, and thiodiglycol; glycol derivatives such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, diethylene glycol monomethyl ether, diethylene glycol monobutyl ether, propylene glycol monomethyl ether, propylene glycol monobutyl ether, dipropylene glycol

monomethyl ether, triethylene glycol monomethyl ether, ethylene glycol diacetate, ethylene glycol monomethyl ether acetate, triethylene glycol monomethyl ether, and ethylene glycol monophenyl ether; amines such as ethanolamine, diethanolamine, triethanolamine, N-methyldiethanolamine, N-ethyldiethanolamine, morpholine, N-ethylmorpholine, ethylenediamine, diethylenetriamine, triethylenetetramine, polyethyleneimine, and tetramethylpropylenediamine; formamide; N,N-dimethylformamide; N,N-dimethylacetamide; dimethylsulfoxide; sulfolane; 2-pyrrolidone; N-methyl-2-pyrrolidone; N-vinyl-2-pyrrolidone; 2-oxazolidone; 1,3-dimethyl-2-imidazolidinone; acetonitrile; and acetone.

Further, the aqueous pigment dispersion of the invention may contain an aqueous resin. As the aqueous resin, there are illustrated water-soluble resins which dissolve in water, water-dispersible resins which can be dispersed in water, colloidal dispersion resins, and a mixture thereof. Specific examples of the aqueous resins include acryl series resins, styrene-acryl series resins, polyester resins, polyamide resins, polyurethane resins, and fluorine-containing resins.

Further, in order to improve dispersibility of the pigment and quality of image, a surfactant and a dispersing agent may be used. As the surfactant, there are illustrated anionic, nonionic, cationic, and amphoteric surfactants, and any of them may be used. However, anionic or nonionic surfactants are preferred to use. Examples of the anionic surfactants include aliphatic acid salts, alkyl sulfate salts, alkylbenzene sulfonate salts, alkyl naphthalene sulfonate salts, dialkyl sulfosuccinate salts, alkyl diaryl ether disulfonate salts, alkyl phosphate salts, polyoxyethylene alkyl ether sulfate salts, polyoxyethylene alkylaryl ether sulfate salts, naphthalenesulfonic acid-formalin condensates, polyoxyethylene alkyl phosphatesalts, glycerol borate fatty acid esters, and polyoxyethylene glycerol fatty acid esters.

Examples of the nonionic surfactants include polyoxyethylene alkyl ethers, polyoxyethylene alkylaryl ethers, polyoxyethylene-oxypropylene block copolymers, sorbitan fatty acid esters, polyoxyethylene sorbitan fatty acid esters, polyoxyethylene sorbitol fatty acid esters, glycerin fatty acid esters, polyoxyethylene fatty acid esters, polyoxyethylene alkylamines, fluorine-containing surfactants, and silicon-containing surfactants.

The non-aqueous pigment dispersion comprises the pigment represented by the general formula (1) dispersed in a non-aqueous vehicle. Examples of resin to be used as the vehicle include petroleum resin, casein, shellac, rosin-modified maleic acid resin, rosin-modified phenol resin, nitrocellulose, cellulose acetate butyrate, cyclized rubber, chlorinated rubber, oxidized rubber, rubber hydrochloride, phenol resin, alkyd resin, polyester resin, unsaturated polyester resin, amino resin, epoxy resin, vinyl resin, vinyl chloride, vinyl chloride-vinyl acetate copolymer, acryl resin, methacryl resin, polyurethane resin, silicone resin, fluorine-containing resin, drying oil, synthetic drying oil, styrene/maleic acid resin, styrene/acryl resin, polyamide resin, polyimide resin, benzoguanamine resin, melamine resin, urea resin, chlorinated polypropylene, butyral resin, and vinylidene chloride resin. It is also possible to use a photo-curable resin as the non-aqueous vehicle.

Examples of the solvents to be used in the non-aqueous vehicles include aromatic solvents such as toluene, xylene, and methoxybenzene; acetate series solvents such as ethyl acetate, butyl acetate, propylene glycol monomethyl ether acetate, and propylene glycol monoethyl ether acetate; propionate series solvents such as ethoxyethyl propionate; alcoholic solvents such as methanol and ethanol; ether series solvents such as butyl cellosolve, propylene glycol monomethyl ether, diethylene glycol ethyl ether, and diethylene glycol dimethyl ether; ketone series solvents such as

methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; aliphatic hydrocarbon series solvents such as hexane; nitrogen-containing compound series solvents such as N,N-dimethylformamide, γ -butyrolactam, N-methyl-2-pyrrolidone, aniline, and pyridine; lactone series solvents such as γ -butyrolactone; and carbamic acid esters such as a 48:52 mixture of methyl carbamate and ethyl carbamate .

The pigment dispersion of the invention is obtained by dispersing the azo pigment and the aqueous or non-aqueous medium using a dispersing apparatus. As the dispersing apparatus, there can be used a simple stirrer, an impeller-stirring system, an in-line stirring system, a mill system (for example, colloid mill, ball mill, sand mill, beads mill, attritor, roll mill, jet mill, paint shaker or agitator mill), a ultrasonic wave system, a high-pressure emulsion dispersion system (high-pressure homogenizer; specific commercially available apparatuses being Gaulin homogenizer, a microfluidizer, and DeBEE2000).

In the invention, the volume-average particle size of the pigment is preferably from 10 nm to 250 nm. Additionally, the volume-average particle size of the pigment particles means the particle size of the pigment particle itself or, in the case where an additive such as a dispersing agent is adhered to the coloring material, the particle size of the pigment particle to which the additive is adhered. In the invention, a nanotrac UPA particle size distribution analyzer (UPA-EX150; manufactured by Nikkiso Co., Ltd.) was used as a measuring apparatus for measuring the volume-average particle size of the pigment. The measurement was performed according to the predetermined method by placing 3 ml of a pigment dispersion in a measuring cell. Additionally, as to parameters to be inputted upon measurement, ink viscosity was used as the viscosity, and pigment density was used as the density of dispersed particles.

The volume-average particle size is more preferably from 20 nm to 250 nm, still more preferably from 30 nm to 230 nm, and most preferably from 30 nm to 150 nm. In case where the volume-average particle size of the particles in the pigment dispersion is less than 20 nm, storage stability of the dispersion might not be ensured in some cases whereas, in case where the size exceeds 250 nm, there might result a low optical density in some cases.

The concentration of the pigment contained in the pigment dispersion of the invention is in the range of preferably from 1 to 35% by weight, more preferably from 2 to 25% by weight. In case where the concentration is less than 1% by weight, an enough image density might not be obtained when the pigment dispersion is singly used as an ink. In case where the concentration exceeds 35% by weight, there might result a reduced dispersion stability in some cases.

As uses of the azo pigments of the invention, there are illustrated image recording materials for forming images, particularly color images. Specifically, there are illustrated inkjet system recording materials to be described in detail below, heat-sensitive recording materials, pressure-sensitive recording materials, recording materials for the electro-photographic system, transfer system silver halide light-sensitive materials, printing inks, and recording pens, preferably inkjet system recording materials, heat-sensitive recording materials, and recording materials for the electro-photographic system, more preferably inkjet system recording materials.

In addition, the pigments can find application to color filters for recording and reproducing color images to be used in solid state imaging devices such as CCDs and in displays such as LCD and PDP and to a pigmenting solution for pigmenting various fibers.

The bisazo pigments of the invention are used by adjusting physical properties

such as solvent resistance, dispersibility, and heat conductivity through selection of the substituents so as to be adapted for the particular use. Also, the bisazo pigments of the invention may be used in an emulsion dispersion state or in a solid dispersion state according to the system wherein they are used.

[Coloring composition]

The coloring composition of the invention means a coloring composition containing at least one kind of the azo pigments of the invention. The coloring composition of the invention can contain a medium and, in the case where a solvent is used as the medium, the composition is particularly appropriate as an ink for inkjet recording. The coloring composition of the invention can be prepared by using an oleophilic medium or an aqueous medium as the medium and dispersing the azo pigment of the invention in the medium. Preferably, the aqueous medium is used. The coloring composition of the invention includes an ink composition excluding the medium. The coloring composition of the invention may contain, as needed, other additives within the range of not spoiling the advantages of the invention. Examples of the other additives include known additives (described in JP-A-2003-306623) such as a drying-preventing agent (a wetting agent), an antifading agent, an emulsion stabilizer, a penetration accelerator, an ultraviolet ray absorbent, an antiseptic, an antifungal agent, a pH-adjusting agent, a surface tension-adjusting agent, an anti-foaming agent, a viscosity-adjusting agent, a dispersing agent, a dispersion stabilizer, a rust inhibitor, and a chelating agent. In the case of water-soluble inks, these various additives are added directly to the ink solution. In the case of oil-soluble inks, it is general to add to a dispersion after preparing the azo pigment dispersion, but they may be added to an oil phase or an aqueous phase upon preparation.

[Ink]

Next, the ink of the invention will be described below.

The ink of the invention contains the pigment dispersion of the invention described above and is preferably prepared by mixing with a water-soluble solvent or water. However, in the case where no particular problems are involved, the pigment dispersion of the invention described above may be used as such.

The ink of the invention for inkjet recording contains the pigment dispersion of the invention, and can also be used as an ink for inkjet recording.

Also, the coloring composition containing the pigment of the invention can preferably be used as an ink for inkjet recording.

The ink of the invention uses the pigment dispersion described above, and is preferably prepared by mixing with a water-soluble solvent or water. However, in the case where no particular problems are involved, the pigment dispersion of the invention described above may be used as such.

The ink of the invention uses the pigment dispersion described above, and is preferably prepared by mixing with a water-soluble solvent or water. However, in the case where no particular problems are involved, the pigment dispersion of the invention described above may be used as such.

[Ink for inkjet recording]

Next, the ink of the invention for inkjet recording will be described below.

The ink of the invention for inkjet recording (hereinafter in some cases referred to as "ink") uses the pigment dispersion described above, and is preferably prepared by mixing with a water-soluble solvent or water. However, in the case where no particular problems are involved, the pigment dispersion of the invention described above may be used as such.

In view of hue, color density, saturation, and transparency of an image formed on a recording medium, the content of the pigment dispersion in the ink of the invention is in the range of preferably from 1 to 100% by weight, particularly preferably from 3 to 20% by weight, most preferably from 3 to 10% by weight.

The pigment of the invention is contained in an amount of from 0.1 part by weight to 20 parts by weight, more preferably from 0.2 part by weight to 10 parts by weight, still more preferably from 1 to 10 parts by weight, in 100 parts by weight of the ink of the invention. The ink of the invention may further contain other pigment in combination with the pigment of the invention. In the case of using two or more kinds of pigments, the total amount of the pigments is preferably within the above-described range.

The ink of the invention can be used for forming a full-color image as well as a mono-color image. In order to form the full-color image, a magenta tone ink, a cyan tone ink, and a yellow tone ink can be used and, further, a black tone ink can be used for adjusting tone.

Further, in the ink of the invention may be used other pigments in addition to the azo pigment of the invention. As yellow pigments to be applied, there are illustrated, for example, C.I. PY-74, C.I. PY-128, C.I. PY-155, C.I. PY-213. As magenta pigments to be applied, there are illustrated C.I. PV-19 and C.I. PR-122. As cyan pigments to be applied, there are illustrated C.I. PB-15:3 and C.I. PB-15:4. Apart from these pigments, any pigment may be used as each pigment. As a black color material, there can be illustrated a carbon black dispersion as well as disazo, trisazo, and tetrazo pigments.

As the water-soluble solvents to be used in the ink of the invention, polyhydric alcohols, polyhydric alcohol derivatives, nitrogen-containing solvents,

alcohols, and sulfur-containing solvents are used.

Specific examples of the polyhydric alcohols include ethylene glycol, diethylene glycol, propylene glycol, butylenes glycol, triethylene glycol, 1,5-pentanediol, 1,2,6-hexanetriol, and glycerin.

Examples of the polyhydric alcohol derivatives include ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, propylene glycol monobutyl ether, dipropylene glycol monobutyl ether, and an ethylene oxide adduct of diglycerin.

Also, examples of the nitrogen-containing solvents include pyrrolidone, N-methyl-2-pyrrolidone, cyclohexylpyrrolidone, and triethanolamine, examples of the alcohols include ethanol, isopropyl alcohol, butyl alcohol, and benzyl alcohol, and examples of the sulfur-containing solvents include thiodiethanol, thiodiglycerol, sulfolane, and dimethylsulfoxide. Besides, propylene carbonate and ethylene carbonate may also be used.

The water-soluble solvents to be used in the invention may be used alone or as a mixture of two or more thereof. As to the content of the water-soluble solvent, the solvent is used in an amount of from 1% by weight to 60% by weight, preferably from 5% by weight to 40% by weight, based on the total weight of the ink. In case where the content of the water-soluble solvent in the entire ink is less than 1% by weight, there might result an insufficient optical density in some cases whereas, in case where the content exceeds 60% by weight, there might result unstable jet properties of the ink liquid in some cases due to the large viscosity of the liquid.

The preferred physical properties of the ink of the invention are as follows.

The surface tension of the ink is preferably from 20 mN/m to 60 mN/m, more

preferably from 20 mN/m to 45 mN/m, still more preferably from 25 mN/m to 35 mN/m. In case where the surface tension is less than 20 mN/m, the liquid might, in some cases, overflow onto the nozzle surface of the recording head, thus normal printing not being performed. On the other hand, in case where the surface tension exceeds 60 mN/m, the ink might, in some cases, slowly penetrate into the recording medium, thus the drying time becoming longer.

Additionally, the surface tension was measured under the environment of 23°C and 55% RH by using a Wilhelmy surface tension balance in the similar manner to above.

The viscosity of the ink is preferably from 1.2 mPa·s to 8.0 mPa·s, more preferably from 1.5 mPa·s to 6.0 mPa·s, still more preferably from 1.8 mPa·s to 4.5 mPa·s. In case where the viscosity is more than 8.0 mPa·s, ink ejection properties might, in some cases, be deteriorated. On the other hand, in case where the viscosity is less than 1.2 mPa·s, the long-term ejection properties might be deteriorated in some cases.

Additionally, the viscosity (including that to be described hereinafter) was measured by using a rotational viscometer Rheomat 115 (manufactured by Contraves Co.) at 23°C and a shear rate of 1,400 s⁻¹.

In addition to the above-mentioned individual components, water is added to the ink within an amount of providing the preferred surface tension and viscosity described above. The addition amount of water is not particularly limited, but is in the range of preferably from 10% by weight to 99% by weight, more preferably from 30% by weight to 80% by weight, based on the total weight of the ink.

Further, for the purpose of controlling characteristic properties such as improvement of ejection properties, there can be used, as needed, polyethyleneimine,

polyamines, polyvinylpyrrolidone, polyethylene glycol, cellulose derivatives such as ethyl cellulose and carboxymethyl cellulose, polysaccharides and derivatives thereof, water-soluble polymers, polymer emulsions such as an acrylic polymer emulsion, a polyurethane series emulsion, and a hydrophilic latex, hydrophilic polymer gels, cyclodextrin, macrocyclic amines, dendrimers, crown ethers, urea and derivatives thereof, acetamide, silicone surfactants, and fluorine-containing surfactants.

Also, in order to adjust electrical conductivity and pH, there can be used compounds of alkali metals such as potassium hydroxide, sodium hydroxide, and lithium hydroxide; nitrogen-containing compounds such as ammonium hydroxide, triethanolamine, diethanolamine, ethanolamine, and 2-amino-2-methyl-1-propanol; compounds of alkaline earth metals such as calcium hydroxide; acids such as sulfuric acid, hydrochloric acid, and nitric acid; and salts between a strong acid and a weak alkali, such as ammonium sulfate.

Besides, pH buffers, antioxidants, antifungal agents, viscosity-adjusting agents, electrically conductive agents, and ultraviolet ray absorbents may also be added as needed.

[Inkjet recording method, inkjet recording apparatus, and ink tank for inkjet recording]

The inkjet recording method of the invention is a method of forming an image on a recording medium by using the ink of the invention for inkjet recording, and ejecting the ink onto the surface of the recording medium through the recording head according to recording signals.

Also, the inkjet recording apparatus of the invention is an apparatus for forming an image, which is equipped with a recording head capable of ejecting the ink of the invention for inkjet recording (a processing solution as needed) onto the surface of a recording medium, with the ink being ejected onto the surface of the recording

medium through the recording head to form an image. Additionally, in the inkjet recording apparatus of the invention, the recording head may be equipped with an ink tank for inkjet recording which can feed the ink to the recording head and is removable from the body of the inkjet recording apparatus (hereinafter in some cases referred to as "ink tank"). In this case, the ink of the invention is retained in the ink tank for inkjet recording.

As the inkjet recording apparatus of the invention, a common inkjet recording apparatus, which is equipped with a printing system capable of using the ink of the invention for inkjet recording, can be utilized. Besides, there may be used, as needed, an apparatus on which a heater for controlling drying is further mounted or an apparatus on which an intermediate transferring mechanism is further mounted and in which the ink and a processing solution are ejected (printed) onto an intermediate transfer member and are then transferred to a recording medium such as paper.

Also, as the ink tank of the invention for inkjet recording, a conventionally known ink tank may be utilized as long as it can be removably mounted on an inkjet recording apparatus equipped with a recording head and has such constitution that the ink can be fed to the recording head.

As to the inkjet recording method (apparatus) of the invention, it is preferred to employ a thermal inkjet recording system or a piezoelectric inkjet recording system in view of reducing feathering and inter-color bleed.

In the case of the thermal inkjet recording system, the ink is heated upon ejection to decrease the viscosity of the ink. Since the temperature of the ink decreases on the recording medium, the viscosity rapidly increases to afford the effect of reducing feathering and inter-color bleed. On the other hand, in the case of the piezoelectric inkjet recording system, ejection of a highly viscous liquid, which is able

to suppress spreading of the liquid in the paper surface direction on the recording medium, is possible, thus the effect of reducing feathering and inter-color bleed being obtained.

In the inkjet recording method (apparatus) of the invention, the ink is preferably replenished (fed) to a recording head from an ink tank (including a processing solution tank) that is filled with the ink. This tank is preferably a cartridge that can be removably attached to the body of the apparatus, and the ink is easily replenished by changing the ink tank cartridge.

[Color toner]

The content of the bisazo pigment of the invention in 100 parts by weight of the color toner of the invention is not particularly limited, but is preferably 0.1 part by weight or more, more preferably from 1 to 20 parts by weight, most preferably from 2 to 10 parts by weight. As a binder resin for color toner to be used for introducing the bisazo pigment of the invention, all binders that are generally used can be used. Examples thereof include styrene series resins, acryl series resins, styrene/acryl series resins, and polyester resins.

Inorganic fine powders and organic fine particles may externally be added to a toner for the purpose of improving fluidity and controlling charging properties. Silica fine particles and titania fine particles, whose surface has been treated with a coupling agent containing an alkyl group, are preferably used. Additionally, these particles preferably have a number-average primary particle size of from 10 to 500 nm, and are added to the toner in an amount of preferably from 0.1 to 20% by weight.

As a releasing agent, all releasing agents that have conventionally been used can be used. Specifically, there are illustrated olefins such as low-molecular-weight polypropylene, low-molecular-weight polyethylene, and ethylene-propylene

copolymer; microcrystalline wax; carnauba wax; sazol wax; and paraffin wax. The addition amount of the releasing agent is preferably from 1 to 5% by weight in the toner.

As a charge-controlling agent which may optionally be added, colorless ones are preferred in view of color-forming properties. For example, there are illustrated those with a quaternary ammonium salt structure and those with a calix arene structure.

As a carrier, either of non-coated carriers constituted only by particles of a magnetic material such as iron or ferrite and resin-coated carriers comprising magnetic material particles coated with a resin may be used. The average particle size of the carrier is preferably from 30 to 150 μm in terms of volume average particle size.

The image-forming method to which the toner of the invention is applied is not particularly limited, but is exemplified by a method wherein color images are repeatedly formed on a photoreceptor, and then the color images are transferred to form an image, and a method wherein an image formed on a photoreceptor is transferred every time to an intermediate transfer member to form a color image on the intermediate transfer member, and then the color image is transferred to an image-forming member such as paper to form a color image.

[Heat-sensitive recording (transfer) material]

The heat-sensitive recording material is constituted by an ink sheet comprising a support having provided thereon a layer containing the bisazo pigment of the invention and a binder; and an image-receiving sheet for immobilizing the pigment migrating corresponding to the heat energy added from a thermal head according to image-recording signals. The ink sheet can be formed by dispersing the bisazo pigment of the invention in a solvent together with the binder to prepare an ink liquid,

coating this ink liquid on the support, and properly drying the coated ink liquid. The coated amount of the ink on the support is not particularly limited, but is preferably from 30 to 1,000 mg/m². As to preferred binder resins, ink solvents, supports, and image-receiving sheets, those described in JP-A-7-137466 can preferably be used.

In order to apply the heat-sensitive recording material to a heat-sensitive recording material which can record a full-color color image, it is preferred to form a cyan ink sheet containing a heat-diffusible cyan colorant capable of forming a cyan image, a magenta ink sheet containing a heat-diffusible magenta colorant capable of forming a magenta image, and a yellow ink sheet containing a heat-diffusible yellow colorant capable of forming a yellow image, by coating on a sheet. In addition, an ink sheet containing a black color image-forming substance may further be formed as needed.

[Color filter]

As a method for forming a color filter, there are a method of first forming a pattern by using a photoresist, and then dyeing it, and a method of forming a pattern by a photoresist having added thereto a colorant as described in JP-A-4-163552, JP-A-4-128703, and JP-A-4-175753. As a method to be employed in the case of introducing the colorant of the invention into a color filter, either one of these methods may be employed. However, as a preferred method, there can be illustrated a method for forming a color filter described in JP-A-4-175753 and JP-A-6-35182, which comprises using a positive resist composition containing a thermosetting resin, a quinonediazide compound, a cross-linking agent, a colorant, and a solvent, coating this composition on a substrate, exposing through a mask, developing the exposed areas to thereby form a positive resist pattern, exposing the entire surface of the positive resist pattern, and then curing the exposed positive resist pattern. Also, a color filter in the

system of RGB primary colors or YMC complementary colors can be obtained by forming a black matrix in a conventional manner. With the color filter, too, the amount of the bisazo pigment of the invention is not limited, but is preferably from 0.1 to 50% by weight.

As the thermosetting resin, quinonediazide compound, cross-linking agent, solvent, and the amounts thereof to be used, those which are described in the aforesaid patent literature can preferably be used.

Examples

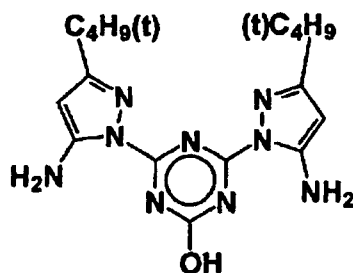
The invention will be described in more detail by reference to Examples which, however, are not to be construed as limiting the invention. Additionally, in Examples, "parts" are by weight.

[Example 1] Synthesis of illustrative pigment (Pig-1):

3.7 Parts of 5-amino-3-methyl-1,2,4-thiazole is added to 45 parts of phosphoric acid, and heated to 38°C to dissolve. This solution is cooled with ice-water to keep the solution at -3°C, 2.5 parts of sodium nitrite is added thereto, and the mixture is stirred for 1.5 hours to obtain a diazonium salt solution. Separately, 4 parts of the compound represented by the following formula (13) is added to 80 parts of N,N-dimethylacetamide to prepare a completely dissolved solution. The above-described diazonium salt solution is added thereto at 8°C. The solution is kept in this state for 2 hours to react. After increasing the temperature of the solution to room temperature, 100 parts of ethanol is added thereto, and a precipitated powder is collected by filtration. This powder is added to 200 parts of water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a yellow powder. This yellow powder is added to a mixed solvent of 40 parts of

N,N-dimethylacetamide and 40 parts of water, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with methanol to obtain 4.8 parts of the azo pigment.

General formula (13)



The infrared absorption spectrum of the thus-obtained azo pigment (Fig-1) is shown in Fig. 1. In the case of conducting the synthesis according to the above-described process, the product shows no absorption peak in the range of from 1700 to 1730 cm⁻¹ in the infrared absorption spectrum.

[Example 2] Synthesis of illustrative pigment (Fig-2):

Diazotization reaction of 5-amino-3-methyl-1,2,4-thiadiazole is conducted in the same manner as in Example 1. Separately, 4 parts of the compound represented by the above formula (13) is added to 80 parts of methanol to suspend. To this suspension is added the above-mentioned diazonium salt solution at 8°C. The reaction was continued as it is for 2 hours and precipitated powder is collected by filtration. This powder is added to 200 parts of water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a slightly reddish yellow powder. This powder is added to a mixed solvent of 40 parts of N,N-dimethylacetamide and 40 parts of water, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with methanol to obtain 6.4 parts of the azo pigment. The infrared absorption spectrum of the

thus-obtained azo pigment (Pig-2) is shown in Fig. 2. In the case of conducting the synthesis according to the above-described process, the product shows a large absorption peak in the range of from 1700 to 1730 cm^{-1} in the infrared absorption spectrum.

[Example 3] Synthesis of illustrative pigment (Pig-4):

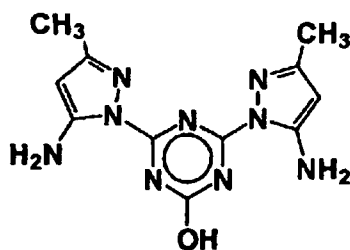
1.6 Parts of 5-amino-1,2,4-thiazole is added to 20 parts of phosphoric acid, and heated to 38°C to dissolve. This solution is cooled with ice-water to keep the solution at -3°C, 1.4 parts of sodium nitrite is added thereto, and the mixture is stirred for 1.5 hours to obtain a diazonium salt solution. Separately, 2 parts of the compound represented by the above formula (13) is added to 200 parts of methanol to prepare a completely dissolved solution. The above-described diazonium salt solution is added thereto at 5°C. The solution is kept in this state for 4 hours to react, and a precipitated powder is collected by filtration. This powder is added to 200 parts of water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a yellow powder. This yellow powder is added to a mixed solvent of 10 parts of N,N-dimethylacetamide and 10 parts of water, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with methanol to obtain 0.9 part of the azo pigment. The infrared absorption spectrum of the thus-obtained azo pigment (Pig-4) is shown in Fig. 3.

[Example 4] Synthesis of illustrative pigment (Pig-7):

1.8 Parts of 5-amino-3-methyl-1,2,4-thiazole is added to 22 parts of phosphoric acid, and heated to 38°C to dissolve. This solution is cooled with ice-water to keep the solution at -3°C, 1.3 parts of sodium nitrite is added thereto, and the mixture is stirred for 1.5 hours to obtain a diazonium salt solution. Separately, 1.5 parts of the compound represented by the following formula (14) is added to 30 parts

of N,N-dimethylformamide to prepare a suspension. The above-described diazonium salt solution is added thereto at 5°C. The solution is kept in this state for 7 hours to react. 40 Parts of methanol is added thereto, and a precipitated powder is collected by filtration. This powder is added to 200 parts of water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a yellow powder. This yellow powder is added to 30 parts of N,N-dimethylacetamide, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with acetone to obtain 1.9 parts of the azo pigment.

General formula (14)



The infrared absorption spectrum of the thus-obtained azo pigment (Pig-7) is shown in Fig. 4.

[Example 5] Synthesis of illustrative pigment (Pig-27)

2.1 Parts of 5-amino-4-cyano-1-phenylpyrazole is added to a mixed solution of 5.1 parts of concentrated sulfuric acid, 22.8 parts of glacial acetic acid, and 2.1 parts of nitrosylsulfuric acid at 4°C. The mixture is stirred in this state for 1 hour to obtain a diazonium salt solution. Separately, 1.5 parts of the compound represented by the following formula (14) is added to 45 parts of N,N-dimethylacetamide to prepare a suspension. The above-described diazonium salt solution is added thereto at 5°C. The solution is kept in this state for 6 hours to react. After increasing the temperature of the solution to room temperature, 60 parts of methanol is added thereto, and a precipitated powder is collected by filtration. This powder is added to 200 parts of

water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a yellow powder. This yellow powder is added to 30 parts of N,N-dimethylacetamide, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with acetone to obtain 0.9 part of the azo pigment. The infrared absorption spectrum of the thus-obtained azo pigment (Fig-27) is shown in Fig. 5.

[Example 6] Synthesis of illustrative pigment (Fig-47)

2.5 Parts of 2-amino-5-methyl-1,3,4-thiadiazole is added to 30 parts of phosphoric acid, and heated to 42°C to dissolve. This solution is cooled with ice-water to keep the solution at -3°C, 1.7 parts of sodium nitrite is added thereto, and the mixture is stirred for 1.5 hours to obtain a diazonium salt solution. Separately, 2.9 parts of the compound represented by the following formula (13) is added to 60 parts of N,N-dimethylacetamide to prepare a completely dissolved solution. The above-described diazonium salt solution is added thereto at 5°C. The solution is kept in this state for 3 hours to react. A precipitated powder is collected by filtration. This powder is added to 200 parts of water, and excess acid is neutralized with sodium hydrogen carbonate. Filtration is again conducted to obtain a yellow powder. This yellow powder is added to a mixed solvent of 25 parts of N,N-dimethylacetamide and 25 parts of water, followed by heating at 100°C for 4 hours to ripen. The thus-ripened solution is hot filtered and washed with methanol to obtain 2.6 parts of the azo pigment. The infrared absorption spectrum of the thus-obtained azo pigment (Fig-47) is shown in Fig. 6.

[Examples 7 to 31]

According to the procedures described in the above detailed description on synthesis of the azo pigments of the invention and Examples 1 to 6, the illustrative

pigments (Pig-9), (Pig-11), (Pig-12), (Pig-13), (Pig-16), (Pig-25), (Pig-28), (Pig-29), (Pig-30), (Pig-31), (Pig-32), (Pig-37), (Pig-39), (Pig-41), (Pig-42), (Pig-43), (Pig-44), (Pig-45), (Pig-46), (Pig-49), (Pig-51), (Pig-52), (Pig-53), (Pig-54) and (Pig-59) are synthesized. The infrared absorption spectra of the thus-obtained azo pigments are shown in Figs. 7 to 31.

[Example 41]

2.5 Parts of the pigment (Pig-1) synthesized in Example 1, 0.5 part of sodium oleate, 5 parts of glycerin, and 42 parts of water are mixed, and subjected to dispersing procedure together with 100 parts of zirconia beads of 0.1 mm in diameter at 300 rpm for 6 hours using a planetary ball mill. After completion of the dispersing procedure, the zirconia beads are separated to obtain a yellow pigment dispersion 1.

[Example 42]

5 Parts of the pigment (Pig-1) synthesized in Example 1, 25.5 parts of an aqueous solution of a high-molecular dispersant of methacrylic acid-methacrylic acid ester copolymer represented by Dispersant Solution 10 which is described in WO2006/064193, p.22, and 19.5 parts of water are mixed, and subjected to dispersing procedure together with 100 parts of zirconia beads of 0.1 mm in diameter at 300 rpm for 6 hours using a planetary ball mill. After completion of the dispersing procedure, the zirconia beads are separated to obtain a yellow pigment dispersion 2.

[Examples 43 to 49]

In the same procedures as in Example 41 except for using (Pig-24), (Pig-26), (Pig-46), (Pig-32), (Pig-70), (Pig-80) and (Pig-59) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow pigment dispersions 3, 4, 5, 6, 7, 8, and 9 respectively.

[Examples 50 to 55]

In the same procedures as in Example 41 except for using (Pig-4), (Pig-6), (Pig-47), (Pig-49), (Pig-51), (Pig-52) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow pigment dispersions 10, 11, 12, 13, 14 and 15 respectively.

[Examples 56 to 60]

In the same procedures as in Example 41 except for using (Pig-7), (Pig-9), (Pig-11), (Pig-12) and (Pig-13) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow pigment dispersions 16, 17, 18, 19 and 20 respectively.

In the same procedures as in Example 41 except for using (Pig-16), (Pig-17) and (Pig-18) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow pigment dispersions 21, 22 and 23 respectively.

[Comparative Example 1]

In the same procedures as in Example 41 except for using C.I. Pigment Yellow 128 (manufactured by Ciba Specialty Co.; CROMOPHTAL YELLOW 8GN) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow comparative pigment dispersion 1.

[Comparative Example 2]

In the same procedures as in Example 41 except for using C.I. Pigment Yellow 74 (manufactured by Ciba Specialty Co.; Iralite YELLOW GO) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow comparative pigment dispersion 2.

[Comparative Example 3]

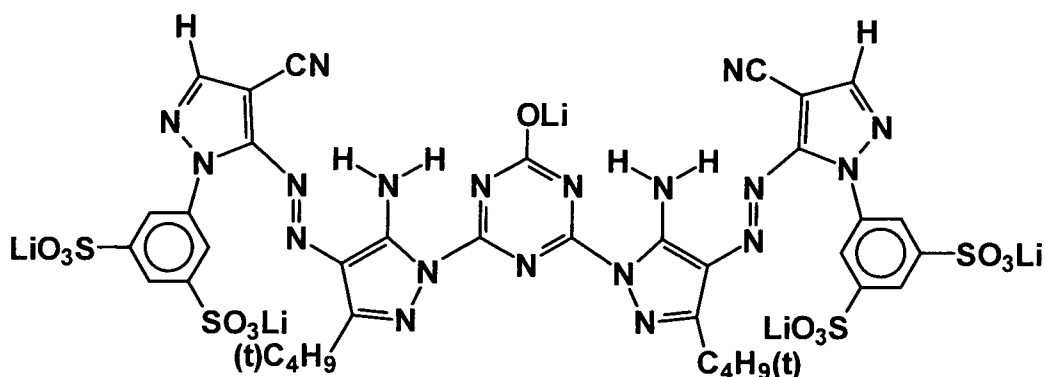
In the same procedures as in Example 41 except for using C.I. Pigment Yellow 155 (manufactured by Clariant Co.; INKJET YELLOW 4G VP2532) in place of the pigment (Pig-1) used in Example 41, there is obtained a yellow comparative

pigment dispersion 3.

[Comparative example 4]

It is tried to prepare a yellow comparative pigment dispersion 4 in the same procedures as in Example 41 except for using a comparative compound 1 of the structure described below in place of the pigment (Pig-1) used in Example 41, but the colorant is dissolved in the solvent to form a solution of the colorant, and a dispersion of fine particles is not obtained.

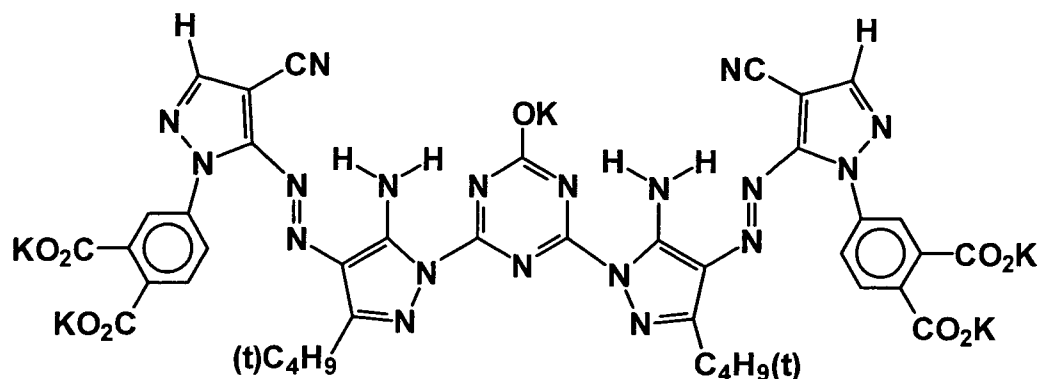
Comparative compound 1



[Comparative example 5]

It is tried to prepare a yellow comparative pigment dispersion 5 in the same procedures as in Example 41 except for using a comparative compound 2 of the structure described below in place of the pigment (Pig-1) used in Example 41, but the colorant is dissolved in the solvent to form a solution of the colorant, and a dispersion of fine particles is not obtained.

Comparative compound 2



<Evaluation of coloring strength>

Each of the pigment dispersions obtained in Examples and Comparative Examples is coated on a photo mat paper (to be used exclusively for pigments) manufactured by Seiko Epson Corporation by using a No.3 bar coater. Image density of each of the thus-obtained coated products is measured by means of a reflection densitometer (X-Rite 938; manufactured by X-Rite Co.), and the results are shown in Table 1 as "coloring strength (OD: Optical Density).

<Evaluation of hue>

Hue is evaluated according to the following criteria: samples of the above-described products which are less greenish and have large vividness in terms of chromaticity when viewed with the eye are ranked A (good); samples which are greenish or have less vividness are ranked B; and samples which are greenish and have less vividness are ranked C (bad). The results are shown in Table 1.

<Evaluation of light fastness>

Each of the coated products of 1.0 in image density used in evaluation of hue is irradiated for 7 days with a xenon light (170,000 lux; in the presence of a cut filter which cuts light of 325 nm or less) and image density thereof is measured before and after irradiation with the xenon light using a reflection densitometer. The pigment dispersions 1 to 23 of the invention and the comparative pigment dispersions 1 to 5 are

evaluated in terms of colorant residual ratio [(density after irradiation/density before irradiation) x 100%]. Samples with a colorant residual ratio of 90% or more are ranked A, samples with a colorant residual ratio of 80% or more are ranked B, samples with a colorant residual ratio of 70% or more are ranked C, samples with a colorant ratio of 60% or more are ranked D, and samples with a colorant ratio of less than 50% are ranked E. The results are shown in Table 1.

<Solvent resistance>

0.05 part of each of the compounds used in Examples and Comparative examples is added to 200 parts of an organic solvent and is allowed to stand for 24 hours. The thus-prepared samples are evaluated. Evaluation is conducted according to the following criteria: samples with which the compounds of Examples or Comparative examples are completely dissolved in the organic solvent are ranked D; samples with which the compounds are not completely dissolved with leaving insolubles, but filtrates thereof are colored are ranked C; samples with which the compounds are not completely dissolved with leaving insolubles, but filtrates thereof are slightly colored are ranked B; and samples with which insolubles remain and filtrates are not colored are ranked A. Additionally, as the organic solvent, a mixture of 25 parts of methanol, 25 parts of acetone, 25 parts of ethyl acetate, and 25 parts of water is used as a mixed solvent.

Table 1

	Pigment Dispersion	Volume-average Particle Size	Coloring Strength	Hue	Light Fastness	Solvent Resistance
Example 41	pigment dispersion 1 of the invention	Mv: about 55 nm	1.35	B	B	B
Example 42	pigment dispersion 2 of the invention	Mv: about 35 nm	1.33	B	B	B
Example 43	pigment dispersion 3 of the invention	Mv: about 50 nm	1.40	A	C	B
Example 44	pigment dispersion 4 of the invention	Mv: about 53 nm	1.40	A	C	B
Example 45	pigment dispersion 5 of the invention	Mv: about 70 nm	1.37	B	C	B
Example 46	pigment dispersion 6 of the invention	Mv: about 60 nm	1.37	B	A	A
Example 47	pigment dispersion 7 of the invention	Mv: about 50 nm	1.35	B	A	A
Example 48	pigment dispersion 8 of the invention	Mv: about 58 nm	1.35	B	B	A
Example 49	pigment dispersion 9 of the invention	Mv: about 56 nm	1.39	B	C	A
Example 50	pigment dispersion 10 of the invention	Mv: about 56 nm	1.33	B	C	B
Example 51	pigment dispersion 11 of the invention	Mv: about 58 nm	1.36	B	B	B
Example 52	pigment dispersion 12 of the invention	Mv: about 60 nm	1.33	B	C	B
Example 53	pigment dispersion 13 of the invention	Mv: about 65 nm	1.39	B	B	B
Example 54	pigment dispersion 14 of the invention	Mv: about 61 nm	1.41	B	B	B
Example 55	pigment dispersion 15 of the invention	Mv: about 64 nm	1.40	B	B	B
Example 56	pigment dispersion 16 of the invention	Mv: about 58 nm	1.36	B	C	B
Example 57	pigment dispersion 17 of the invention	Mv: about 60 nm	1.34	B	B	B
Example 58	pigment dispersion 18 of the invention	Mv: about 54 nm	1.34	B	C	B
Example 59	pigment dispersion 19 of the invention	Mv: about 63 nm	1.35	B	C	B
Example 60	pigment dispersion 20 of the invention	Mv: about 68 nm	1.34	B	C	B
Example 61	pigment dispersion 21 of the invention	Mv: about 55 nm	1.34	B	B	C
Example 62	pigment dispersion 22 of the invention	Mv: about 56 nm	1.38	B	C	B
Example 63	pigment dispersion 23 of the invention	Mv: about 54 nm	1.33	B	C	B
Compara-tive Example 1	comparative pigment dispersion 1	Mv: about 50 nm	1.03	C	C	A
Compara-tive Example 2	comparative pigment dispersion 2	Mv: about 50 nm	1.43	A	E	B
Compara-tive Example 3	comparative pigment dispersion 3	Mv: about 45 nm	1.09	C	D	A
Compara-tive Example 4	comparative pigment dispersion 4	Fine particle dispersion not being formed	-	-	-	D
Compara-tive Example 5	comparative pigment dispersion 5	Fine particle dispersion not being formed	-	-	-	D

[Example 64]

The high-molecular dispersant represented by Dispersant 10 and described in WO2006/064193, page 22 is neutralized with an aqueous solution of potassium hydroxide. 30 Parts by weight of the azo pigment (Pig-1) synthesized in Example 1 and 95 parts by weight of deionized water are added to 75 parts by weight of the thus-obtained dispersant aqueous solution (solid content: 20%), and mixed and coarsely dispersed with a disper agitating member. 600 Parts by weight of zirconia beads are added to the mixed and coarsely dispersed solution, and dispersed in a dispersing machine (sand grinder mill) for 4 hours, followed by separating the dispersion from the beads. To the thus-obtained mixture is gradually added 2 parts by weight of polyethylene glycol diglycidyl ether at 25°C under stirring, and the mixture is stirred at 50C for 6 hours. Further, impurities are removed by using an ultrafiltration membrane of 300K in molecular cutoff, and the resulting dispersion is filtered through a 20-ml volume syringe fit with a filter having a pore size of 5 μ m (acetylcellulose membrane; outer diameter: 25 mm; manufactured by Fuji Photo Film Co., Ltd.) to remove coarse particles. Thus, a pigment dispersion 24 containing 10% solid components (average particle size: Mv= about 55 nm; measured by using Nanotracer 150 (UPA-EX150) manufactured by Nikkiso Co., Ltd.) is obtained.

[Comparative Example 6]

A comparative pigment dispersion 6 is obtained in the same manner as in Example 64 except for using a yellow pigment (C.I. Pigment Yellow 128 (CROMOPHTAL YELLOW 8GN manufactured by Ciba Specialty Co.) in place of the azo pigment (Pig-1) used in Example 64.

[Example 65]

Individual components are added so that the content of the pigment dispersion

24 obtained in Example 64 is 5% by weight, the content of glycerin is 10% by weight, the content of 2-pyrrolidone is 5% by weight, the content of 1,2-hexanediol is 2% by weight, the content of triethylene glycol monobutyl ether is 2% by weight, the content of propylene glycol is 0.5% by weight, and the content of deionized water is 75.5% by weight. The thus-obtained mixed solution is filtered through a syringe fit with a filter having a pore size of 1 μm (acetylcellulose membrane; outer diameter: 25 mm; manufactured by Fuji Photo Film Co., Ltd.) to remove coarse particles. Thus, a pigment ink liquid 1 shown in Table 2 is obtained.

[Comparative Example 7]

A comparative pigment ink liquid 1 is obtained in the same manner as in Example 65 except for using the comparative pigment dispersion 6 obtained in Comparative Example 6 in place of the pigment dispersion 24 obtained in Example 64.

The ink liquids obtained in Example 65 and Comparative Example 7 are used as yellow pigment ink liquids.

[Comparative Example 8]

Also, as a comparative ink type, a yellow ink cartridge (comparative pigment ink liquid 2) of PX-V630 manufactured by Epson Co. is used.

Additionally, in Table 2, with respect to “ejection stability”, “light fastness”, “heat fastness”, “ozone (gas) resistance”, “metal gloss”, “chromaticity”, and “ink liquid stability”, each ink is filled in a yellow ink cartridge of an inkjet printer PX-V630 manufactured by Seiko Epson Corporation, inks of PX-V630 are used for other color inks, and a yellow mono-color pattern with the density being stepwise changed and an image pattern comprising green, red, and gray are printed on an image-receiving sheet, i.e., photographic paper <Kotaku> manufactured by Seiko Epson Corporation or photographic paper CRISPIA <Ko-kotaku> manufactured by

Seiko Epson Corporation with the recommended mode “Kirei” to evaluate image quality, ink ejection properties, and image fastness.

The ink liquid of Example 65 (pigment ink liquid 1) and the comparative ink liquids of Comparative Examples (comparative pigment ink liquid 1 and yellow pigment ink liquid of PX-V630, i.e., comparative pigment ink liquid 2) for use in inkjet recording are subjected to the following evaluations. The results are shown in Table 2.

(Evaluation experiments)

1) As for the ejection stability, after setting the cartridge in the printer and confirming the ejection of ink from all nozzles, the image pattern is outputted on 20 sheets of A4-size paper and rated based on the following criteria.

A: Printing is not disordered from start through end of the printing.

B: Printing is disordered in some outputs.

C: Printing is disordered from start through end of the printing.

2) As for the yellow image preservability, the following evaluations are conducted by using a printed sample.

[1] In the evaluation of light fastness, the image density C_i immediately after printing is measured by X-rite 310, the image is then irradiated with xenon light (100,000 lx) for 35 days by the use of Weathermeter made by Atlas, and the image density C_f is again measured. The yellow image residual ratio $C_f/C_i \times 100$ is determined and evaluated. The yellow image residual ratio is evaluated at three points each having a reflection density of 1, 1.5, and 2, and the light fastness is rated A when the yellow image residual ratio is 80% or more at any density, rated B when less than 80% at two points, or rated C when less than 80% at all points.

[2] In the evaluation of heat fastness, the density is measured by X-rite 310

before and after the sample is stored for 14 days under the conditions of 80°C and 60% RH, and the yellow image residual ratio is determined and evaluated. The yellow image residual ratio is evaluated at three points each having a reflection density of 1, 1.5, and 2, and the heat fastness is rated A when the yellow image residual ratio is 95% or more at any density, rated B when less than 95% at two points, or rated C when less than 95% at all densities.

[3] In the evaluation of ozone resistance (ozone fastness), the sample is left standing for 35 days in a box set to an ozone gas concentration of 5 ppm (23°C, 50%), and the image density before and after standing in the ozone gas atmosphere is measured by a reflection densitometer (Photographic Densitometer 310; manufactured by X-Rite) and evaluated as the yellow image residual ratio. The reflection density is measured at three points of 1, 1.5, and 2.0. The ozone gas concentration in the box is set by using an ozone gas monitor (Model: OZG-EM-01) manufactured by APPLICS. The ozone resistance is rated on a three-stage scale, namely, rated A when the yellow image residual ratio is 80% or more at any density, rated B when less than 80% at one or two points, or rated C when less than 70% at all densities.

3) Occurrence or non-occurrence of metal gloss: The yellow, green, and red solid printed image portions are visually observed by reflected light, and evaluated.

Samples with non-occurrence of metal gloss are evaluated as A, and samples with occurrence of metal gloss are evaluated as B.

4) Chromaticity: A yellow mono-color image pattern with a stepwise changing density is measured for CIE L*a*b* by Spectro Eye manufactured by Gretag Macbeth. The a* and the b* at a reflection density of 1.0 are shown in the following table. As the image-receiving sheet, photographic paper CRISPIA <Ko-kotaku> manufactured by Seiko Epson Corporation is used.

5) Ink liquid stability: Each of the pigment ink liquids of Examples and Comparative Examples is allowed to stand at 60°C for 10 days. Samples undergoing no change in the particle size of particles in the pigment ink liquids are rated A, samples undergoing change in the particle size are rated B. The results are shown in Table 2 below.

Table 2

Ink	Ejection Stability	Light Fastness	Heat Fastness	Ozone Fastness	Metal Gloss	Chromaticity a*	Chromaticity b*	Ink Liquid Stability	Pigment
Example 52 (present invention)	A	A	A	A	A	-8.52	75.79	A	Pig-1
Comparative Example 7	A	B	A	A	B	-9.33	61.15	A	C.I. PY-128
Comparative Example 8	A	C	A	A	A	-11.97	73.68	A	PX-V630

It is seen from the results of Table 2 that the pigment ink liquid using the pigment of the invention shows excellent ink-ejecting properties and excellent weatherability, undergoes less occurrence of metal gloss, shows excellent hue as yellow (a* being minus which means less reddishness, and b* being large which means high saturation), and has excellent pigment ink liquid stability.

As is apparent from the results in Table 2, it can be seen that the system wherein the ink of the invention is used is excellent in all performances. In particular, in comparison with Comparative Examples, the ink of the invention has excellent light fastness and excellent ink liquid stability.

[Example 66]

An image is printed on an inkjet paper of photo gloss paper "Gasai" manufactured by Fuji Photo Film Co., Ltd. by means of PX-V630 manufactured by Seiko Epson Corporation using the pigment ink liquid prepared in Example 65, and is evaluated in the same manner as in Example 65 to obtain similar results.

As is apparent from the results in Tables 1 and 2, the pigment dispersions 1 to 23 using the pigments of the invention and the pigment ink liquid 1 using the pigment of the invention are excellent in color tone and show high coloring strength and light resistance.

Accordingly, the pigment dispersions using the pigments of the invention can preferably be used in an ink for printing such as inkjet printing, a color toner for electrophotography, a color filter to be used for displays such as LCD and PDP and photographing devices such as CCD, a paint, and in colored plastics.

Industrial Applicability

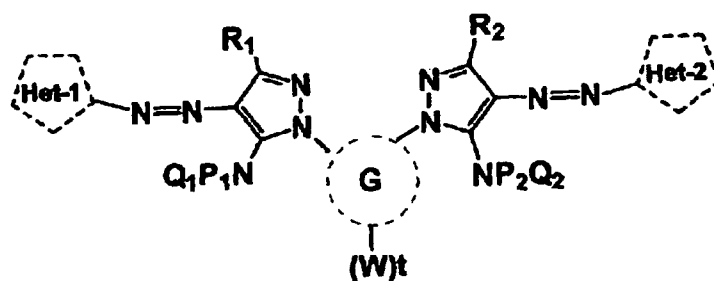
According to the invention, there are provided azo pigments having excellent coloring characteristics such as coloring ability and hue and having excellent durability such as light fastness and resistance to ozone. A pigment dispersion, a coloring composition, and an ink for ink jet recording, having excellent coloring characteristics, durability, and dispersion stability, can be obtained by dispersing the pigment of the invention in various media. The pigment dispersion can be used for an ink for printing such as ink jet printing, a color toner for electrophotography, a display such as LCD or PDP, a color filter to be used in photographing equipment such as CCD, a paint, a colored plastic, etc.

The entire disclosure of each and every foreign patent application from which the benefit of foreign priority has been claimed in the present application is incorporated herein by reference, as if fully set forth.

CLAIMS

1. An azo pigment represented by the following general formula (1), a tautomer of the azo pigment, and a salt or a hydrate thereof:

General formula (1)



wherein

each of R_1 , R_2 , P_1 , P_2 , Q_1 , and Q_2 independently represents a hydrogen atom or a substituent,

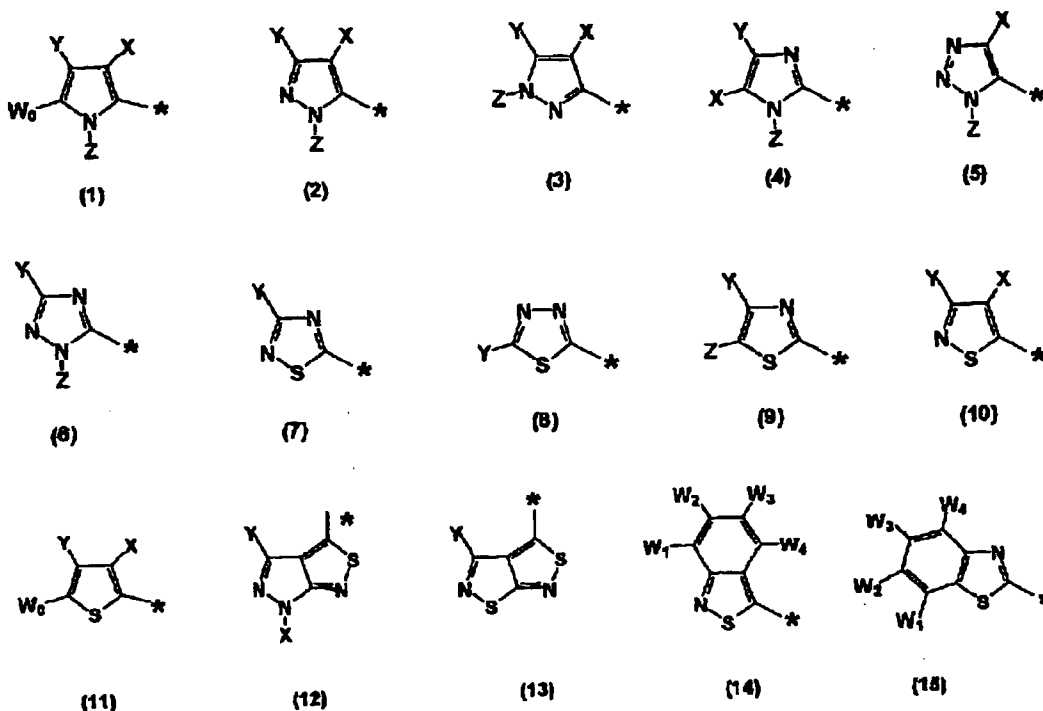
G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G ,

t represents an integer of from 0 to 4,

each of $Het-1$ and $Het-2$ independently represents a group selected from the aromatic heterocyclic groups represented by the following general formula (2):

General formula (2)



wherein

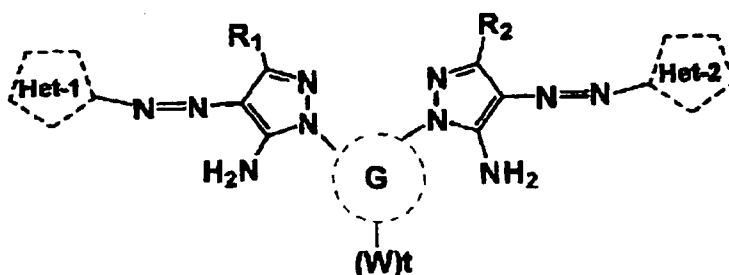
each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the azo linkage in the general formula (1).

2. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to claim 1, wherein

the azo pigment is represented by the following general formula (3):

General formula (3)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G ,

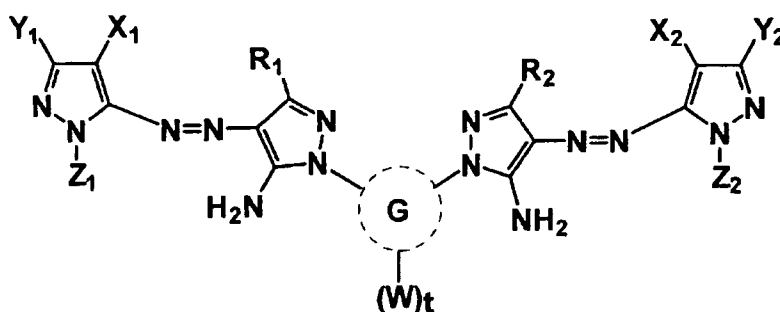
t represents an integer of from 0 to 4,

each of Het-1 and Het-2 independently represents a group selected from aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (3).

3. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to claim 1 or 2, wherein

the azo pigment is represented by the following general formula (4):

General formula (4)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

each of X_1 and X_2 independently represents an electron-withdrawing group having a Hammett's σ_p value of 0.2 or more,

each of Y_1 , Y_2 , Z_1 , and Z_2 independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

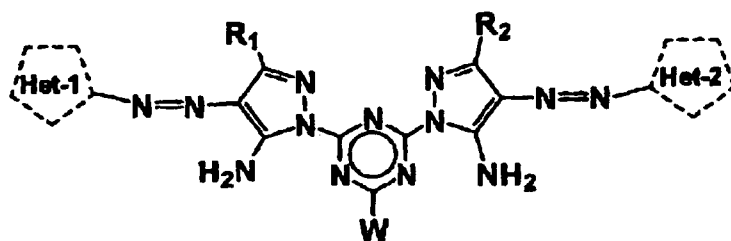
W represents a substituent capable of binding to the heterocyclic group constituted by G, and

t represents an integer of from 0 to 4.

4. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to claim 1 or 2, wherein

the azo pigment is represented by the following general formula (5):

General formula (5)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (5), and

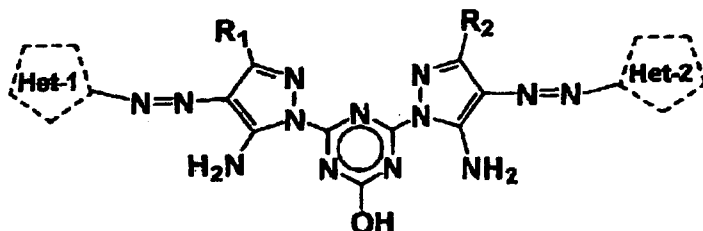
W represents a substituent on the s-triazinyl group.

5. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate

thereof according to any one of claims 1, 2 and 4, wherein

the azo pigment is represented by the following general formula (6):

General formula (6)



wherein

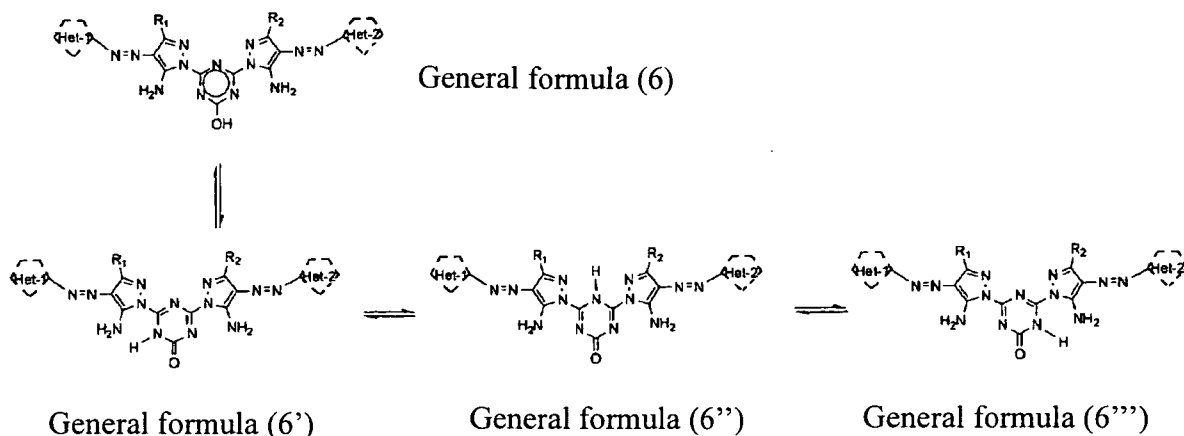
each of R₁ and R₂ independently represents a hydrogen atom or a substituent,

and

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formula (6).

6. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of claims 1, 2, 4 and 5, wherein

the tautomer of the azo pigment is represented by any one of the following general formulae (6') to (6'''):



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

and

each of Het-1 and Het-2 independently represents a group selected from the aromatic heterocyclic groups represented by the general formula (2), provided that * in the general formula (2) shows the point of attachment to the azo linkage in the general formulae (6') to (6''').

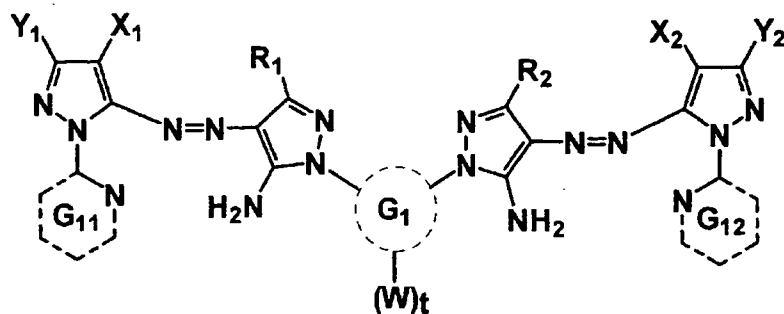
7. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of claims 1 to 6, wherein

the azo pigment has a peak absorption intensity in the range of from 1700 to 1730 cm^{-1} in the IR absorption spectrum which is 1/3 or less of a peak absorption intensity in the range of from 1620 to 1670 cm^{-1} .

8. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to any one of claims 1 to 3, wherein

the azo pigment is represented by the following general formula (7):

General formula (7)



wherein

each of R_1 and R_2 independently represents a hydrogen atom or a substituent,

each of X_1 and X_2 independently represents an electron-withdrawing group having a Hammett's σ_p value of 0.2 or more,

each of Y_1 , and Y_2 independently represents a hydrogen atom or a substituent,

G_1 represents the non-metallic atoms necessary to complete a 5- to 6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G_1 ,

t represents an integer of from 0 to 4,

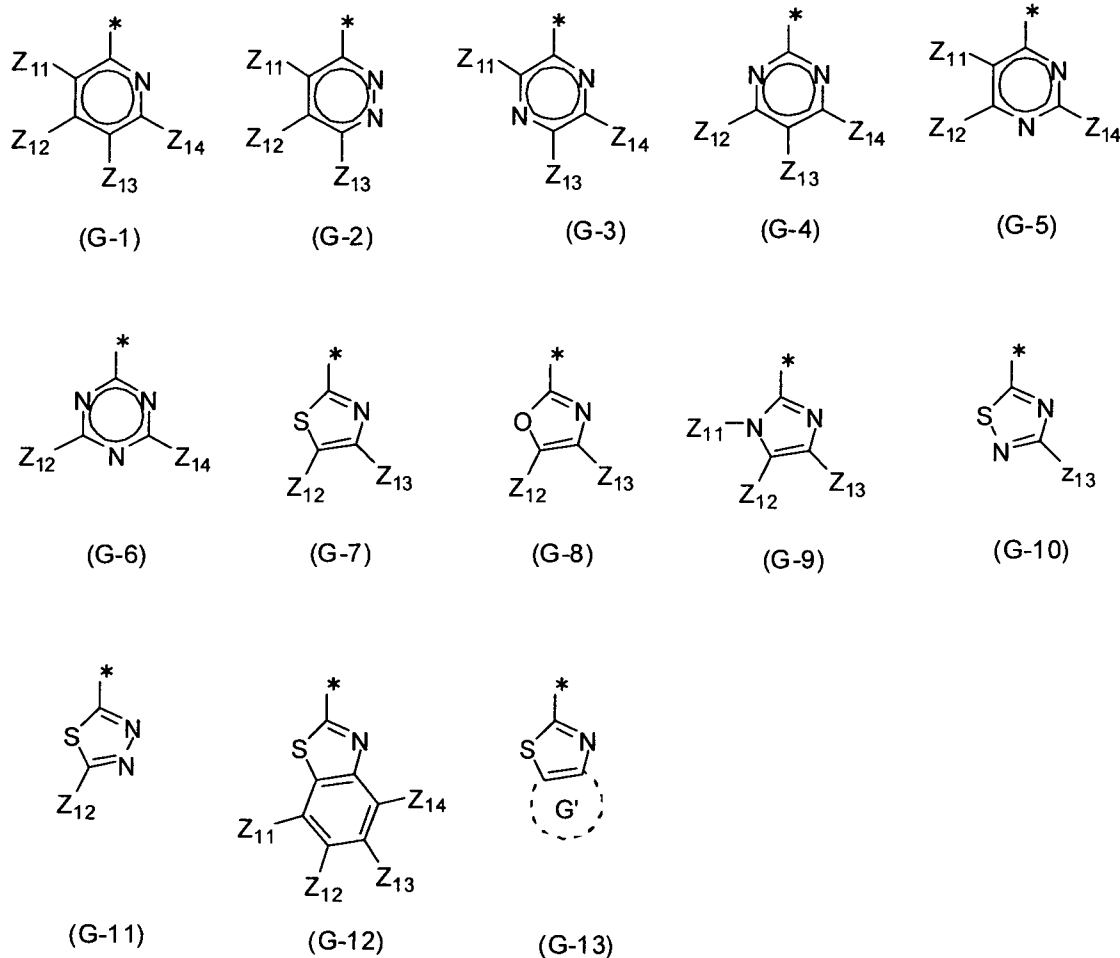
each of G_{11} and G_{12} independently represents the non-metallic atom groups necessary to complete a 5- to 6-membered heterocyclic group, provided that each of the heterocyclic groups represented by G_{11} and G_{12} may independently be unsubstituted or may have a substituent, and may be a monocyclic ring or may have a condensed ring.

9. The azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof according to claim 8, wherein

at least one of the nitrogen-containing heterocyclic groups respectively represented by G_{11} and G_{12} is represented by any one of (G-1) to (G-13) in the

following general formula (8):

General formula (8):



wherein

* in (G-1) to (G-13) shows the point of attachment to the N atom on the pyrazole ring in the general formula (7),

each of Z_{11} to Z_{14} represents a substituent capable of binding to the heterocyclic group, and

G' in (G-13) represents the non-metallic atoms necessary to complete a heterocyclic group.

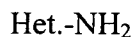
10. A process for producing the azo pigment described in any one of claims 1 to 9, comprising:

preparing a diazonium compound by diazotization of a heterocyclic amine represented by the following general formula (9),

dissolving a compound represented by the following formula (11) in an organic solvent, and

coupling the diazonium compound and the compound represented by the general formula (11) after the dissolution of the compound represented by the general formula (11):

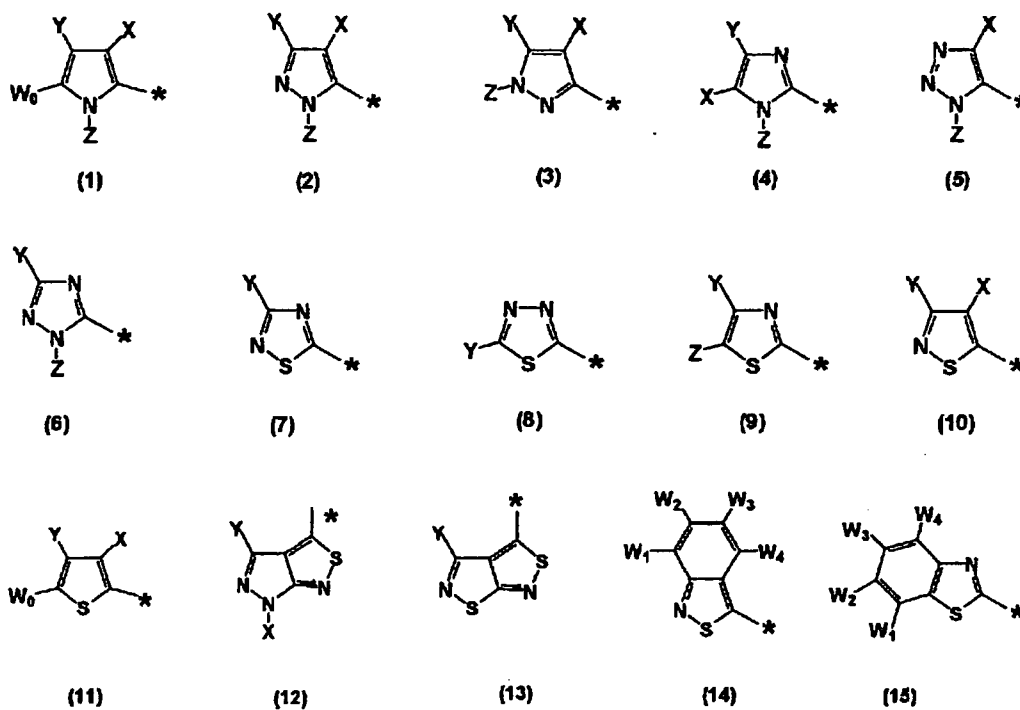
General formula (9)



wherein

Het. represents a heterocyclic group selected from aromatic heterocyclic groups represented by the following general formula (10):

General formula (10)

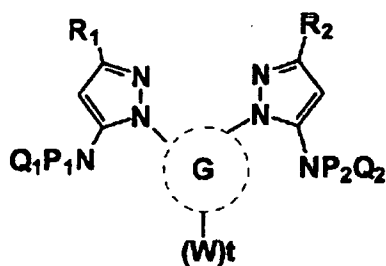


wherein

each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the amino group in the general formula (9):

General formula (11)



wherein

each of R₁, R₂, P₁, P₂, Q₁, and Q₂ independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to

6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G, and

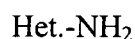
t represents an integer of from 0 to 4.

11. A process for producing the azo pigment described in any one of claims 1 to 9, comprising:

preparing a diazonium compound by diazotization of a heterocyclic amine represented by the following general formula (9),

coupling the diazonium compound and a compound represented by the following general formula (11) in the presence of a polar aprotic solvent:

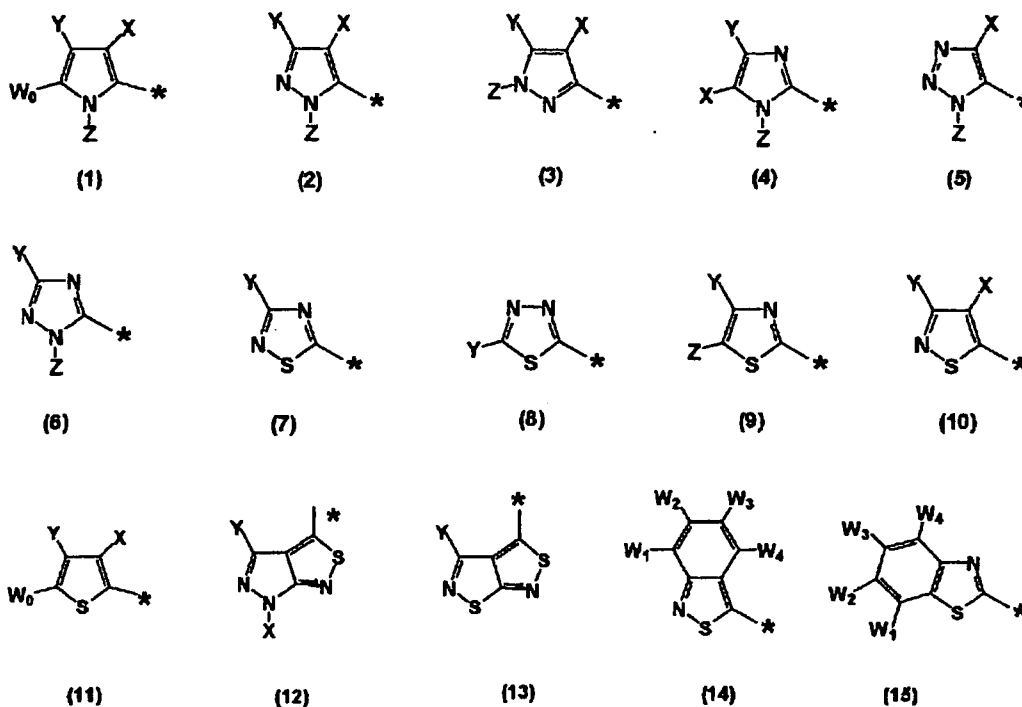
General formula (9)



wherein

Het. represents a heterocyclic group selected from aromatic heterocyclic groups represented by the following general formula (10):

General formula (10)

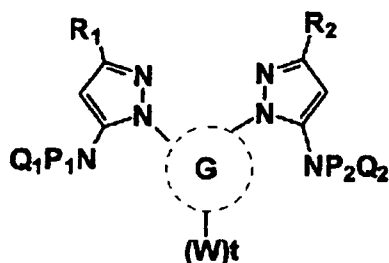


wherein

each of X, Y, Z, W₀, W₁, W₂, W₃, and W₄ independently represents a hydrogen atom or a substituent, and

* shows the point of attachment to the amino group in the general formula (9):

General formula (11)



wherein

each of R₁, R₂, P₁, P₂, Q₁, and Q₂ independently represents a hydrogen atom or a substituent,

G represents the non-metallic atoms necessary to complete a 5- to

6-membered heterocyclic group,

W represents a substituent capable of binding to the heterocyclic group constituted by G, and

t represents an integer of from 0 to 4.

12. The azo pigment according to any one of claims 1 to 9, which is obtained by the process described in claim 10 or 11.

13. A pigment dispersion comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of claims 1 to 9 and 12.

14. A coloring composition comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of claims 1 to 9 and 12.

15. An ink for inkjet recording, comprising:

at least one of the azo pigment, the tautomer of the azo pigment, and the salt or hydrate thereof described in any one of claims 1 to 9 and 12.

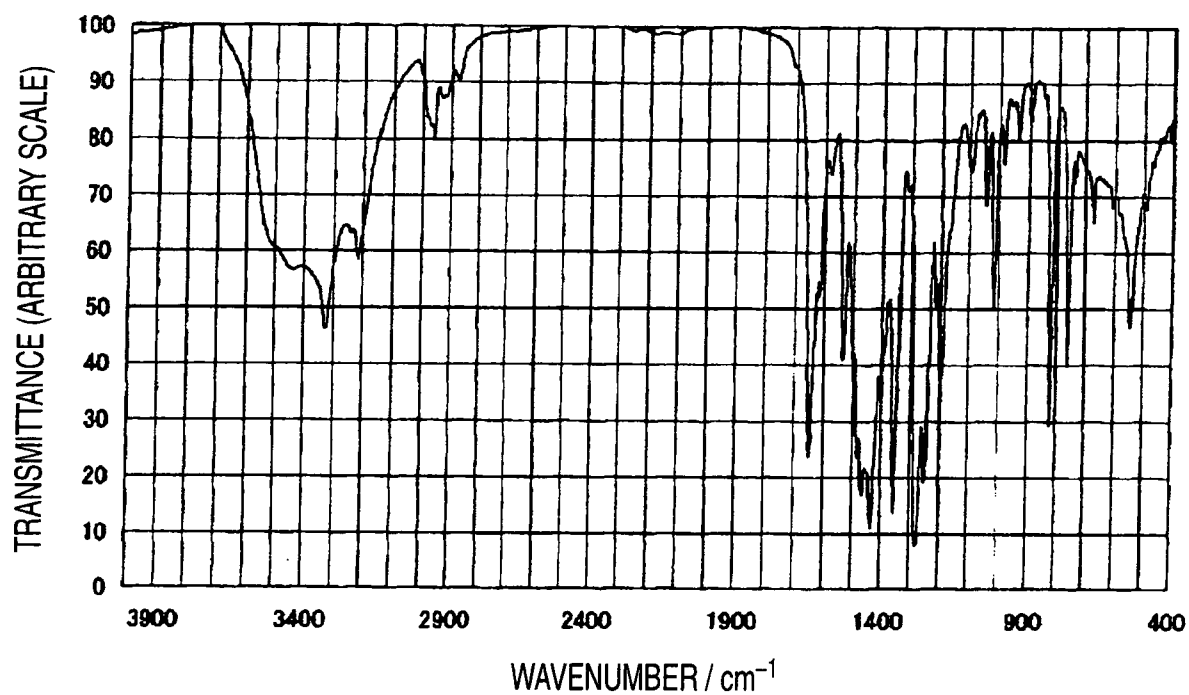
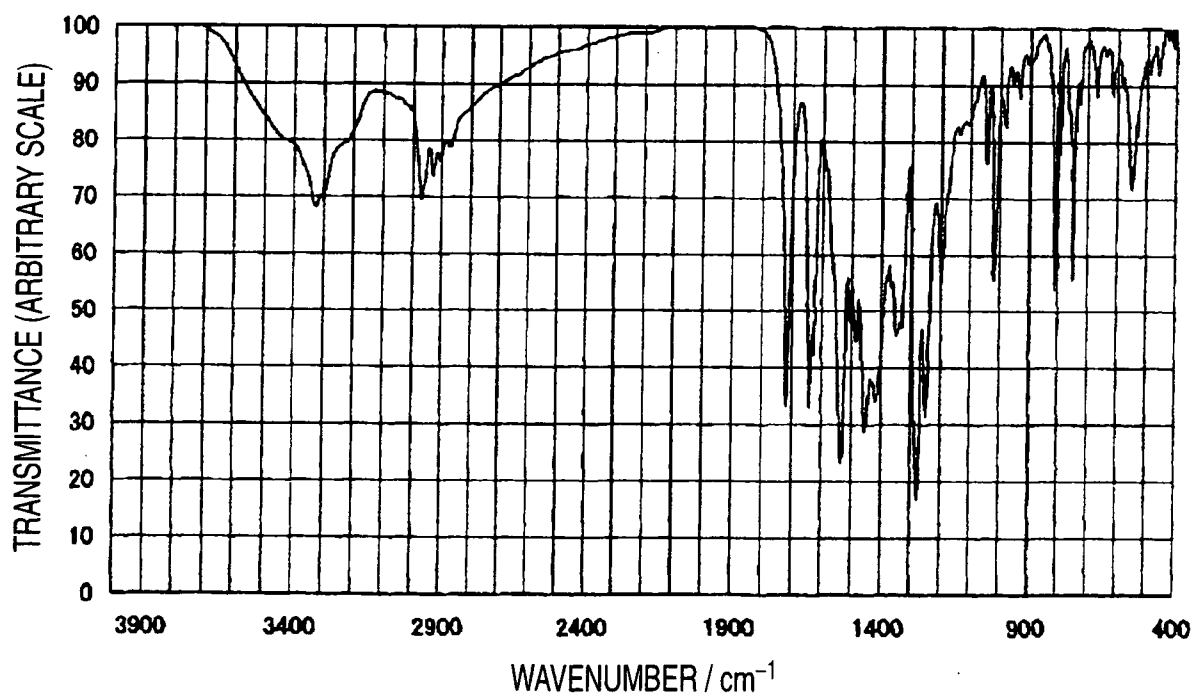
FIG. 1*FIG. 2*

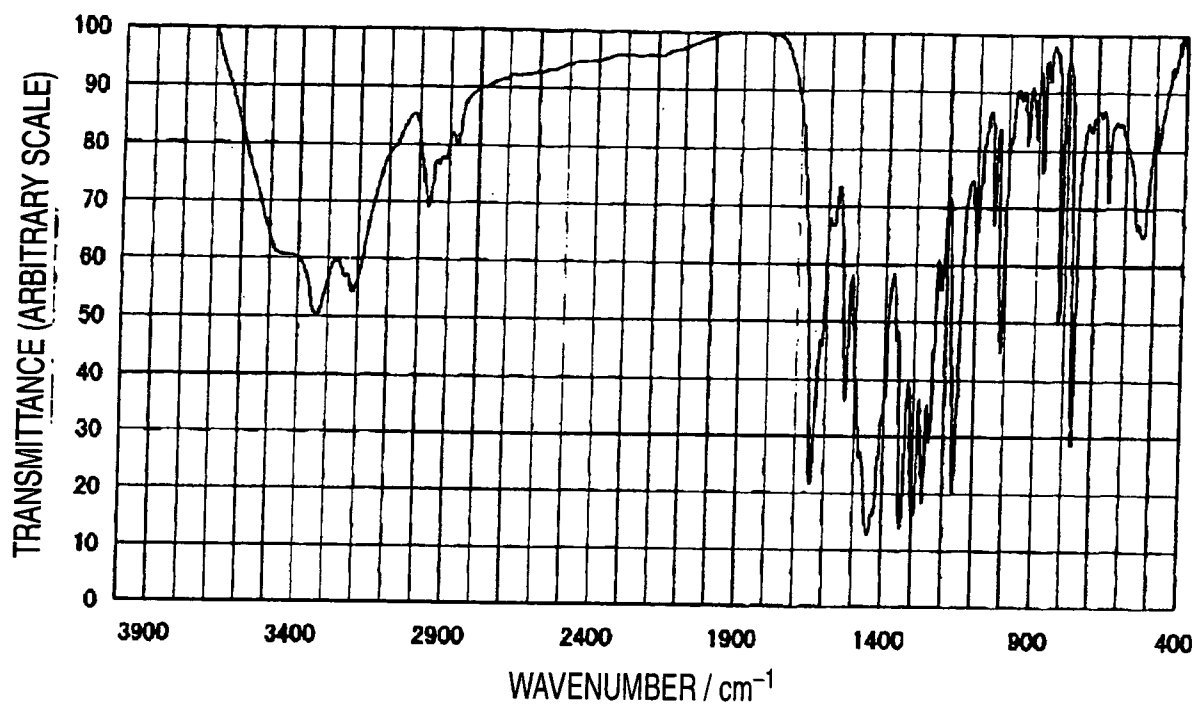
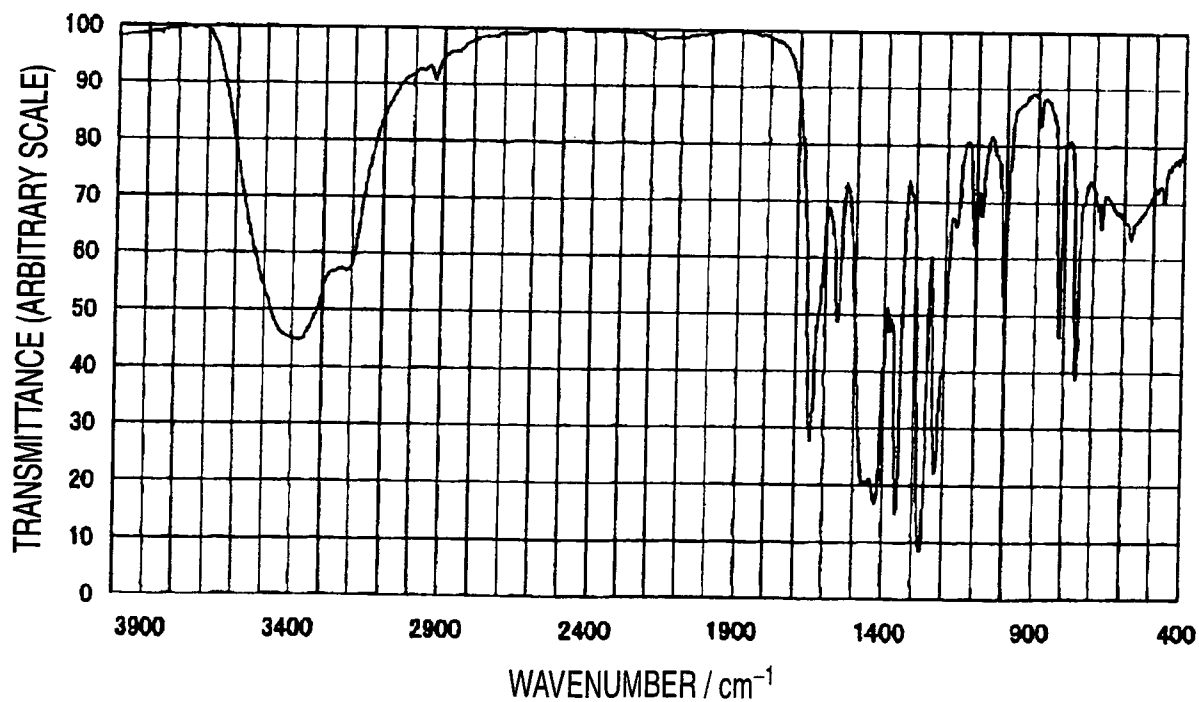
FIG. 3*FIG. 4*

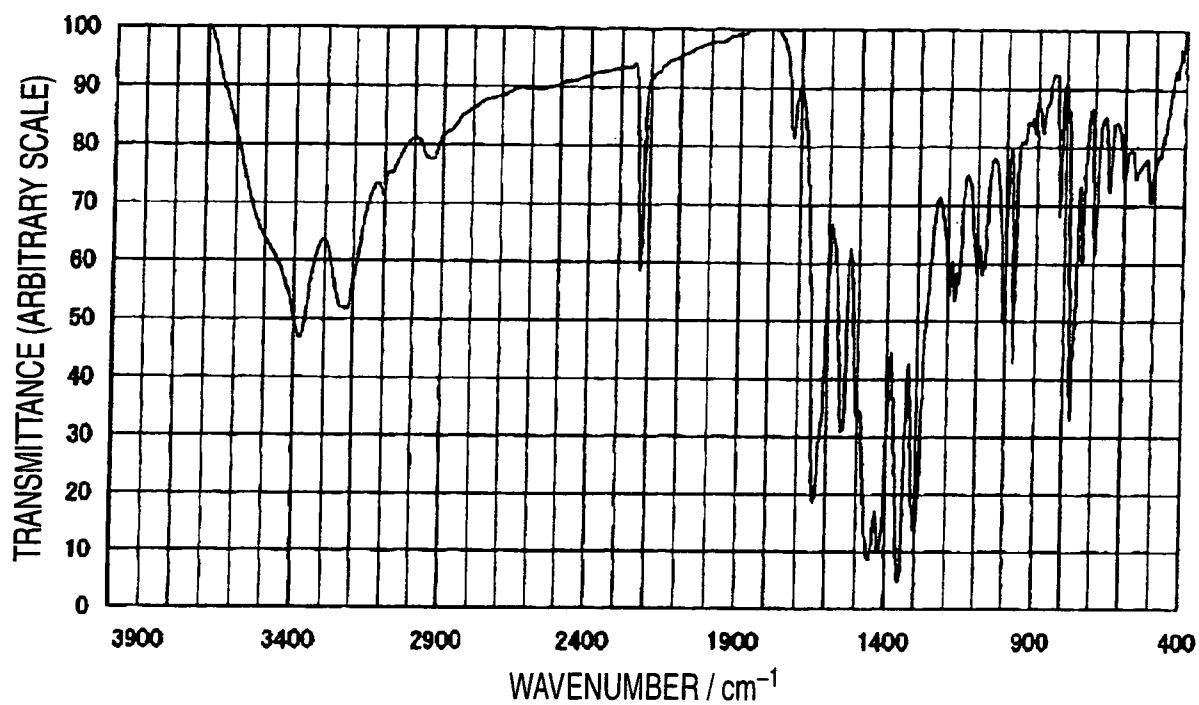
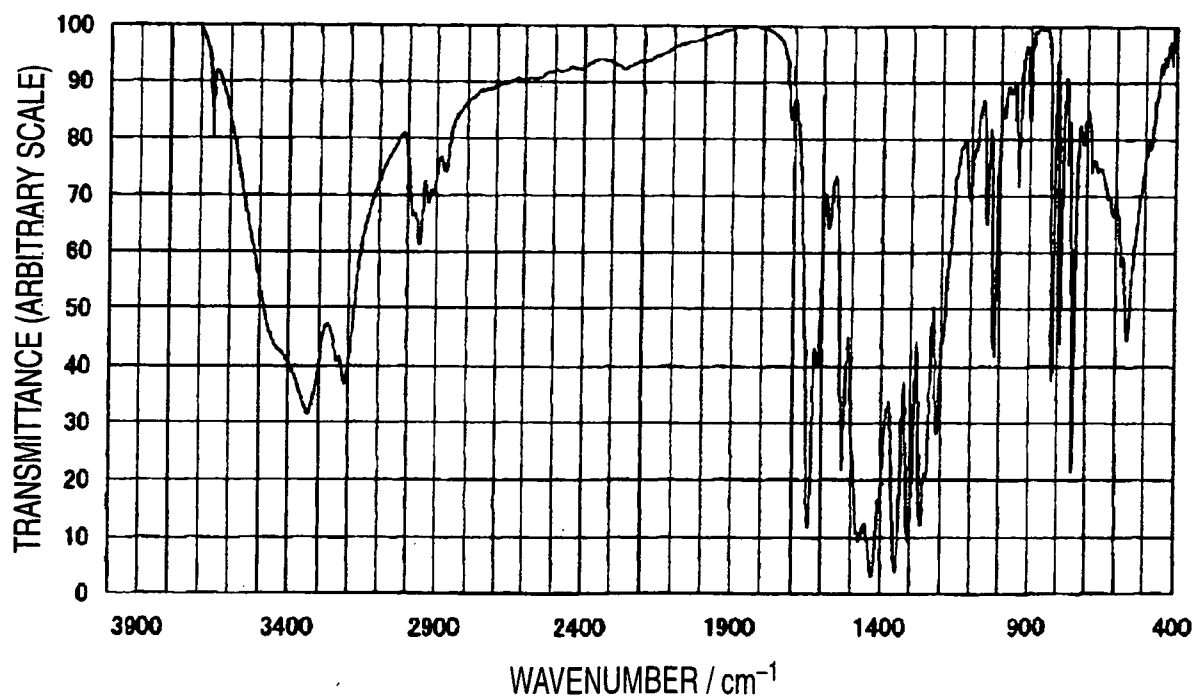
FIG. 5*FIG. 6*

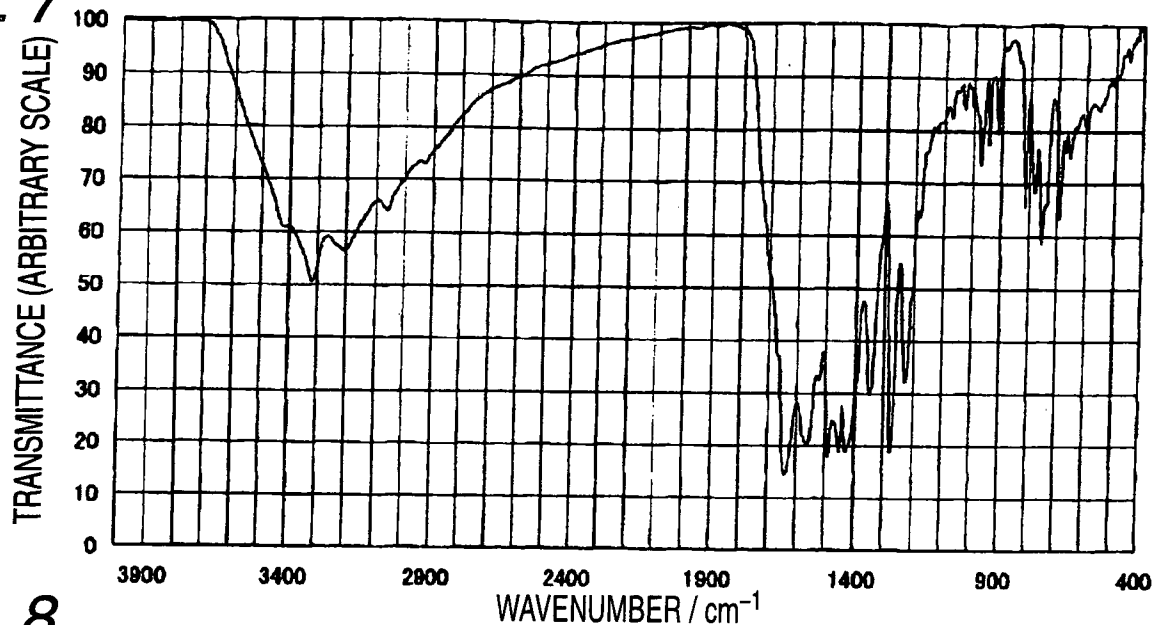
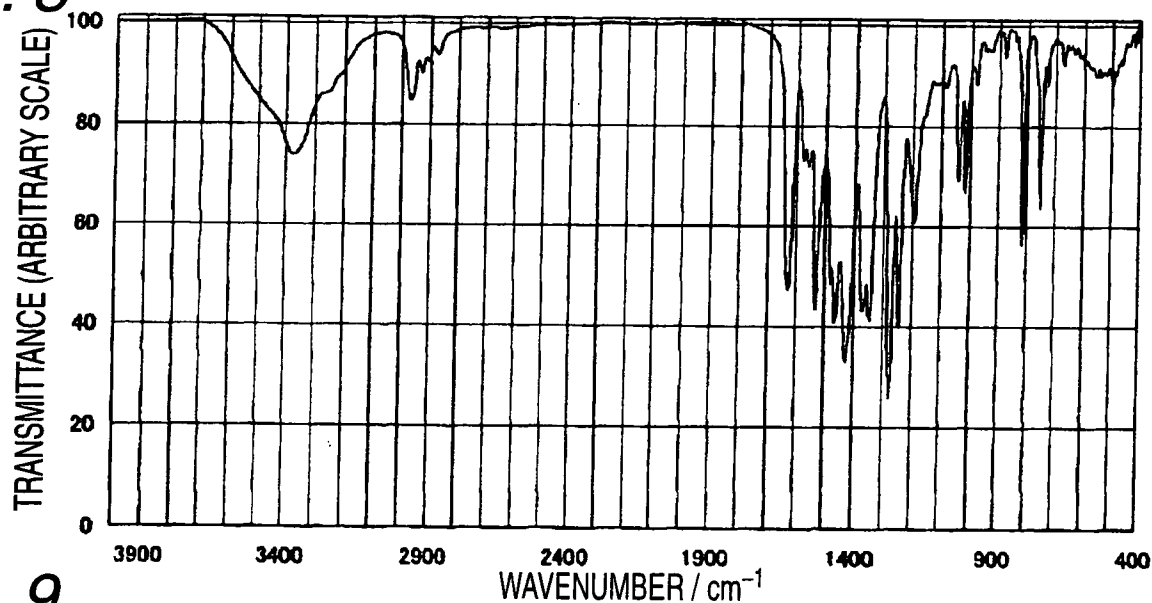
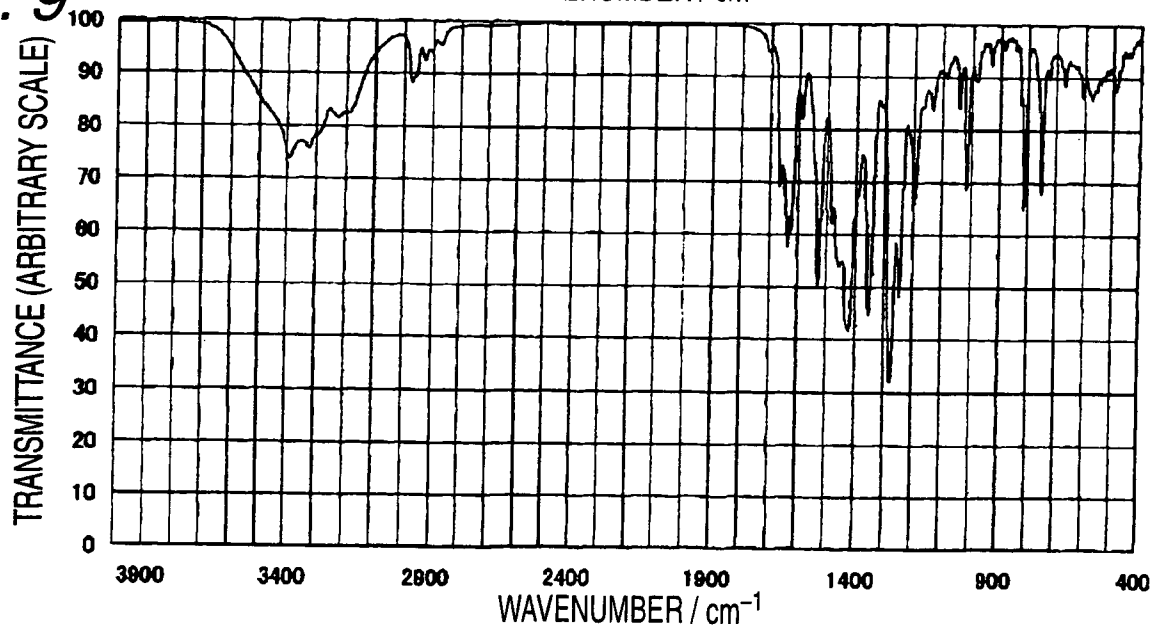
FIG. 7**FIG. 8****FIG. 9**

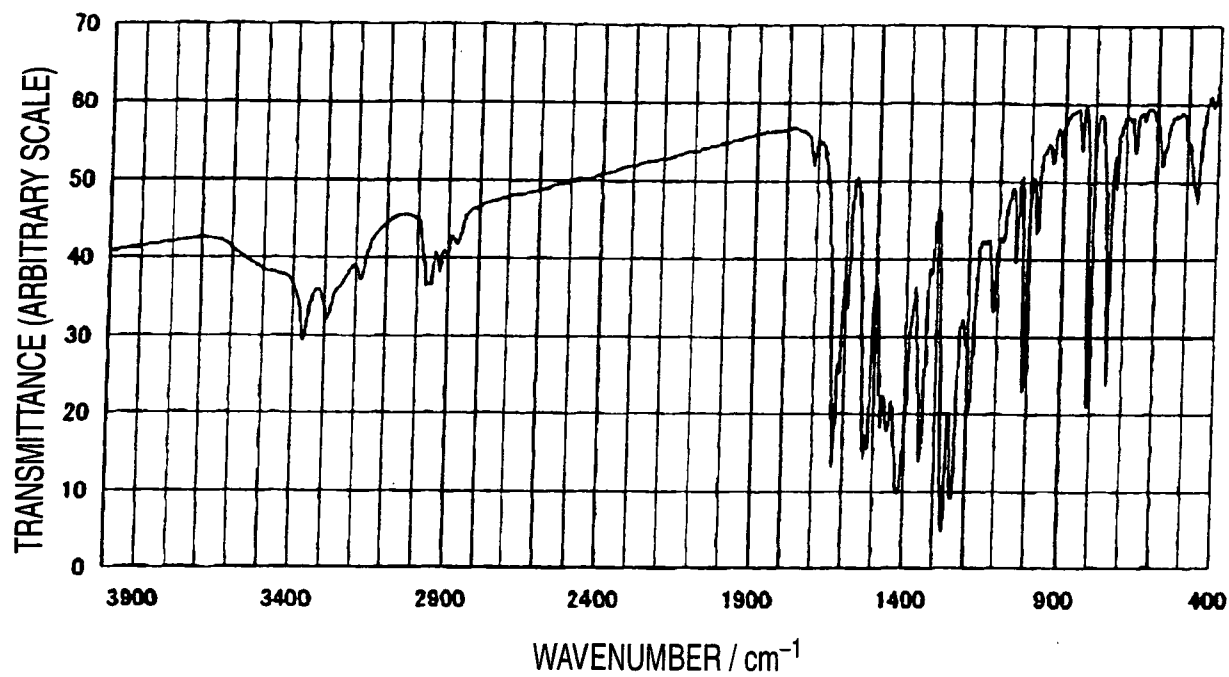
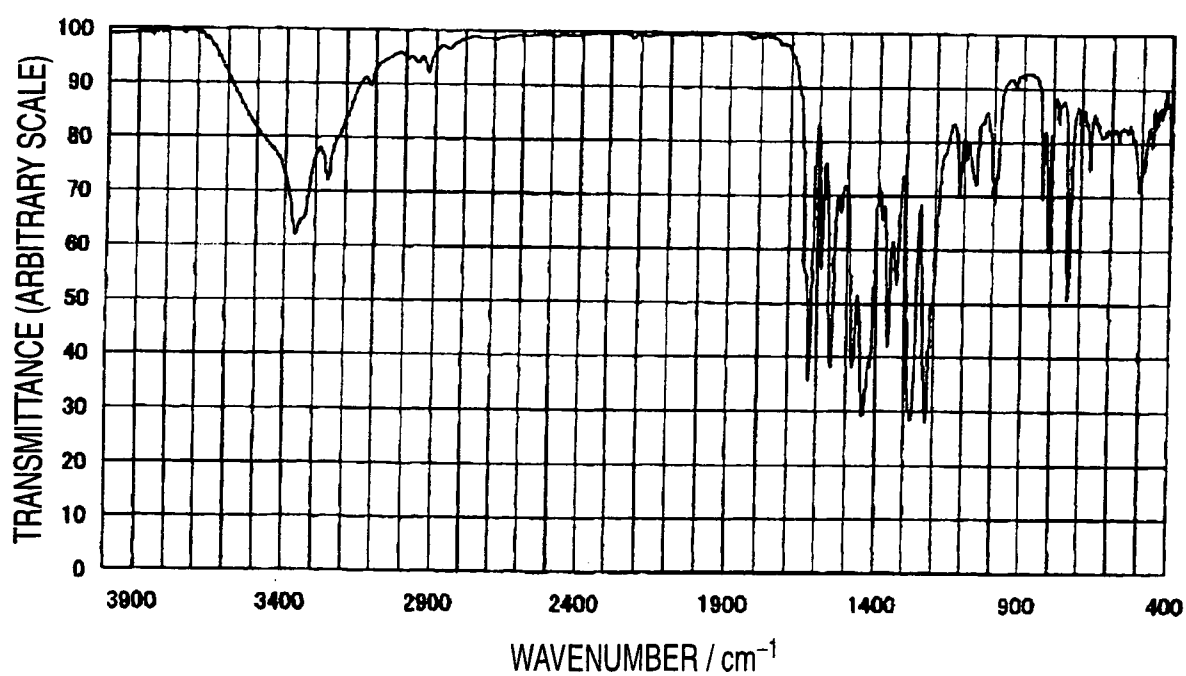
FIG. 10*FIG. 11*

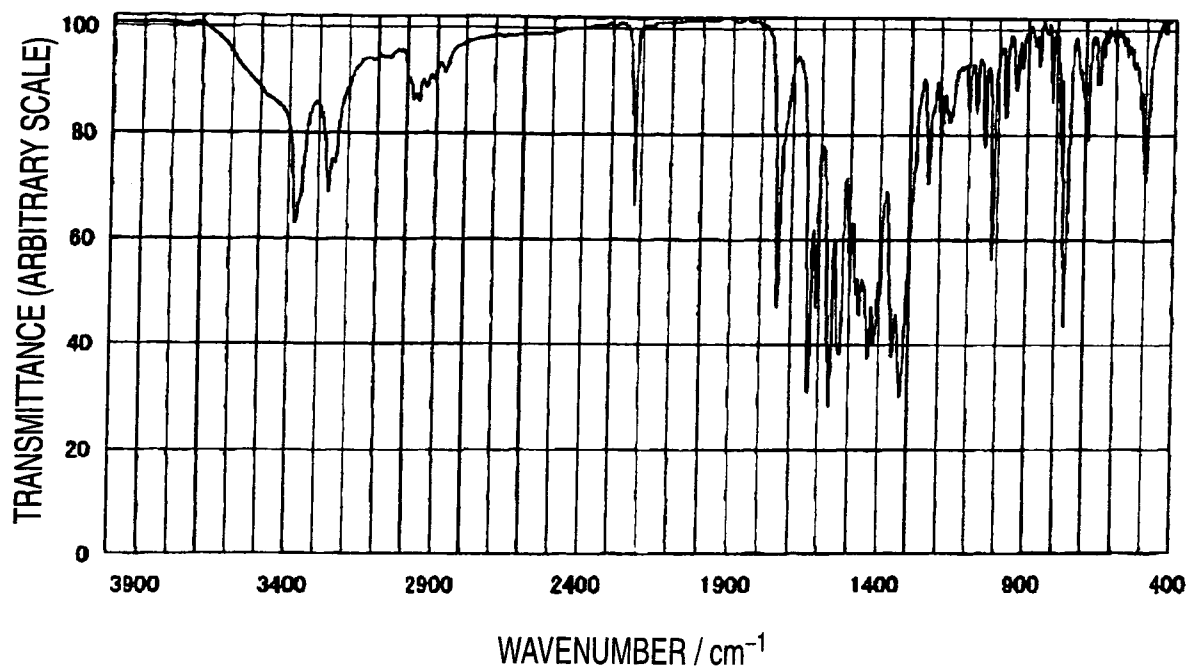
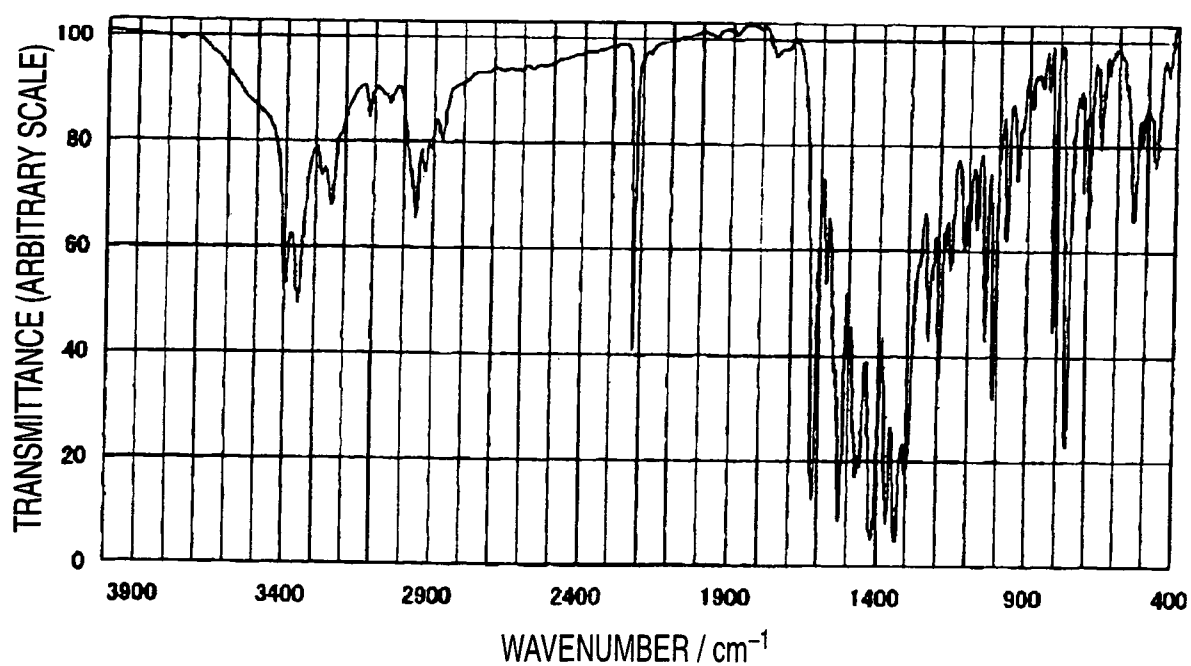
FIG. 12*FIG. 13*

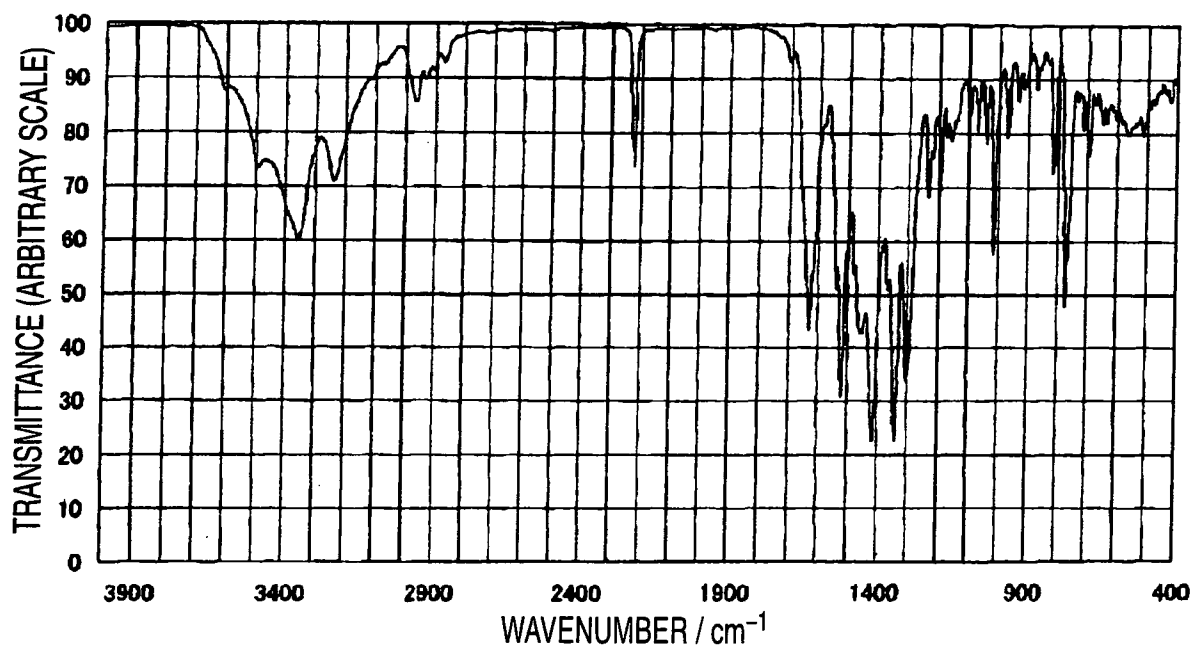
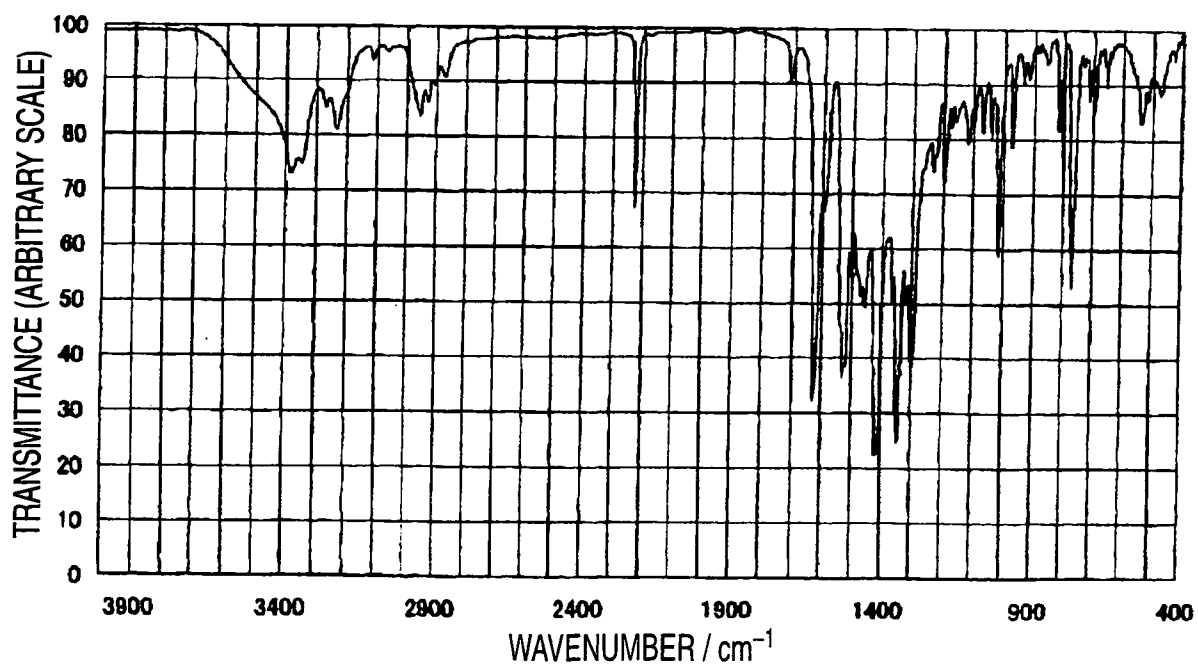
FIG. 14*FIG. 15*

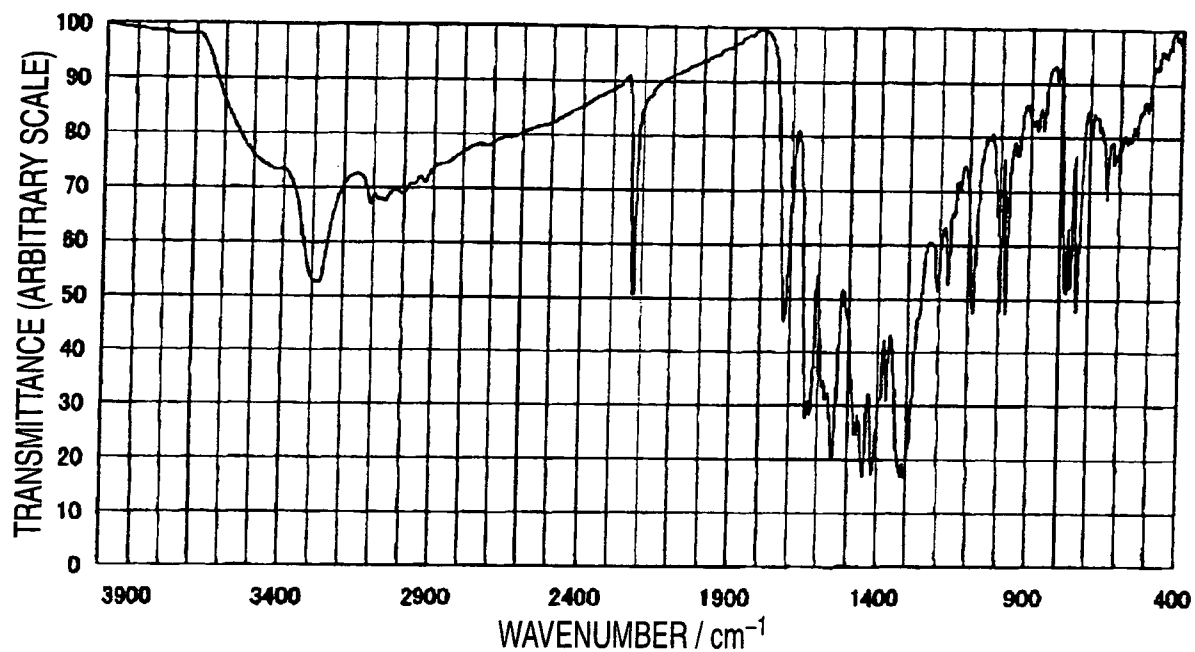
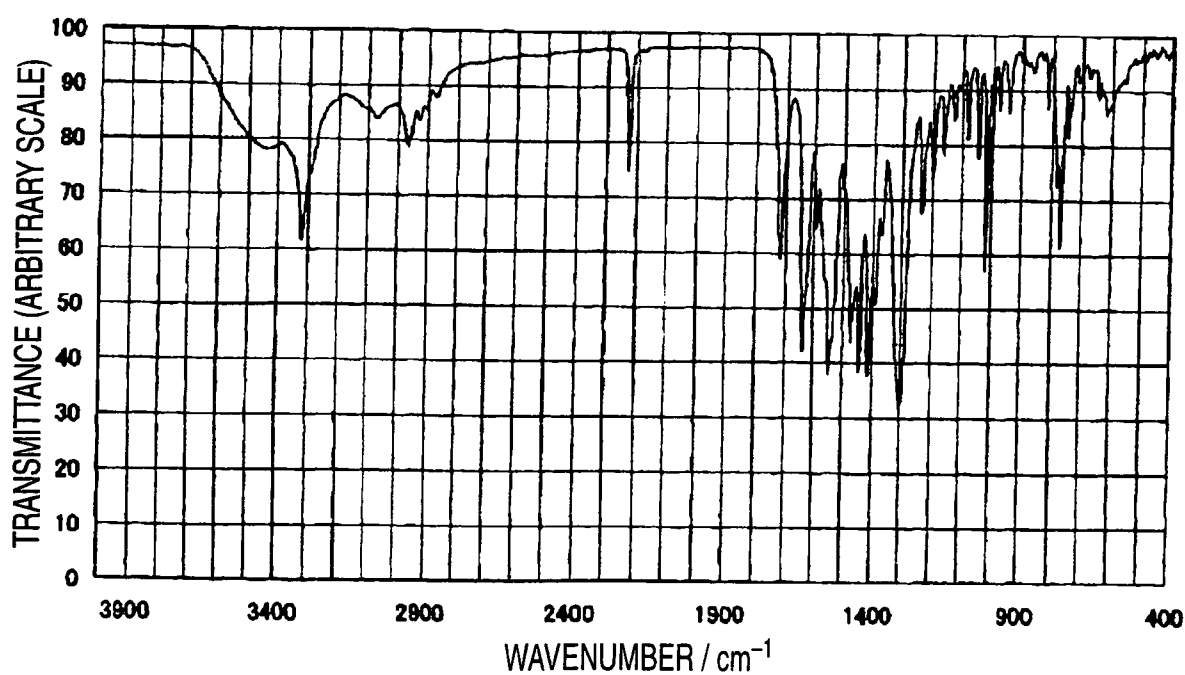
FIG. 16*FIG. 17*

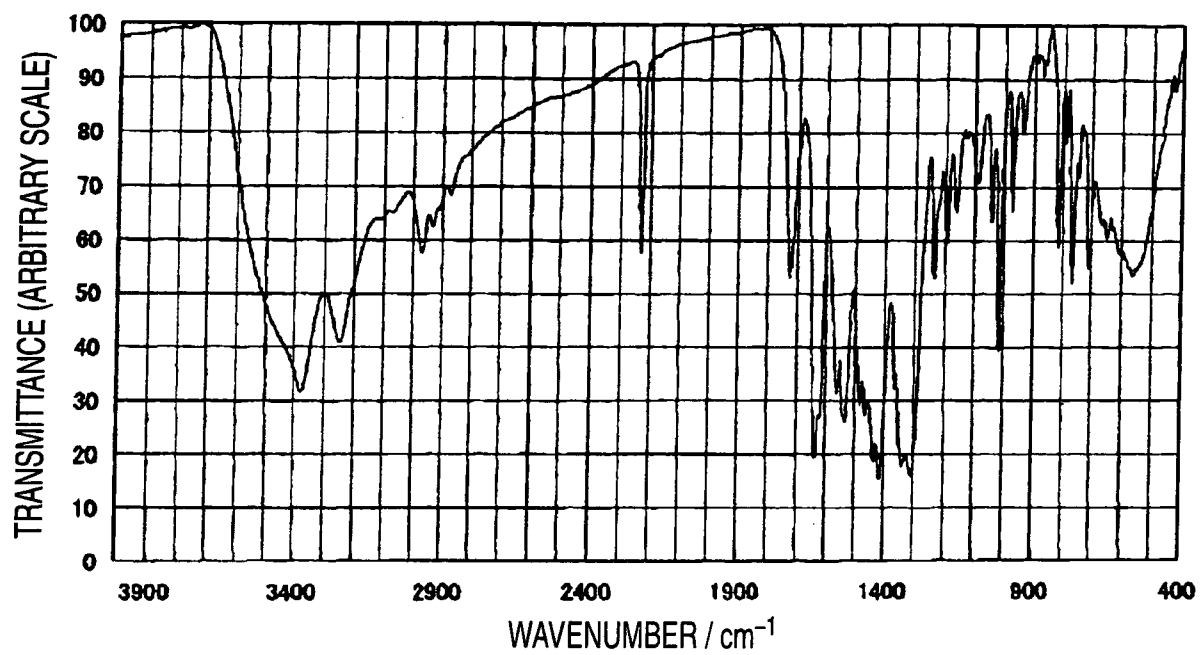
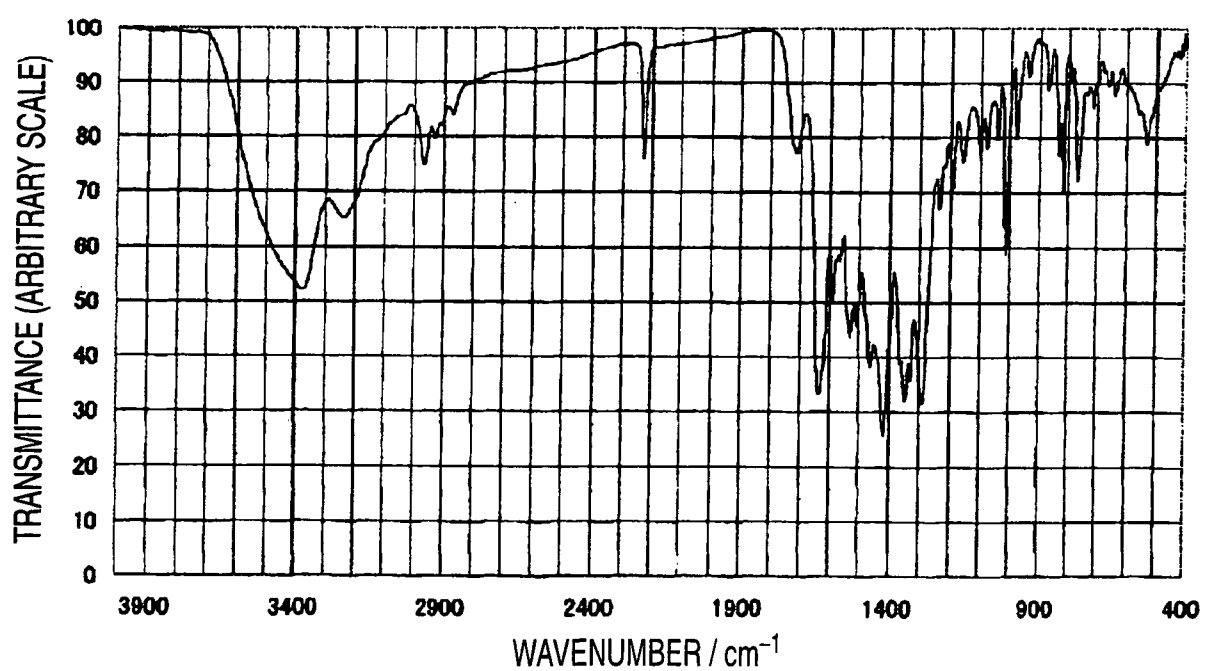
FIG. 18*FIG. 19*

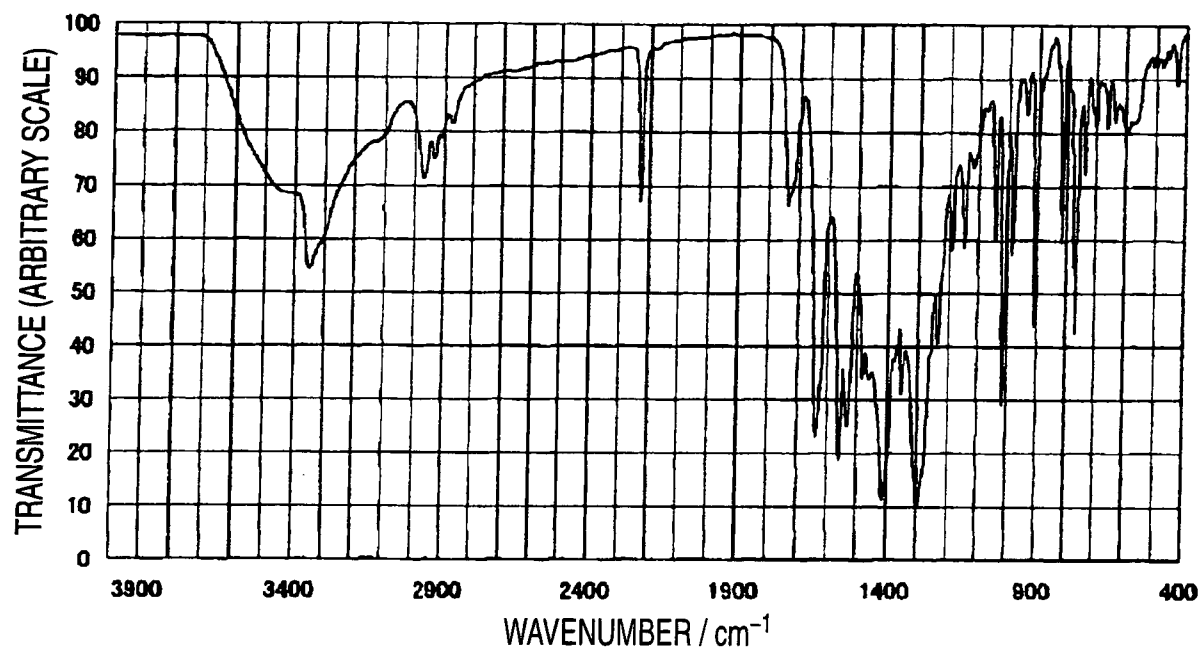
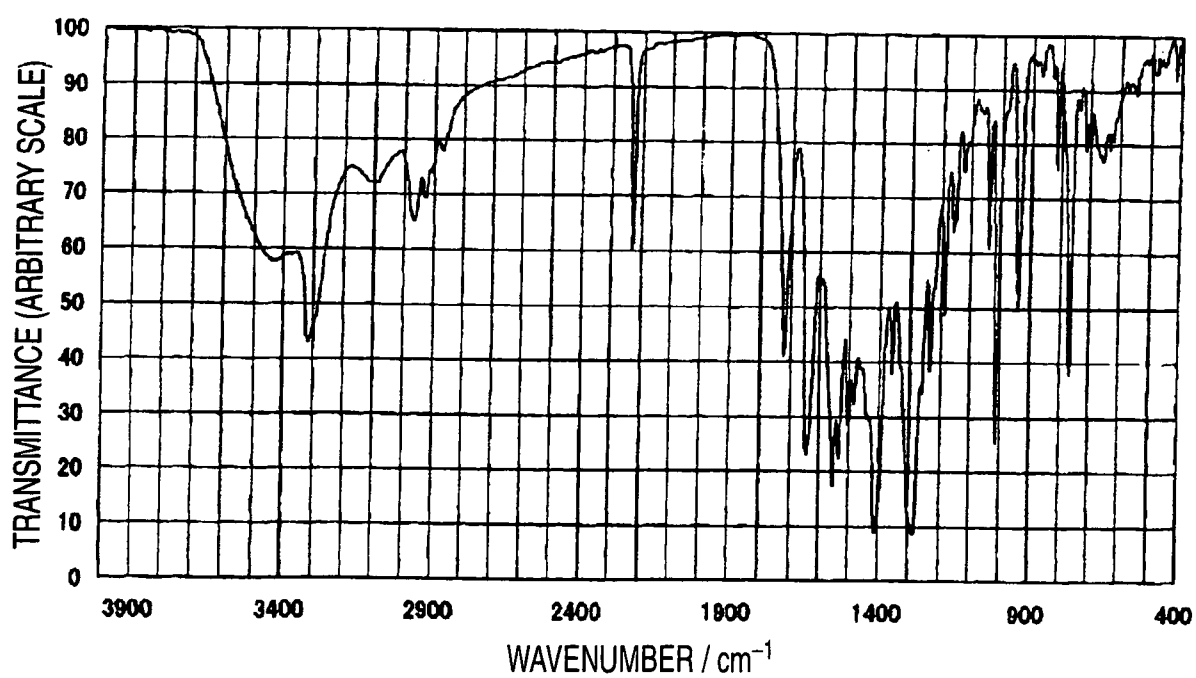
FIG. 20*FIG. 21*

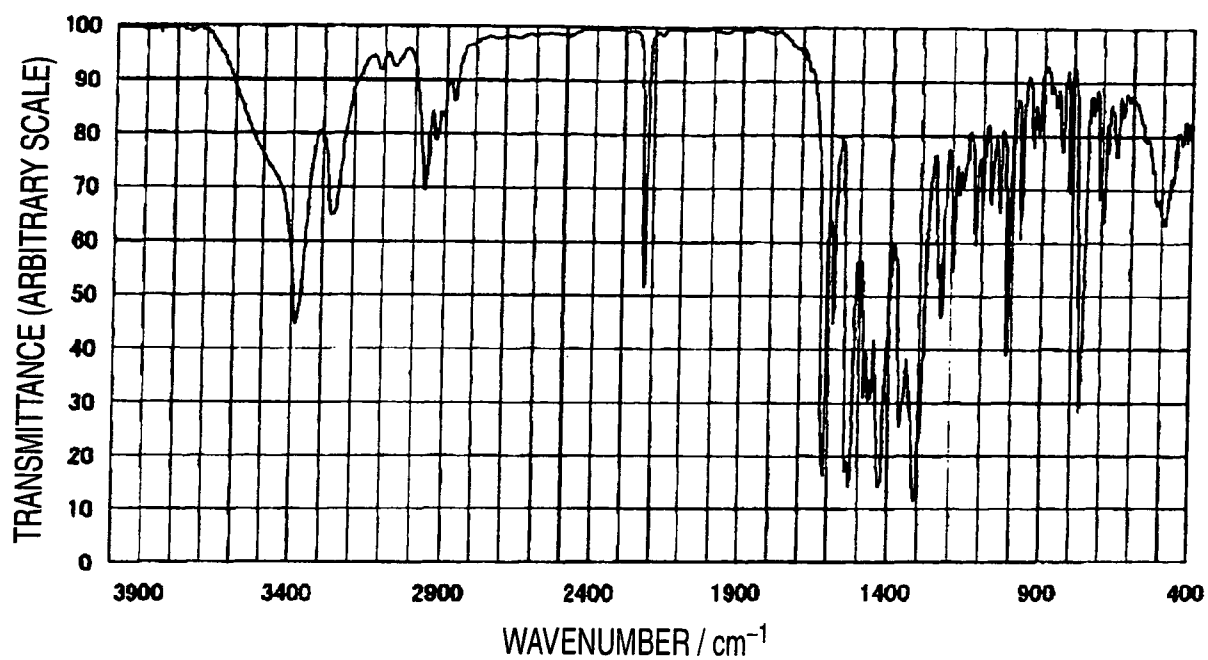
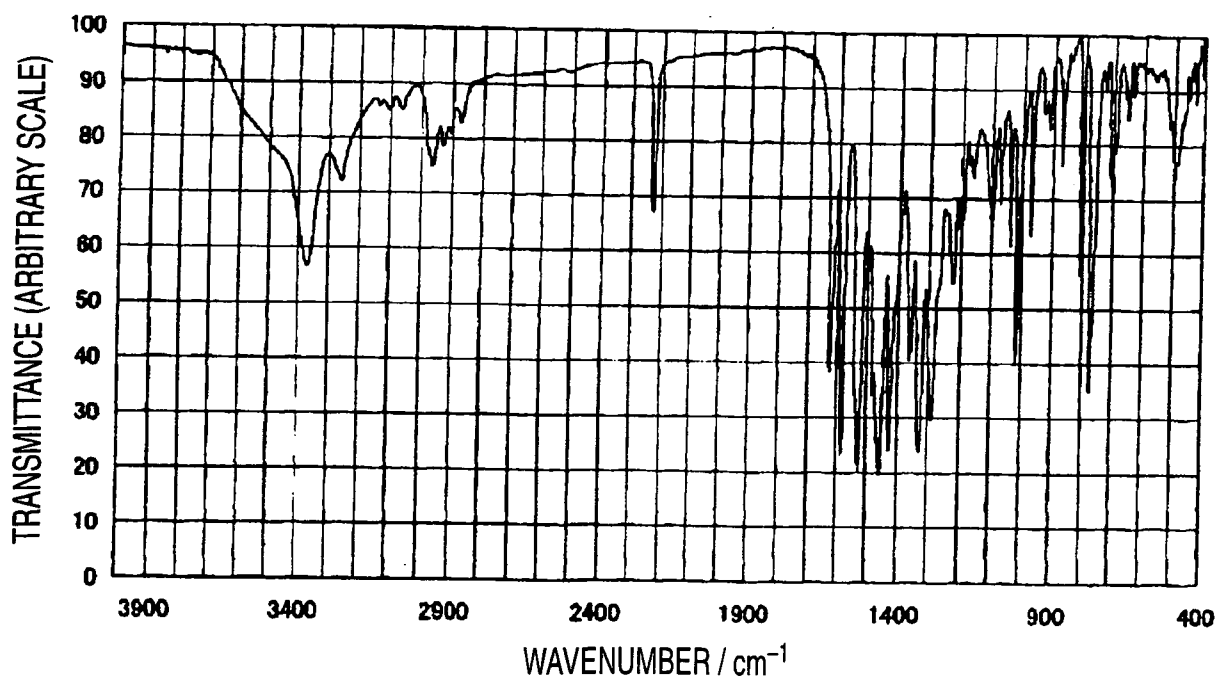
FIG. 22*FIG. 23*

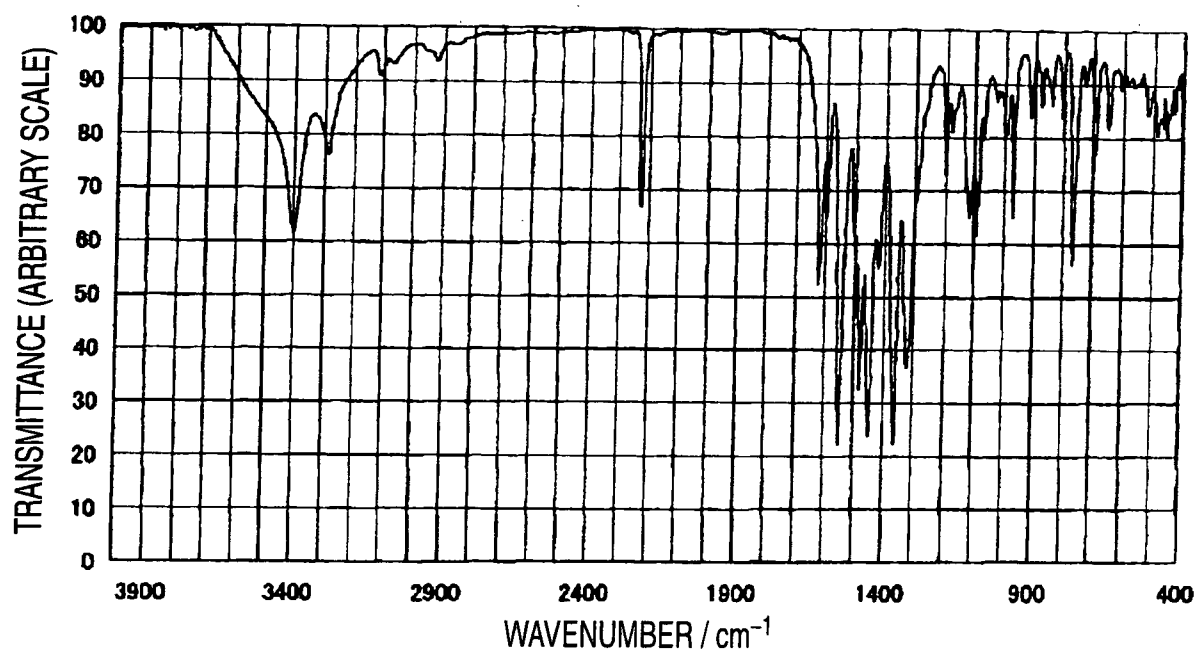
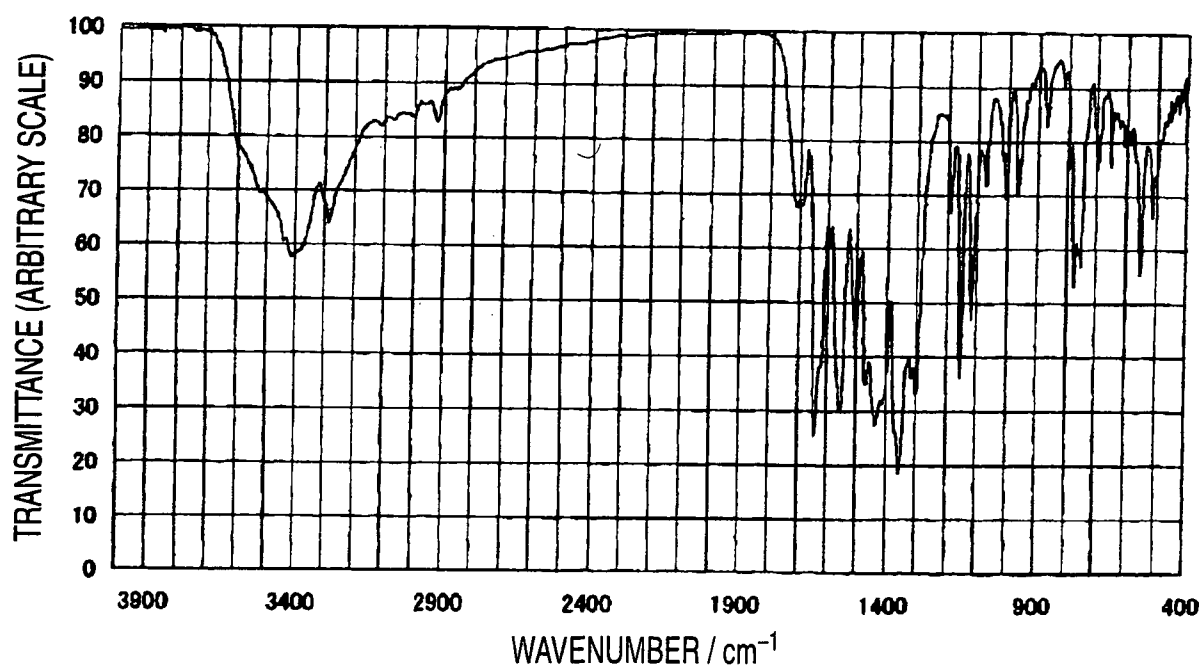
FIG. 24*FIG. 25*

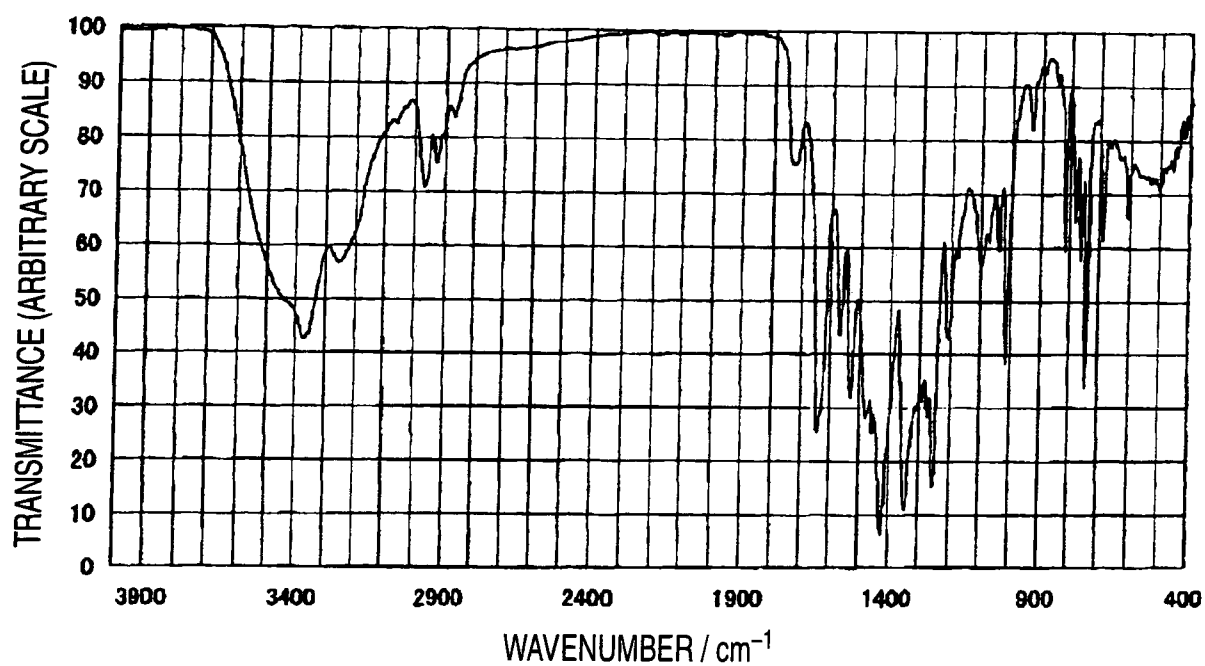
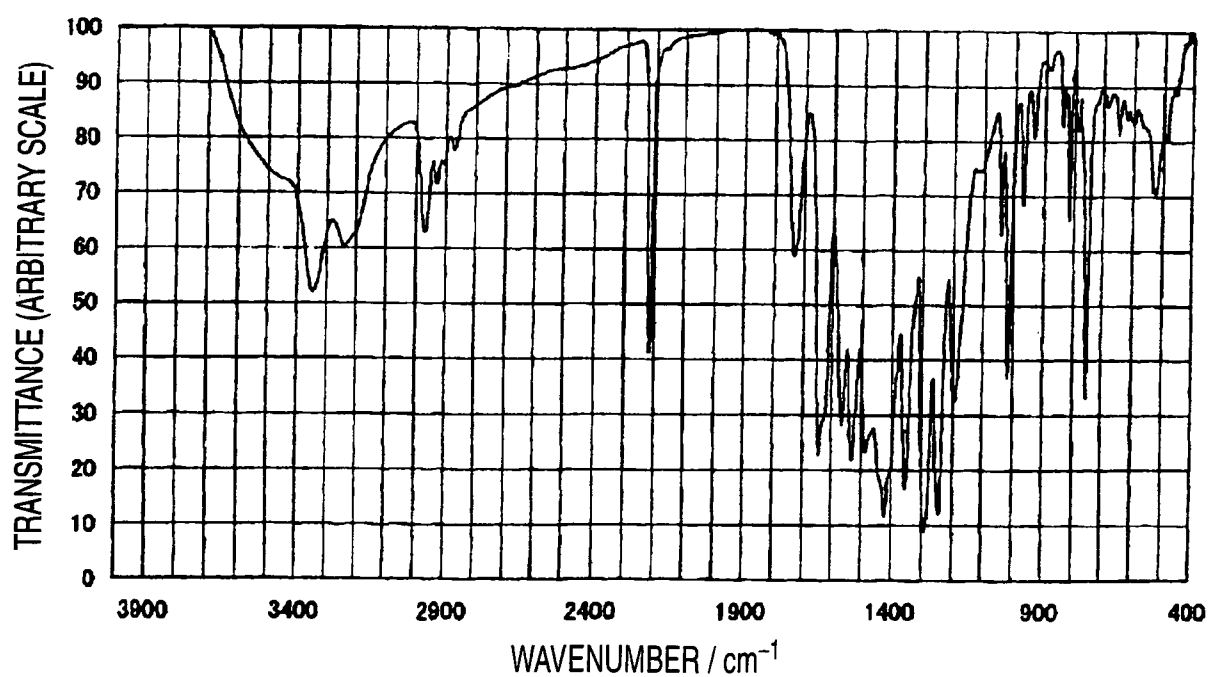
FIG. 26*FIG. 27*

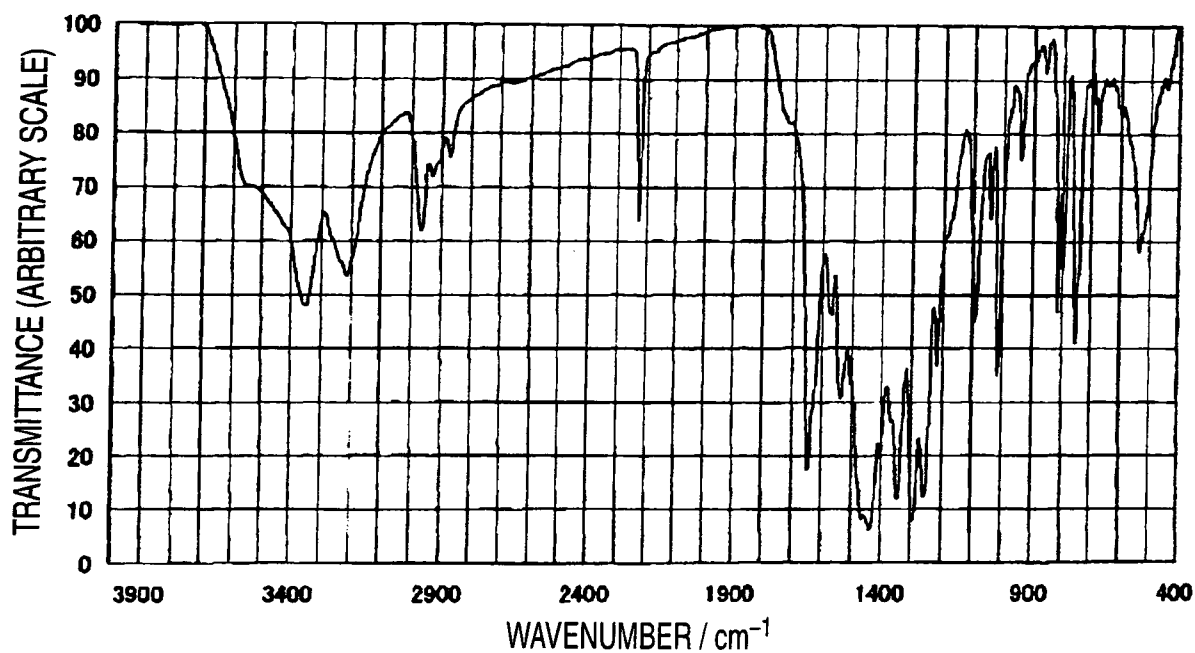
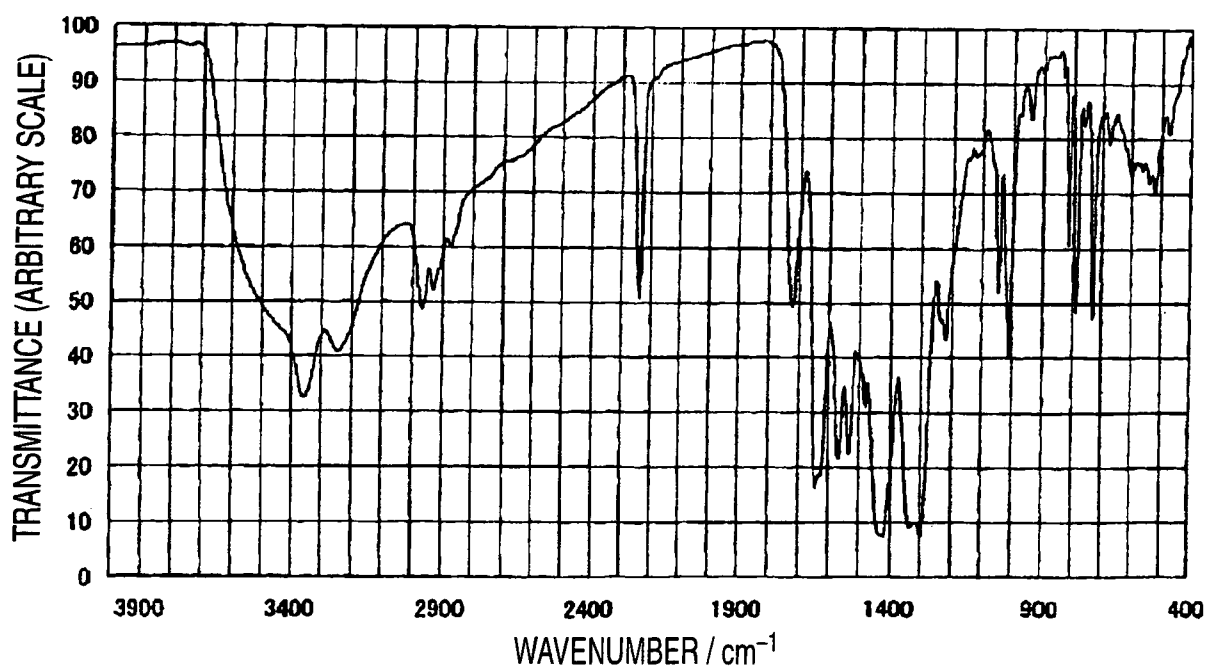
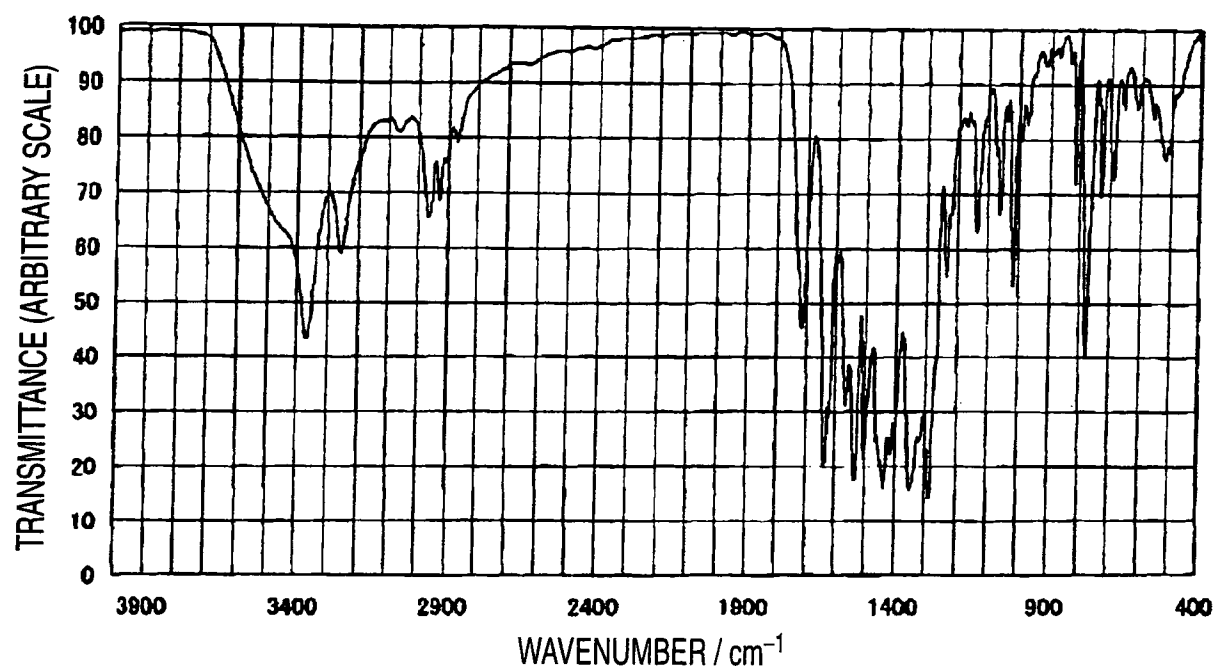
FIG. 28*FIG. 29*

FIG. 30*FIG. 31*