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(73) Patenthaver: **Polska Wytwornia Papierow Wartosciowych S.A., Ul. Sanguszki 1, 00-222 Warszawa, Polen**

(72) Opfinder: **Gurtowska, Joanna, ul. Zeglugi Wislanej 16a/52, 03-043 Warszawa, Polen**
Biernacki, Ariel, ul. Anastazego Kowalczyka 1/88, 03-193 Warszawa, Polen
Molga, Edyta, Ul. Abrahama 18 m. 165, 03-982 Warszawa, Polen
Wojcik, Pawel Tomasz, ul. Mysliborska 98E m. 66, 03-185 Warszawa, Polen
Wojciechowska, Agata, ul. Na Uboczu 28B/27, 02-791 Warszawa, Polen
Leszczynska-Ambroziewicz, Ewa, ul. Lazurowa 6, 05-200 Wolomin, Polen

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

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WO-A1-2004/050376
WO-A2-95/13597
US-A1- 2011 298 204

DESCRIPTION

TECHNICAL FIELD

[0001] The disclosure relates to security documents, in particular comprising a substrate layer with a printed security feature.

BACKGROUND

[0002] Security documents comprise various security features that make them difficult to be copied and falsified. The security features may, for example, have a form of an imprint on a substrate of the document, comprising various digits, letters or other graphical symbols. The security features may be permanent (i.e. the same for a group of documents) or personalized (i.e. individual for each document).

[0003] There are known various pigments utilized in film-forming print compositions, which are invisible for a naked eye in a visible light, but become visible when illuminated with an electromagnetic wave of a specified wavelength, different than the spectrum of visible light (VIS), for example by infrared light (IR) or ultraviolet light (UV).

[0004] There are known anti-stokes pigments, which exhibit up-conversion luminescence - they are invisible for human eye in the visible light, but when excited by infrared light in the range of 900-1000nm they become visible in a specified colour, which depends on the pigment structure and its chemical composition.

[0005] The up-conversion luminescence, involving emission of anti-stokes radiation, occurs for up-conversion of luminescent pigments, when the excited electron in the pigment particle absorbs another energy quantum in the form of a photon, which results in additional excitation of the electron (it is transferred to an even higher energy band). When the excited electron subsequently returns to its base state, it emits a photon of energy which is the sum of the energy of both absorbed photons, decreased by the energy of the rotational-vibrational excitation of the pigment particle. Therefore, the energy emitted by the pigment particle results in radiation (electromagnetic wave) of a wavelength shorter than the wavelength of the absorbed radiation. Therefore, the emitted radiation is shifted towards higher frequencies. In case when photons absorbed by the electron of the pigment particle are photons from the infrared radiation frequency, the emitted radiation may be in the visible light spectrum. The up-conversion luminescence is observed for some pigments having a crystal structure which are doped with ions of rare earth chemical elements: lanthanides, i.e. chemical elements with an atomic number between 59 and 71 (Ce - Lu).

[0006] A PCT patent application WO9513597A2 discloses a copy protection device that

comprises a marking defined by a pair of inks which present a continuous, substantially plain coloured area when viewed and illuminated under visible light, but when the area is scanned at and/or illuminated under at least one wavelength outside the visible wavelength range, a pattern is generated which is detectable.

[0007] A US patent application US2011298204A1 discloses a a security mark with visible and hidden portions. Each first mark constituent is visible in a first lighting condition and is detectable in a second lighting condition; each second mark constituent is hidden in the first lighting condition and is detectable in the second lighting condition; each third mark constituent is visible in the first lighting condition and is hidden in the second lighting condition. The first lighting condition is visible light and the second lighting condition is IR or UV light.

[0008] A PCT patent application WO2004050376A1 discloses a security device that comprises two or more regions, wherein each region contains a material or combination of materials wherein the two or more regions exhibit substantially the same visible appearance under first viewing conditions and different visible appearances under second viewing conditions. The second viewing conditions comprise a combination of a) visible light and b) substantially any UV wavelength.

[0009] In the above-mentioned applications, the different visibility of the areas in the IR region is due to different absorption spectrum of the inks used in the wavelength outside the visible wavelength range. For example, the prior art inks may have absorption spectra as shown in Fig. 4A.

[0010] There is a need to provide a security document comprising a substrate with a printed security feature, which may take advantage of the up-conversion luminescence phenomenon, for securing the document against forgery and allowing an unequivocal and simple procedure for verification of the authenticity of the document.

SUMMARY

[0011] The object of the invention is a security document comprising a substrate layer with a printed security feature comprising a first area and a second area, wherein in both areas the security feature is visible under visible light in a basic colour, characterized in that when excited with infrared light, the first area is visible in visible light in a first colour and the second area is visible in visible light in a second colour different than the first colour, wherein the security feature is a print layer made of a composition comprising, in the first area, a first additional up-conversion luminescence pigment excitable by the infrared light, and in the second area a second additional up-conversion luminescence pigment excitable by the infrared light, wherein the second additional pigment is different than the first additional pigment.

[0012] The security feature may be a print layer made of a composition comprising, in the first area and in the second area, a basic pigment visible in visible light.

[0013] The film-forming compositions of the first area and the second area may have substantially the same absorption spectra across the visible and infrared wavelengths.

[0014] The difference ΔE_{1-2} between the first and the second colour in a CIELab space may be equal to at least 5.

[0015] The difference difference ΔE_{1-B} between the first colour and the basic colour, as well as the difference ΔE_{2-B} between the second colour and the basic colour may be equal to at least 5.

[0016] The first area may be located on the substrate layer in a distance from the second area.

[0017] The first area on the substrate layer may be adjacent to the second area.

[0018] The first area on the substrate layer may overlap, at least partially, the second area.

[0019] The security feature may be located between two layers of a substrate.

BRIEF DESCRIPTION OF FIGURES

[0020] The security document is presented herein by means of example embodiments shown in a drawin, in which:

Fig. 1A presents schematically a cross-section of a first embodiment of a security document.

Fig. 1B presents schematically a cross-section of a second embodiment of a security document.

Fig. 2A-2C present schematically various locations of security print areas.

Fig. 3 presents schematically pigments used in different areas of the security print.

DETAILED DESCRIPTION

[0021] A security document 10, shown in a cross-section in the first embodiment in Fig. 1A, comprises a substrate layer 12 with a print layer 11 applied thereon.

[0022] The security document shown in a cross-section in the second embodiment in Fig. 1B, differs from the first embodiment from Fig. 1A in that the print layer 11 is located between two

layers of the substrate material 12, 13 - for example, it is printed on one of the layers 12 and subsequently covered with the second layer 13, wherein the two layers are subsequently laminated with each other.

[0023] The substrate layer 12, 13 may be made of various materials, including a single material or more than one type of material. It may have a form of a single layer, a laminate or a composite material. For example, the substrate layer 12, 13 may be made of paper or thermoplastics or thermosetting plastics such as: polycarbonate (PC), polyethylene (PE), polypropylene (PP), acrylonitrile-butadienestyrene (ABS), poly(methyl methacrylate) (PMMA), poly(styrene-co-acrylonitrile) (SAN), polyvinyl chloride (PVC) or various kinds of resins, for example, phenolic, or phenol-formaldehyde resins.

[0024] The print layer 11 forms a security feature for the document 10. The print layer 11 is made of a film-forming composition, which may be applied to the substrate 12 by means of various techniques, such as: inkjet printing, offset printing, intaglio printing or screen printing.

[0025] The print layer comprises a first area 11a and a second area 11b. In one form of a pattern as shown in Fig. 2a, the first area 11a may be applied on the substrate 12 in a distance from the second area 11b. In another form of the pattern, as shown in Fig. 2B, the first area 11a may be adjacent to the second area 11b. In yet another form of the pattern, as shown in Fig. 2C, the first area 11a may partially overlap with the second area 11b. The areas 11a, 11b may form various shapes, such as graphical symbols, letters or digits.

[0026] The print layer 11 is made of a pigmented film-forming composition, such as a paint, lacquer, enamel or ink. The composition includes pigments visible in a visible light and pigments excited by an infrared light.

[0027] Both areas 11a, 11b comprise a basic pigment visible in the visible light (VIS). Moreover, the first area 11a comprises a first additional up-conversion luminescence pigment excitable by infrared light (IR), and the second area 11b comprises a second additional up-conversion luminescence pigment excitable by infrared light (IR). The first additional pigment is different than the second additional pigment.

[0028] Preferably, the pigments are uniformly distributed in the areas 11a, 11b, such that the areas 11a, 11b are visible in the visible light (VIS) as surfaces having a uniform colour.

[0029] As a result, when the security print layer 11 is observed in the visible light, the same basic colour B is visible in both areas 11a, 11b, wherein the colour shade depends on the basic pigment used. However, when the security print layer 11 is excited by infrared light, the first area 11a is visible in the visible light in the first colour (1), depending on the first additional pigment used, different than the second colour (2) which is visible on the second area 11b, depending on the second additional pigment used. This is schematically shown in Fig. 3.

[0030] The first and the second additional pigments are preferably selected such that the first

and the second colour, in which these pigments are visible in visible light when excited by infrared light, are distinctly different from each other. Preferably, the difference ΔE_{1-2} between the first and the second colour in a CIELab space is equal to at least 5, and more preferably to at least 10.

[0031] The difference ΔE is generally defined as:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

wherein L is brightness (luminance), a - colour from green to magenta, b - colour from blue to yellow.

[0032] The CIELAB definition provided above is defined for example by CIE publication 15.2 (1986) and ISO 11664-4:2008.

[0033] The first and the second additional pigment are preferably selected such that the first and the second colour are distinctly different from the basic colour. Preferably in the CIELab the difference ΔE_{1-B} between the first colour and the basic colour, as well as the difference ΔE_{2-B} between the second colour and the basic colour is equal to at least 5 and more preferably to at least 10.

[0034] Arbitrary known pigments for film-forming compositions may be used as basic pigment.

[0035] The additional up-conversion luminescence pigments may be based on compounds having a matrix in a form of a crystalline lattice doped with trivalent rare earth elements including: Ho^{3+}, Er^{3+}, Gd^{3+}, Yb^{3+}, ions of alkaline earth elements: Ca^{2+}, Sr^{2+}, Ba^{2+} or particular transition metals, such as Zr4+, Ti4+, whereas for creation of matrices of these pigments, particular halides may be used: $NaYF_4$, YF_3, LaF_3, oxides for example Y_2O_3, ZrO_2 or sulfoxides Y_2O_2S, La_2O_2S.

[0036] The first and second areas preferably have substantially the same absorption spectra, preferably in the whole wavelength range. In particular, they have the same absorption spectra in the visible range and in the infrared range as shwon in Fig. 4B, which presents absorption spectra for 4 different film-forming compositions. The term "substantially" is to be understood that the reflectance measured by the spectofotometer in one area is different from the reflectance in another area not more than 10%, and more preferably not more than 5% of the absolute value (for example, as shown in Fig. 4B, for 950 nm the lowest reflectance value is about 70% for one composition and the highest value is about 73% for another composition, therefore the difference is 3%).

[0037] In order to detect the security feature, the areas may be illuminated by a laser or a laser diode of a particular wavelength, such as 980 nm, which results in the excitation of the up-conversion luminescence pigments, such that they become visible in visible light at different colours. In contrast, when the areas are not illuminated by the particular wavelength that

excites the up-conversion pigments, the areas have the same visibility across all wavelengths, according to the absorption spectra shown in Fig. 4B, therefore there is no change in colour visible, whether the areas are observed under visible or infrared light.

[0038] This is in contrast to the prior art, where the areas having absorption spectra as shown in Fig. 4A, when viewed via an infrared camera, will be visible in different colors.

[0039] The film-forming compositions for the areas 11a, 11b comprise a color base (defining the basic colour) and an additive of the up-conversion component, which has the same basic colour for visible light as the color base and further comprises a particular up-conversion luminescence pigment. The amount of the up-conversion component may be different, depending on the visibility of the component. In such case, additional components may be used for the composition, such as diluents, to obtain compositions of uniform colour and structure. A skilled person will realize, without inventive skills, particular compositions to obtain particular effects, depending on the components used.

[0040] For example, the following compositions can be used:

Compositions for printing on polymer substrates, such as polycarbonate or PVC:

- A: colour base 97% + green up-converter additive 3%;
- B: colour base 71% + yellow up-converter additive 25% + diluent 4%.

Compositions for printing on polymer substrates, such as polycarbonate or PVC:

- colour base 95% + green up-converter additive 5%;
- colour base 73% + red up-converter additive 23% + diluent 4%.

Compositions for printing on polymer substrates, such as polycarbonate or PVC:

- colour base 78% + yellow up-converter additive 18% + diluent 4%;
- colour base 71% + blue up-converter additive 25% + diluent 4%.

Compositions for printing on a paper substrate:

- transparent base 91% + green up-converter additive 5% + drying compound 4%;
- transparent base 71% + yellow up-converter additive 25% + drying compound 4%.

[0041] The security document 10 may have a form of a banknote, an identity card, a driving license, a passport, a credit card, a diploma, a certificate, or any other known security document.

[0042] The utility of the security document results in that the security feature is visible for a naked human eye as a printed area having a first colour in the visible light, whereas when excited by the infrared light in the range of 900-1000nm it is visible as a two-colour or a

multicolour area. This allows fast and convenient localization of the security feature on the document substrate, in the visible light and subsequently verification of the authenticity of the document by illumination of the security feature with infrared light.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO9513597A2A2 **[0006]**
- US2011298204A1 **[0007]**
- WO2004050376A1A **[0008]**

Patentkrav

1. Sikkerhedsdokument omfattende et substratlag (12) med et trykt sikkerhedselement (11) omfattende et første område (11a) og et andet område (11b), hvor, i begge områder (11a, 11b), sikkerhedselementet (11) er synligt under synligt lys i en grundfarve (P), hvor, ved excitering med infrarødt lys, det første område (11a) er synligt i synligt lys i en første farve (1), og det andet område (11b) er synligt i synligt lys i en anden farve (2), der er forskellig fra den første farve (1), **kendetegnet ved at**
sikkerhedselementet (11) er et tryklag, der er fremstillet af en sammensætning omfattende, i det første område (11a), et første yderligere opkonverteringsluminescenspigment, der kan exciteres af det infrarøde lys, og i det andet område (11b), et andet yderligere opkonverteringsluminescenspigment, der kan exciteres af det infrarøde lys, hvor det andet yderligere pigment er forskelligt fra det første yderligere pigment.

2. Sikkerhedsdokument ifølge krav 1, hvor sikkerhedselementet (11) er et tryklag, der er fremstillet af en sammensætning omfattende, i det første område (11a) og i det andet område (11b), et grundpigment, der er synligt i synligt lys.

3. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor de filmdannende sammensætninger af det første område (11a) og det andet område (11b) har i det væsentlige de samme absorptionsspektra over de synlige og infrarøde bølgelængder.

4. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor forskellen ΔE_{1-2} mellem den første og den anden farve i et CIELab-rum er lig med mindst 5.

5. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor forskellen ΔE_{1-B} mellem den første farve og grundfarven såvel som forskellen ΔE_{2-B} mellem den anden farve og grundfarven er lig med mindst 5.

6. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor det første område (11a) befinder sig på substratlaget (12) i en afstand fra det

andet område (11b).

7. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor det første område (11a) på substratlaget (12) grænser op til det andet område (11b).

8. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor det første område (11a) på substratlaget (12) mindst delvist overlapper det andet område (11b).

9. Sikkerhedsdokument ifølge et hvilket som helst af de foregående krav, hvor sikkerhedselementet (11) befinder sig mellem to lag af et substrat (12, 13).

DRAWINGS

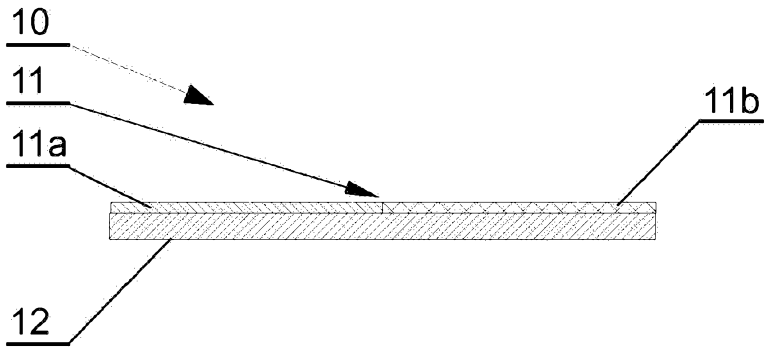

Fig. 1A

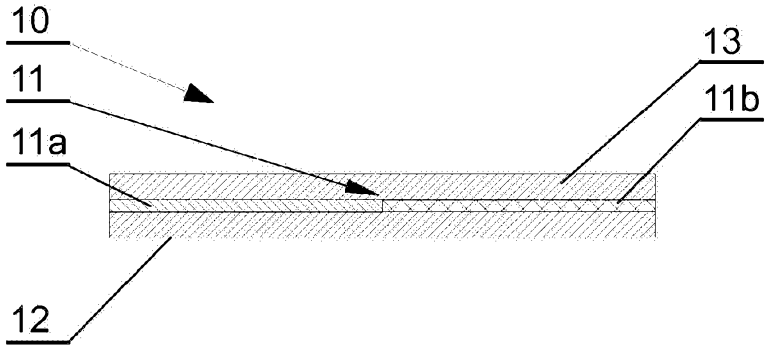

Fig. 1B

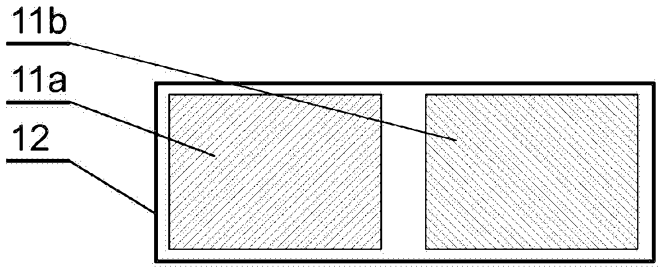

Fig. 2A

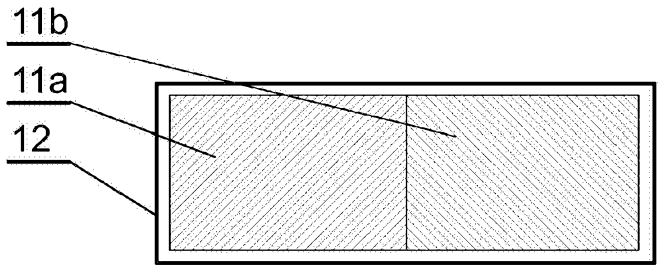

Fig. 2B

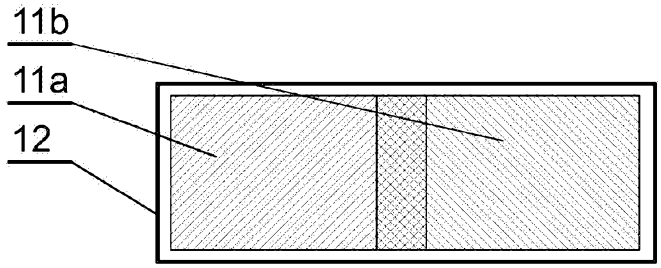

Fig. 2C

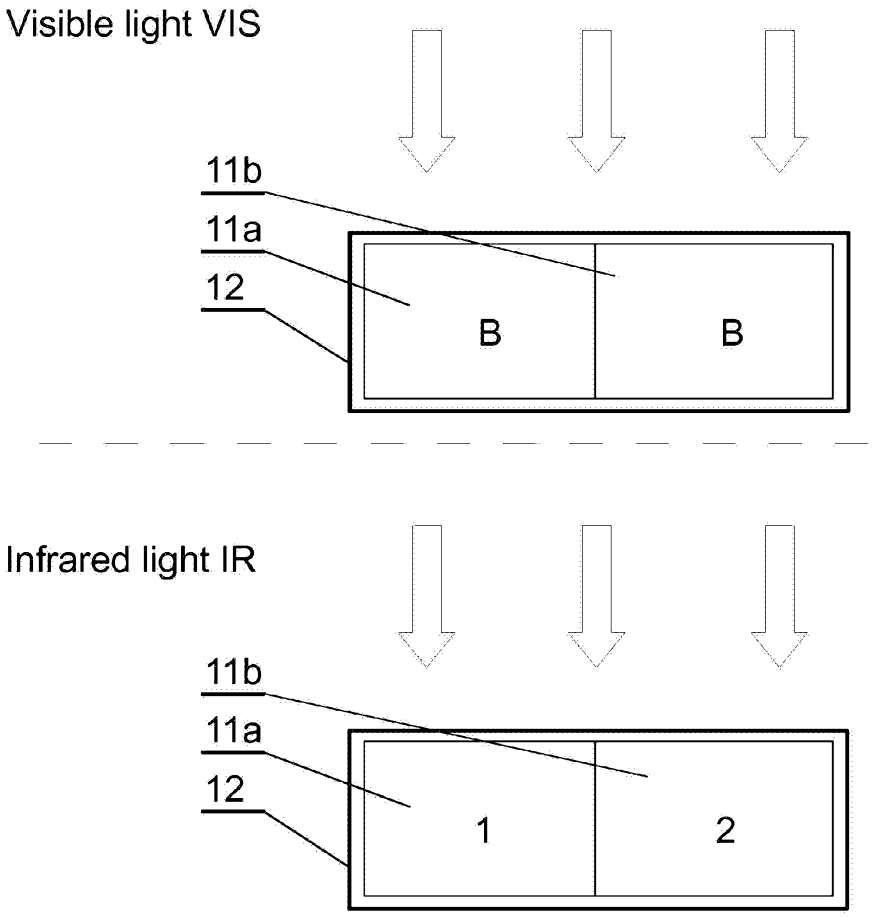
Visible light VIS
11b
11a
12
B
B
Infrared light IR
11b
11a
12
1
2

Fig. 3

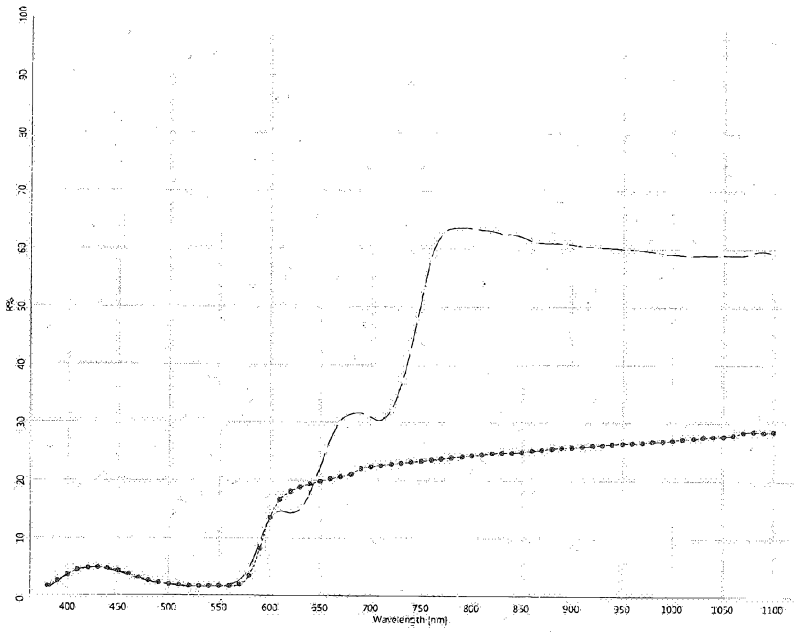

Fig. 4A (prior art)

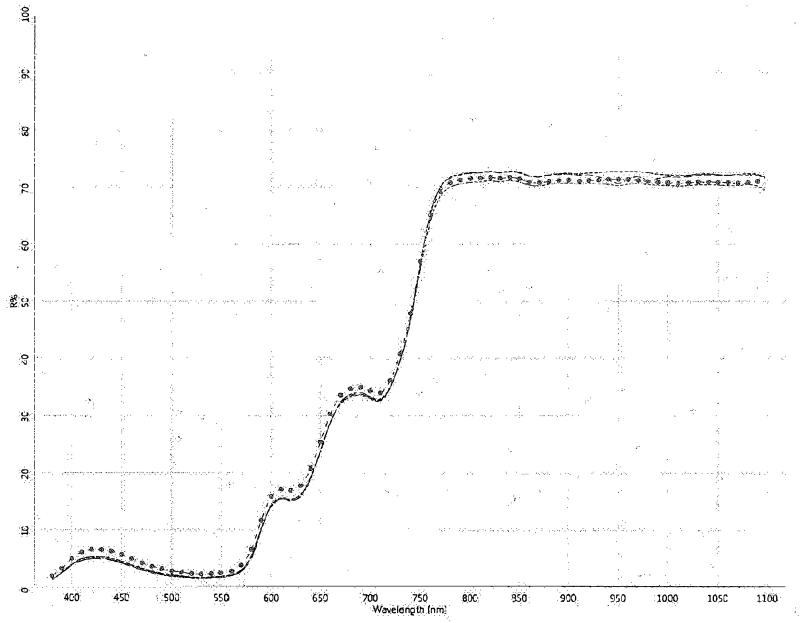

Fig. 4B