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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) A method for making a latent image on a document substrate and a document substrate with a latent image

(57) A method for making a latent image (110) on a document substrate (100), comprising raised elements (120) forming image fragments (111,112) of variable visibility dependent on the viewing angle, wherein the method comprises the steps of providing a laser-engravable document substrate (100), and subjecting the document substrate (100) to a laser beam to engrave the raised elements (120).
A document substrate (100) with a latent image, a security document comprising said document substrate, and a method for making said security document.

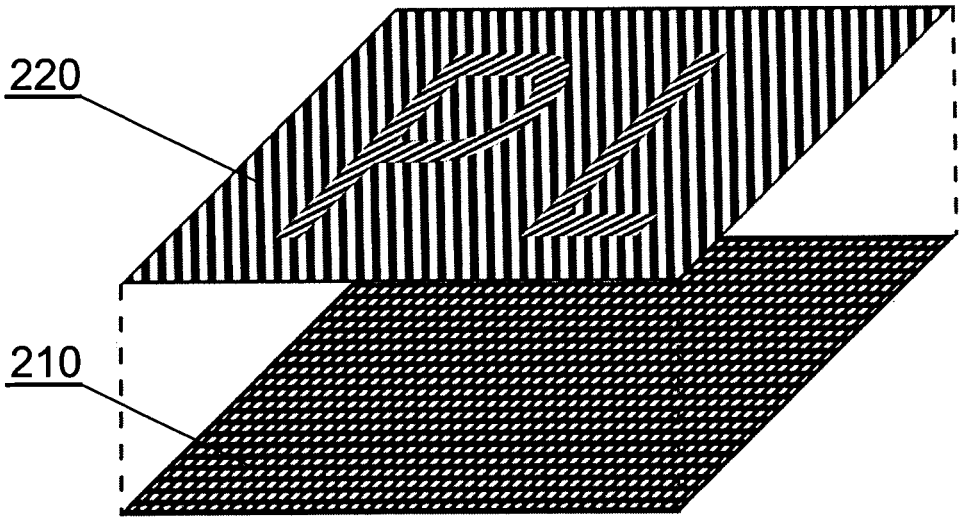

Fig. 2

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Description

[0001] The present invention relates to a method for securing documents by making a latent image on the document substrate, as well as to a document substrate secured with a latent image.

[0002] A latent image is a popular first level security feature, allowing verification of a document by a naked eye, without the need to use additional devices. A latent image comprises raised elements forming image fragments of variable visibility dependent on the viewing angle. Usually, raised elements having a form of parallel lines are used, which when viewed in parallel to the direction of the lines create an impression of a light image, whereas when viewed perpendicularly to the direction of the lines create an impression of a dark image. A US patent US5,722,693 describes a method for making a security document, wherein a first and second set of lines is printed on a substrate, and next a third set of lines, comprising lines raised with respect to the printing area, is printed.

[0003] A US patent US6,296,281 presents a latent image structure, comprising raised elements having a form of line fragments.

[0004] The known methods for making raised elements which form the latent image comprise hot stamping or intaglio print. These techniques involve large energy consumption and long application time. Due to the required use of printing plates, these techniques are impractical for making small number of documents, nor for latent images individualized for each document.

[0005] Other methods for making raised elements of documents are also known. For example, application of the laser-engraved or mechanically-engraved plates while lamination.

[0006] The object of the present invention is to provide a method for making a latent image, which allows quicker and less costly making of latent image, both for small and large number of documents.

[0007] The object of the invention is a method for making a latent image on a document substrate, comprising raised elements forming image fragments of variable visibility dependent on the viewing angle, wherein the method comprises the steps of providing a laser-engravable document substrate, and subjecting the document substrate to a laser beam to engrave the raised elements .

[0008] Preferably, the document substrate is subjected to the laser beam in at least two runs, wherein for each run a different energy density of the laser beam is used and a different component image is engraved.

[0009] Preferably, the energy density of the laser beam is increased for consecutive runs.

[0010] Preferably, in at least one run, a component image is engraved comprising elements forming component image fragments visible from the above.

[0011] Preferably, in at least two runs, component images are engraved comprising raised elements forming component image fragments of variable visibility.

[0012] Preferably, in at least one run, a component image is engraved comprising flat elements forming component image fragments visible from the above, and raised elements forming component image fragments visible by viewing at a particular angle.

[0013] Preferably, in at least one run, all the raised elements are engraved with the same energy density of the laser beam.

[0014] Another object of the present invention is a document substrate comprising a latent image comprising raised elements forming image fragments of variable visibility dependent on the viewing angle, wherein the document substrate is a laser-engravable substrate and the raised elements are engraved by subjecting the document substrate to a laser beam.

[0015] Preferably, the latent image comprises at least two overlaid component images, engraved by using a different energy density of the laser beam for each component image.

[0016] Preferably, at least one component image comprises elements forming component image fragments visible from the above.

[0017] Preferably, the component image fragments visible from the above comprise letters, numbers, graphic symbols, vector graphic, raster graphic and/or uniform background.

[0018] Preferably, at least two component images comprise raised elements forming component image fragments of variable visibility.

[0019] Preferably, at least one component image comprises flat elements forming component image fragments visible from the above and raised elements forming component image fragments of variable visibility.

[0020] Another object of the invention is a security document comprising the document substrate according to the invention.

[0021] A further object of the invention is a method for making a security document, characterized in that at least part of the security document is made on a document substrate according to the invention.

[0022] The object of the invention is shown by way of exemplary embodiments on a drawing, in which:

Fig. 1 shows a cross-section of a document substrate with a latent image according to the invention;
Figs. 2-6 show embodiments of a document substrate according to the invention, comprising a plurality of component images.

[0023] The document substrate according to the invention is a substrate susceptible to laser engraving. The substrate may be made of plastics, such as polycarbonate, poly(ethylene terephthalate), poly(vinyl chloride) or composite of polycarbonate and copolymer of poly (ethylene terephthalate) and ethylene glycol (PEC). It may be also a paper substrate, comprising an additive allowing laser engraving. Furthermore, the substrate may be a composite substrate, for example a laminate

of paper and polycarbonate foil or a laminate of paper and PEC foil. Due to a high energy of a laser beam, at the intersection of the laser beam and the laser-engravable substrate, the substrate is decomposed and its volume increases, which results in creation of local raisings. Preferably, the laser-engravable surface is also subject to carbonization, which results in darkening or a change to a different shade, characteristic for a particular substrate, for example a shade of sepia. The level of raising and darkening of the substrate depends on the parameters of laser operation: the beam energy density, the pulse frequency, the pulse duration and the beam movement speed across the engraved surface.

[0024] In the method according to the invention, the laser-engravable substrate is subject to a laser beam to engrave raised elements, creating image fragments of variable visibility, dependent on the viewing angle. Therefore, a latent image is formed on the substrate.

[0025] Preferably, for engraving latent images a solid-state laser (e.g. Nd:YAG or Nd-$YV0_4$) or different laser is used. Preferably, the laser impulse duration is set to 15ns, the pulse frequency is set to 3000 Hz, the beam movement speed across the surface is set to 160 mm/s and the laser beam energy density is set in the range from $5*10^{13}$ W/m^2 to $2*10^{14}$ W/m^2.

[0026] Fig. 1 shows, not in scale in order to increase visibility, an exemplary document substrate 100 with a latent image 110, comprising raised elements 120, in the present embodiment having the form of lines, creating image fragments 111, 112 of variable visibility, dependent on the viewing angle. Looking at the image from the bottom right, a dark fragment 111 is visible, comprising letters PL, on a light background formed by the fragment 112, whereas looking at the image from the bottom left, a light fragment 111 is visible on a dark background formed by the fragment 112.

[0027] The image 110 may be made in a single laser run, wherein the raised elements 120 are engraved with a high energy density laser beam, whereas the areas between the raised elements are engraved by a low energy density laser beam. Therefore, a high relief is obtained and a high darkening of raised elements and a low relief (or no relief at all) and low darkening of the areas between the raised elements.

[0028] Latent images having complicated structure can be difficult to make using a laser engraving devices having a limited potential to change the laser beam parameters during operation. In order to solve this problem, the preferred embodiments of the invention present a method for making a latent image by subjecting the document substrate to a laser beam in a plurality of runs, wherein for each run a different laser beam energy density is used and a different component image is engraved.

[0029] Fig. 2 presents an embodiment, wherein the final image is made by engraving on a PEC substrate consecutively two component images 210 and 220. The component image 210 which is engraved first is made using a laser beam having energy density for example of $5,1*10^{13}$ W/m^2, which is lower than the energy density of the laser beam used to engrave the second component image 220, for example $5,8*10^{13}$ W/m^2. The other parameters of the laser beam, in particular the impulse duration, the impulse frequency or the beam speed across the surface remain identical for engraving both component images. The first component image 210 comprises flat elements forming component image elements visible directly from the above, for example a dense grid forming the background of the final image. The second component image 220 comprises raised elements forming component image fragments of variable visibility, dependent on the viewing angle, namely a fragment comprising letters PL and the remaining fragment, constituting the background of the letters. For example, looking at the image from the bottom right, a dark "PL" sign will be visible on a light background, whereas looking at the image from bottom right a light "PL" sign will be visible on a dark background. In turn, looking at the image directly from the above, a dark rectangle will be visible.

[0030] Fig. 3 presents another embodiment, wherein the final image is made by engraving on a laminate of paper and polycarbonate foil consecutively a first component image 310, by using a laser beam having energy density for example of $3,3*10^{13}$ W/m^2, and a second component image 320, using a laser beam having energy density of for example $6,5*10^{13}$ W/m^2. The first component image 310 comprises a flat uniform background, constituting component image fragment of constant visibility, with a cut-out in shape of "X", whereas the letter X is formed by raised elements in form of lines, constituting component image fragment of variable visibility. The second component image 320 comprises raised elements forming image fragments of variable visibility, namely a first fragment constituting a ring and a second fragment constituting the background of the ring. Looking at the image from the bottom right, a dark ring is visible on a light background, looking at the image from the bottom left a light ring and a light letter X are visible on a dark background, whereas looking at the image directly from the above, a light letter X is visible on a dark background.

[0031] Fig. 4 presents yet another embodiment, wherein the final image is made by engraving on a PEC substrate consecutively a first component image 410, by using a laser beam having energy density for example of $3,6*10^{13}$ W/m^2, a second component image 420, using a laser beam having energy density of for example $3,8*10^{13}$ W/m^2, a third component image 430, using a laser beam having energy density of for example $6,0*10^{13}$ W/m^2 and a fourth component image 440, using a laser beam having energy density of for example $5,4*10^{13}$ W/m^2. The first component image 410 comprises a uniform, non-raised background, due to using a laser beam having energy density, which causes only little darkening of the document substrate, for example to a light-grey color. The second component image 420 comprises uniform non-raised background in a color darker

than the color of the first component image 410, for example in a dark-grey color, wherein empty spaces are left having the shape of mirrored letters D. The third component image 430 comprises raised elements forming one component image fragment having variable visibility in the form of an inverted letter D. The fourth component image 440 comprises raised elements forming one component image fragment having variable visibility in the shape of an ellipse, raised elements forming a background of the component image of variable visibility, as well as empty fragment in the shape of an inverted letter D. Looking at the image from the bottom right, a black ellipse and a black letter D are visible on a grey background, looking at the image from the bottom left, a light-grey ellipse and a light-grey two mirrored letters D are visible on a black background, whereas looking at the image from the above, two light-grey letters D are visible on a dark-grey background. The above description of the visible features assumes that when viewing the image at an angle parallel to the raised lines, the flat area between the raised lines reflects incident light independently of the darkening level and becomes light. At the same time, in the area of the image covered by lines perpendicular to the viewing angle, light is not reflected from the flat surfaces, therefore the area becomes black.

[0032] Fig. 5 presents another embodiment, wherein the final image is made by engraving on a PEC substrate consecutively a first component image 510, by using a laser beam having energy density for example of $3,6*10^{13}$ W/m^2, a second component image 520, using a laser beam having energy density of for example $3,8*10^{13}$ W/m^2, a third component image 530, using a laser beam having energy density of for example $6,0*10^{13}$ W/m^2 and a fourth component image 540, using a laser beam having energy density of for example $5,4*10^{13}$ W/m^2. The first component image 510 comprises a uniform non-raised background, for example in light-grey color. The second component image 520 comprises a uniform non-raised background in a dark grey color, comprising empty spaces in the shape of digits 8. The third component image 530 comprises raised elements forming one component image fragment of variable visibility in the shape of digits 2345. The fourth component image 540 comprises raised elements forming a background, comprising an empty space in the form of digits 2345. Looking at the image from the bottom right, black digits 2345 are visible on a grey background, looking at the image from the bottom left, light-grey digits 2345 are visible on a dark-grey background, whereas looking at the image from the above, light-grey digits 8 are visible on a dark-grey background.

[0033] Fig. 6 presents a further embodiment, wherein the final image is made by engraving on a PC substrate consecutively a first component image 610, by using a laser beam having energy density for example of $1,0*10^{14}$ W/m^2 and a second component image 620, using a laser beam having energy density of for example $1,45*10^{14}$ W/m^2. The first component image 610 comprises flat elements forming component image fragments visible from the above, forming for example a dense grid and a photo of a person. The second component image 620 comprises raised elements forming component image fragments of variable visibility, dependent on the viewing angle, namely a fragment comprising letters PL and another fragment, forming the background of the letters. Looking at the image from the bottom right, a dark sign PL will be visible on a light background, looking at the image from the bottom left a light sign PL will be visible on a dark background, whereas looking at the image from the above, a dark rectangle will be visible and a photo of the person on the right of the rectangle.

[0034] Laser engraving of the substrate in a plurality of runs facilitates making complicated latent images by separating elements of variable relief to individual layers. Therefore, there is no need to change the energy density of the laser beam within one layer, or the range of changes may be limited.

[0035] One of the effects which can be obtained by the method according to the invention is a latent image on a background with an image comprising letters, digits, graphical symbols, vector graphics, raster graphics and/or a uniform background.

[0036] Use of laser engraving eliminates the need to use printing plates, therefore personalized latent images can be made, individually for each document. The method according to the invention can be also employed to make document substrates which are not personalized, such as tickets, excise duty stamps, as well as personalized, such as identity cards, certificates, permits, communication documents, banking cards or marriage documents.

[0037] The term "document" as used within the description and claims is to be understood in its broad sense, meaning any object carrying information thereon. Therefore, the term "document" covers also packaging for articles, made on a laser-engravable substrate, for example packaging having some information elements, such as manufacturer's logo or article's logo, engraved by laser such as to obtain a latent image. A packaging made in this way guarantees the origin of the product to the user.

[0038] Latent images engraved by laser according to the invention may be verified by blind and sand-blind persons, which constitutes another useful feature of the invention.

Claims

1. A method for making a latent image (110) on a document substrate (100), comprising raised elements (120) forming image fragments (111, 112) of variable visibility dependent on the viewing angle, **characterized in that** the method comprises the steps of providing a laser-engravable document substrate (100), and subjecting the document substrate (100)

to a laser beam to engrave the raised elements (120).

2. The method of claim 1, comprising the steps of subjecting the document substrate (100) to the laser beam in at least two runs, wherein for each run a different energy density of the laser beam is used and a different component image (210, 220, 310, 320, 410, 420, 430, 440, 510, 520, 530, 540, 610, 620) is engraved.

3. The method of claim 2, comprising the step of increasing the energy density of the laser beam for consecutive runs.

4. The method of claim 2, comprising the step of, in at least one run, engraving a component image (210, 310, 410, 420, 510, 520, 610) comprising elements forming component image fragments visible from the above.

5. The method of claim 2, comprising the steps of, in at least two runs, engraving component images (430, 440, 530, 540) comprising raised elements forming component image fragments of variable visibility.

6. The method of claim 2, comprising the step of, in at least one run, engraving a component image (110) comprising flat elements forming component image fragments visible from the above, and raised elements forming component image fragments visible by viewing at a particular angle.

7. The method of claim 2, comprising the step of, in at least one run, engraving all the raised elements with the same energy density of the laser beam.

8. A document substrate (100) comprising a latent image (110) comprising raised elements (120) forming image fragments (111, 112) of variable visibility dependent on the viewing angle, **characterized in that** the document substrate (100) is a laser-engravable substrate and the raised elements (120) are engraved by subjecting the document substrate (100) to a laser beam.

9. The document substrate according to claim 8, **characterized in that** the latent image (110) comprises at least two overlaid component images (210, 220, 310, 320, 410, 420, 430, 440, 510, 520, 530, 540, 610, 620), engraved by using a different energy density of the laser beam for each component image.

10. The document substrate according to claim 9, **characterized in that** at least one component image (210, 310, 410, 420, 510, 520, 610) comprises elements forming component image fragments visible from the above.

11. The document substrate according to claim 10, **characterized in that** the component image (610) fragments visible from the above comprise letters, numbers, graphic symbols, vector graphic, raster graphic and/or uniform background.

12. The document substrate according to claim 9, **characterized in that** at least two component images (310, 320, 430, 440, 530, 540) comprise raised elements forming component image fragments of variable visibility.

13. The document substrate according to claim 9, **characterized in that** at least one component image (110) comprises flat elements forming component image fragments visible from the above and raised elements forming component image fragments of variable visibility.

14. A security document comprising the document substrate (100) according to any of claims 8 to 13.

15. A method for making a security document, **characterized in that** at least part of the security document is made on a document substrate (100) according to any of claims 8 to 13.

Amended claims in accordance with Rule 137(2) EPC.

1. A method for making a latent image (110) on a document substrate (100), the latent image (110) comprising raised elements (120) forming image fragments (111, 112) of variable visibility dependent on the viewing angle, **characterized in that** the method comprises the steps of providing a laser-engravable document substrate (100) susceptible to change of shade and raising under a laser beam, and subjecting the document substrate (100) to the laser beam to engrave the raised elements (120), each raised element being raised above the non-engraved substrate (100) and having a shade uniformly different than the shade of the non-engraved substrate (100).

2. The method of claim 1, comprising the steps of subjecting the document substrate (100) to the laser beam in at least two runs, wherein for each run a different energy density of the laser beam is used and a different component image (210, 220, 310, 320, 410, 420, 430, 440, 510, 520, 530, 540, 610, 620) is engraved.

3. The method of claim 2, comprising the step of increasing the energy density of the laser beam for consecutive runs.

4. The method of claim 2, comprising the step of, in at least one run, engraving a component image (210, 310, 410, 420, 510, 520, 610) comprising elements forming component image fragments visible from the above.

5. The method of claim 2, comprising the steps of, in at least two runs, engraving component images (430, 440, 530, 540) comprising raised elements forming component image fragments of variable visibility.

6. The method of claim 2, comprising the step of, in at least one run, engraving a component image (110) comprising flat elements forming component image fragments visible from the above, and raised elements forming component image fragments visible by viewing at a particular angle.

7. The method of claim 2, comprising the step of, in at least one run, engraving all the raised elements with the same energy density of the laser beam.

8. A document substrate (100) comprising a latent image (110) comprising raised elements (120) forming image fragments (111, 112) of variable visibility dependent on the viewing angle, **characterized in that** the document substrate (100) is a laser-engravable substrate susceptible to change of shade and raising under a laser beam and the raised elements (120), each being raised above the non-engraved substrate (100) and having a shade uniformly different than the shade of the non-engraved substrate (100), are engraved by subjecting the document substrate (100) to a laser beam.

9. The document substrate according to claim 8, **characterized in that** the latent image (110) comprises at least two overlaid component images (210, 220, 310, 320, 410, 420, 430, 440, 510, 520, 530, 540, 610, 620), engraved by using a different energy density of the laser beam for each component image.

10. The document substrate according to claim 9, **characterized in that** at least one component image (210, 310, 410, 420, 510, 520, 610) comprises elements forming component image fragments visible from the above.

11. The document substrate according to claim 10, **characterized in that** the component image (610) fragments visible from the above comprise letters, numbers, graphic symbols, vector graphic, raster graphic and/or uniform background.

12. The document substrate according to claim 9, **characterized in that** at least two component images (310, 320, 430, 440, 530, 540) comprise raised elements forming component image fragments of variable visibility.

13. The document substrate according to claim 9, **characterized in that** at least one component image (110) comprises flat elements forming component image fragments visible from the above and raised elements forming component image fragments of variable visibility.

14. A security document comprising the document substrate (100) according to any of claims 8 to 13.

15. A method for making a security document, **characterized in that** at least part of the security document is made on a document substrate (100) according to any of claims 8 to 13.

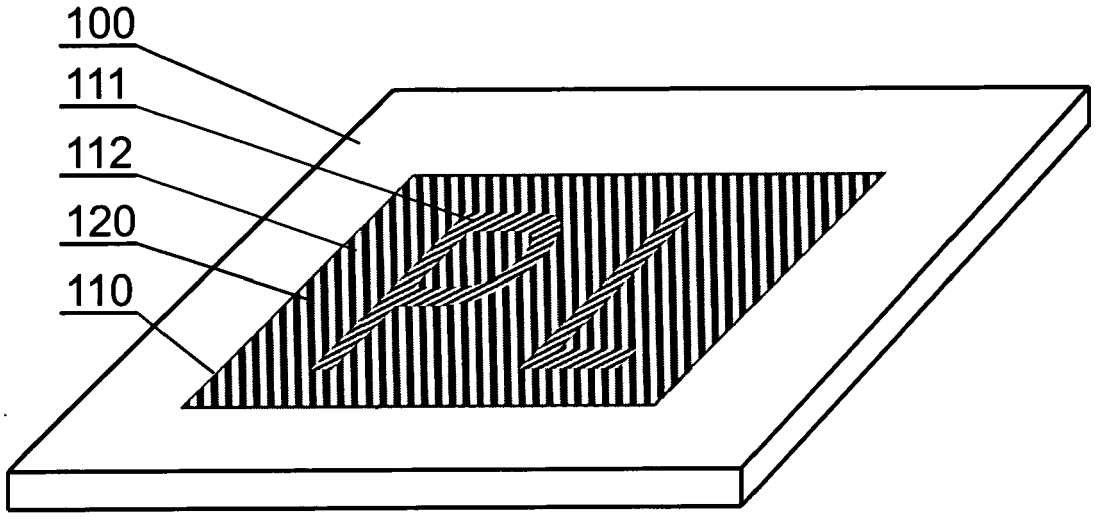

Fig. 1

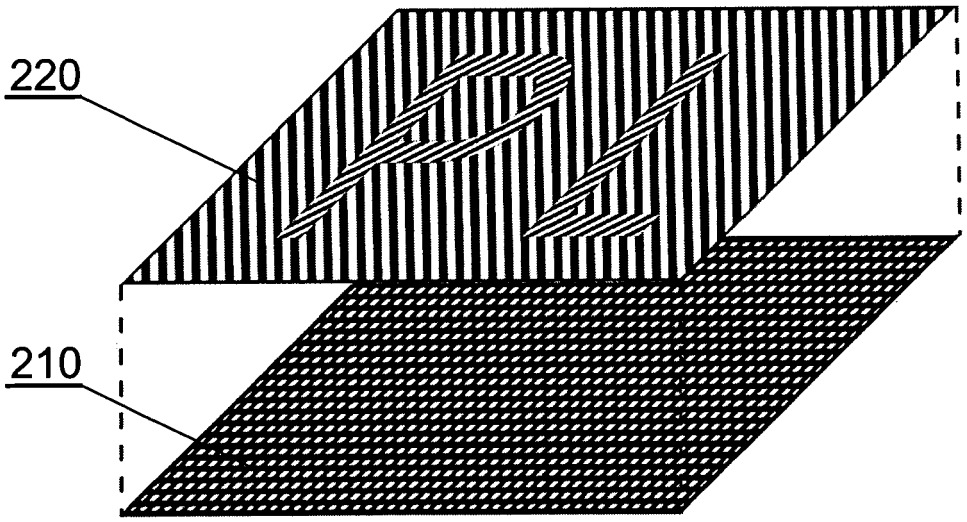

Fig. 2

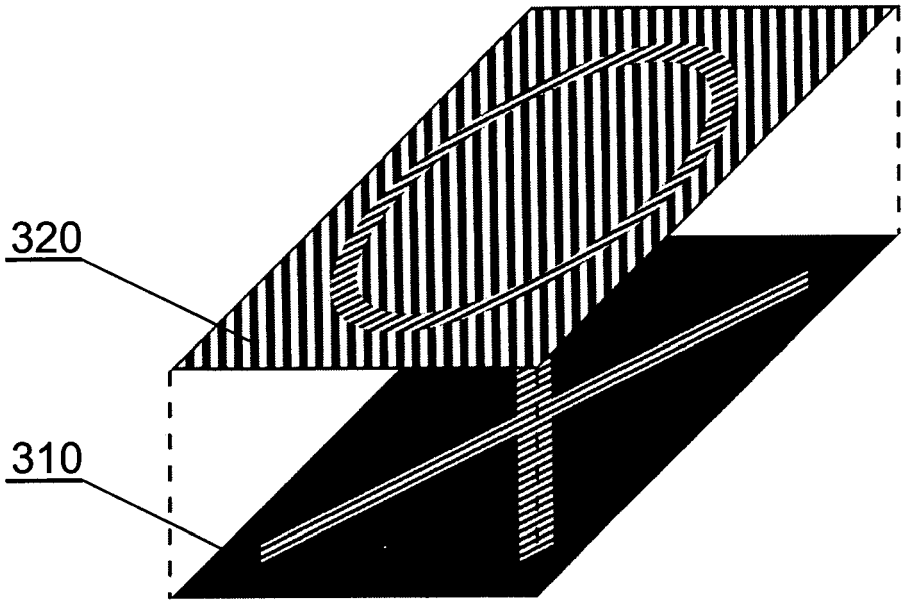

Fig. 3

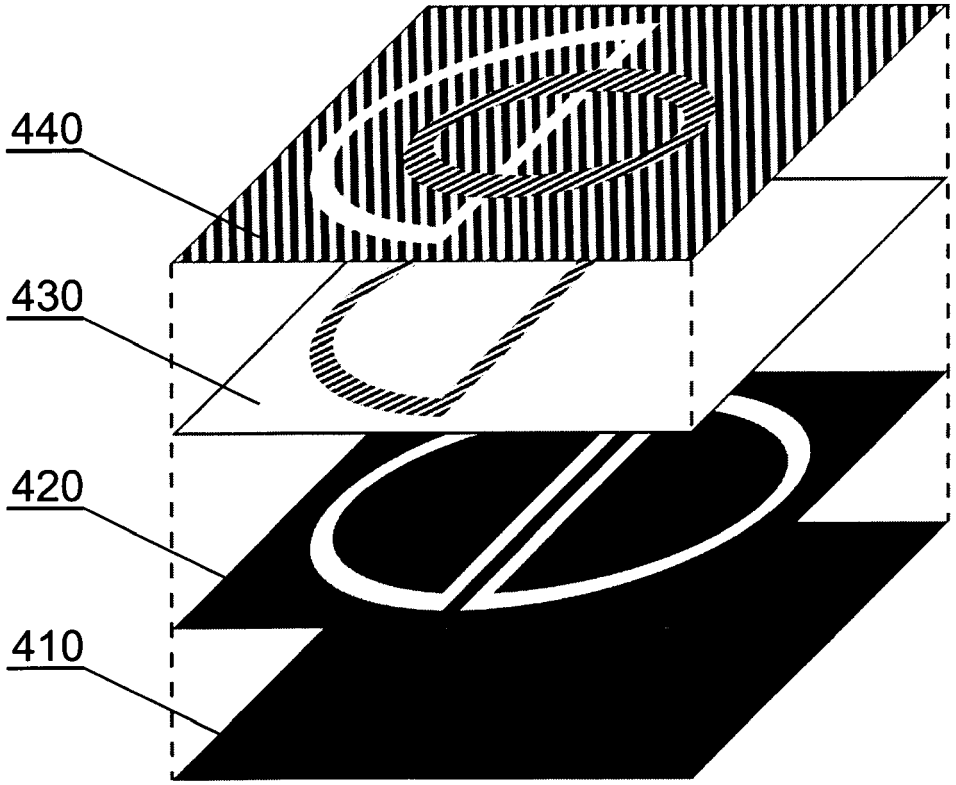

Fig. 4

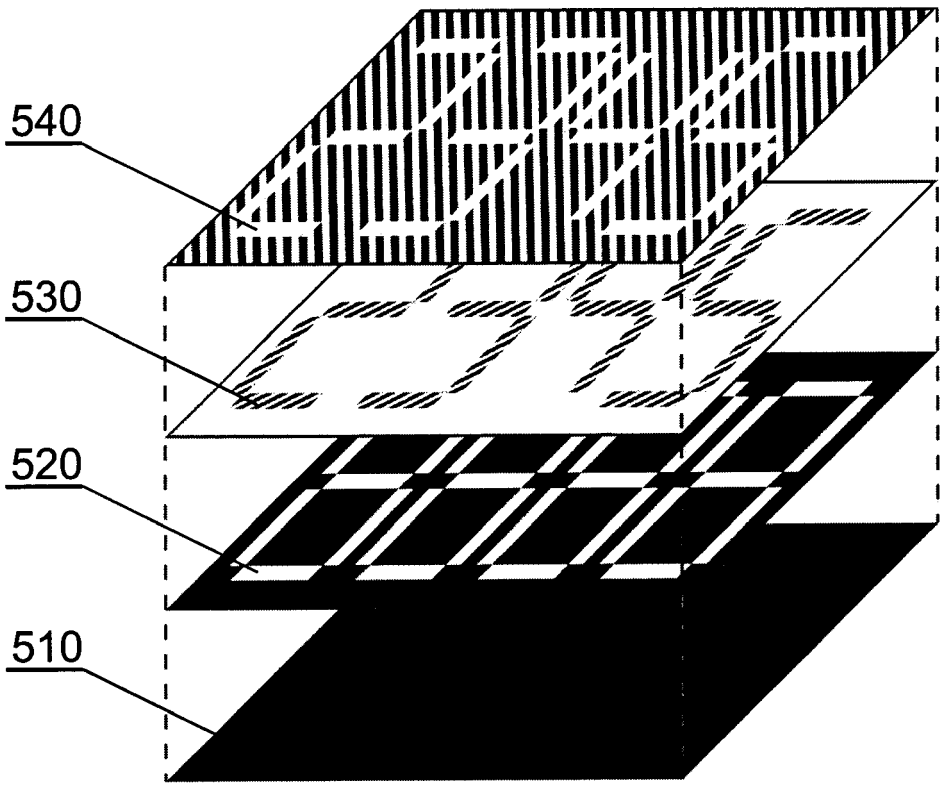

Fig. 5

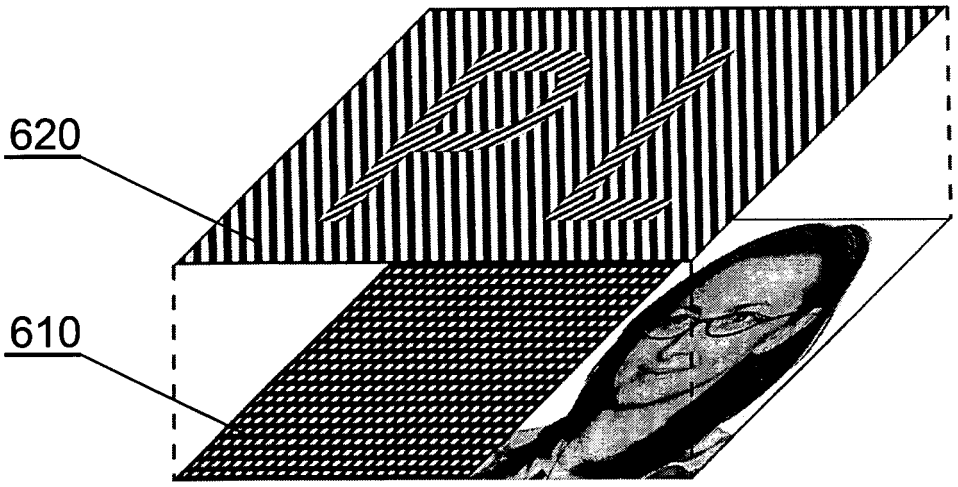

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 09 46 0049

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2005 052562 A1 (GIESECKE & DEVRIENT GMBH [DE]) 3 May 2007 (2007-05-03) * laser engrave-able substrate, with latent image including raised elements of variable visibility depending on the viewing angle, engraved by laser beam in at least two runs (first run for forming raised elements, second run for forming flat markings), wherein for each run a different energy density of the laser is used (different energy for different height/marking) and a different component image is engraved.; paragraphs [0021], [0036], [0084], [0092] - [0095], [0100], [0101], [0114] - [0116]; claims 1,3,7,9,16,21; figures * -----	1-15	INV. B42D15/00 B42D15/10
X	US 2009/134618 A1 (ERDMANN MARKUS [DE] ET AL) 28 May 2009 (2009-05-28) * laser engrave-able substrate, with latent image including raised elements of variable visibility depending on the viewing angle (shadow visible in oblique), engraved by laser beam in at least two runs (first run for forming raised elements, second run for forming contours), wherein for each run a different energy density of the laser is used (different energy mode) and a different component image is engraved.; paragraphs [0011], [0014], [0019], [0025], [0026], [0030], [0053]; figures * ----- -/--	1-15	TECHNICAL FIELDS SEARCHED (IPC) B42D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 March 2010	Cametz, Cécile

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
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D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

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EUROPEAN SEARCH REPORT

Application Number
EP 09 46 0049

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/127844 A1 (DORFLER WALTER [DE] ET AL) 21 May 2009 (2009-05-21) * laser engrave-able substrate, with latent image including raised elements of variable visibility depending on the viewing angle, engraved by laser beam in at least two runs (for ex. first run for forming first lamellar structure, second run for forming second lamellar structure), wherein for each run a different energy density of the laser is used (different parameters) and a different component image is engraved.; paragraphs [0004], [0006], [0012], [0013], [0021], [0044], [0045], [0054], [0055], [0058] - [0063]; claims 49,52,53,54; figures * -----	1-15	
X	WO 2007/149692 A2 (OPSEC SECURITY GROUP INC [US]; HILL DEAN R [US]; RENTON ROBERT E [GB];) 27 December 2007 (2007-12-27) * laser engrave-able substrate, with latent image including raised elements of variable visibility depending on the viewing angle (diffractive structure), engraved by laser beam.; page 1, line 7 - line 12 * * page 4, line 3 - line 22 * * page 5, line 1 - line 3 * * page 9, line 1 - line 8 * * page 9, line 29 - page 10, line 18 * * page 18, line 26 - line 31 * * page 19, line 6 - line 10; figures * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

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Munich	30 March 2010	Cametz, Cécile

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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1 EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 46 0049

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30-03-2010

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