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(11) **EP 2 284 019 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.02.2011 Bulletin 2011/07

(51) Int Cl.:
B42D 15/10 *(2006.01)* ***D21H 19/38*** *(2006.01)*
D21H 21/40 *(2006.01)* ***G07D 7/14*** *(2006.01)*

(21) Application number: **09460025.1**

(22) Date of filing: **22.06.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

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Remarks:
•A request for correction ..... has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).
•Amended claims in accordance with Rule 137(2) EPC.

(54) **Security paper for laser engraving, security document and method for making security documents**

(57) A security paper for laser engraving comprises a paper substrate layer (110) comprising an antimony-doped tin oxide laser-marking pigment and titanium white, the paper substrate layer (110) being coated with a coating layer (120) comprising the antimony-doped tin oxide laser-marking pigment, such that when the security paper (100) is subject to a laser beam, the antimony-doped tin oxide laser-marking pigment causes change of color of the security paper (100) both within the paper substrate layer (110) and the coating layer (120).

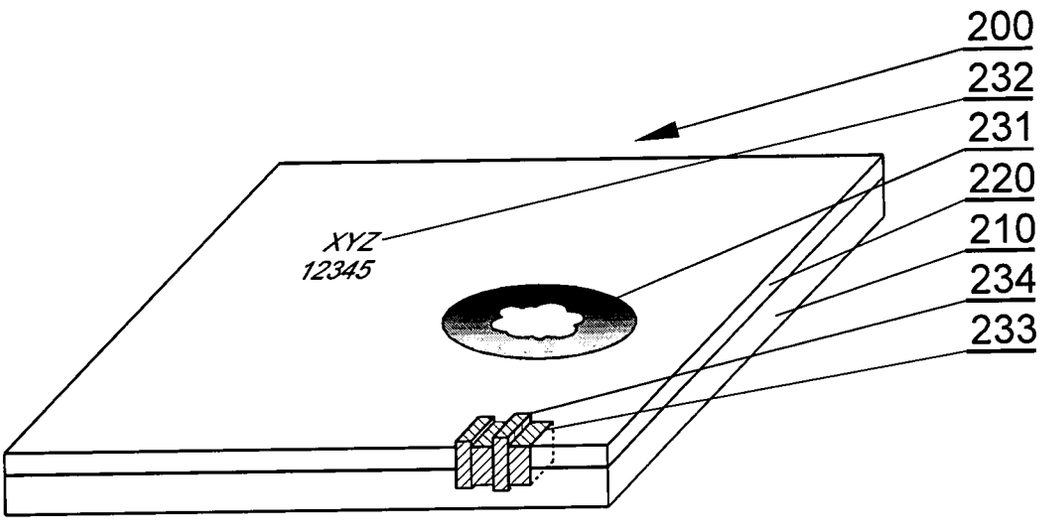

Fig. 2

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Description

[0001] The invention relates to a security paper for laser engraving, a security document and a method for making security documents.

[0002] Security documents may comprise various security features, such as watermarking, microlettering, raised print etc. The security features may be common to all documents of specific type or, preferably, may form personalization markings, i.e. document-individual markings.

[0003] Laser engraving is one of the techniques to make markings on security documents. Various attempts have been made to achieve efficient laser engraving of paper-based documents.

[0004] A European patent application EP07460036 discloses a paper for personal document sheets, which is coated with a coating mixture containing a pigment, which subjected to laser beam changes color to a contrasting color in relation to the background paper color. Such paper may have personalization markings made thereon by laser engraving, where the laser activates the pigment in the coating.

[0005] The aim of the present invention is to provide an improved security paper for laser engraving, a security document comprising the security paper and a method for making security documents, providing improved legibility and clarity of laser-engraved markings.

[0006] The object of the invention is a security paper for laser engraving, comprising a paper substrate layer comprising an antimony-doped tin oxide laser-marking pigment and titanium white, the paper substrate layer being coated with a coating layer comprising the antimony-doped tin oxide laser-marking pigment, such that when the security paper is subject to a laser beam, the antimony-doped tin oxide laser-marking pigment causes change of color of the security paper both within the paper substrate layer and the coating layer.

[0007] Preferably, the antimony-doped tin oxide laser-marking pigment comprises from 95% to 99% by weight of tin oxide (SnO_2) and from 1% to 5% by weight of antimony oxide (Sb_2O_3).

[0008] Preferably, titanium white comprises rutile form of titanium dioxide (TiO_2).

[0009] Preferably, the paper substrate layer comprises from 2,5% to 10%, preferably 5%, by weight of the antimony-doped tin oxide laser-marking pigment. Preferably, the paper substrate layer comprises from 2,5% to 10%, preferably 3,5%, by weight of titanium white. Preferably, the coating layer comprises from 0,5% to 3%, preferably 2%, by weight of the antimony-doped tin oxide laser-marking pigment.

[0010] Preferably, the concentration of the antimony-doped tin oxide laser-marking pigment in the paper substrate layer increases towards the side of the paper substrate layer coated by the coating layer comprising the antimony-doped tin oxide laser-marking pigment coating.

[0011] Another object of the present invention is a security document comprising the security paper according to the invention and comprising laser-engraved markings having increased visibility in transmitted light, made by activating the antimony-doped tin oxide laser-marking pigment in the coating layer and in the paper substrate layer by laser beam.

[0012] Preferably, at least part of the laser-engraved markings are raised. Preferably, the laser-engraved markings comprise microlettering. Preferably, at least part of the laser-engraved markings are of different shades.

[0013] Another object of the present invention is a method for making security documents, comprising the steps of providing a security paper according to the invention and making markings having increased visibility in transmitted light by laser engraving the security paper by activating the antimony-doped tin oxide laser-marking pigment in the coating layer and in the paper substrate layer by laser beam.

[0014] Preferably, the method comprises the step of laser engraving the security paper with a first set of laser beam parameters so as to obtain raised markings. Preferably, the method comprises the step of laser engraving the security paper with a second set of laser beam parameters so as to obtain microlettering markings. Preferably, the method comprises the step of varying the laser beam parameters so as to obtain markings of different shades.

[0015] The invention will now be described by way of example and with reference to the accompanying drawings in which:

Fig. 1 shows a structure of a security paper for laser engraving according to the invention.

Fig. 2 shows a structure of a security document according to the invention.

[0016] The drawings are not in scale in order to show individual features of the invention more clearly.

[0017] A security paper for laser engraving according to the invention has a structure shown in Fig. 1. The paper 100 comprises a paper substrate layer 110 which is coated with a coating layer 120. The paper substrate layer 110 comprises an antimony-doped tin oxide laser-marking pigment and titanium white. The coating layer 120 comprises the antimony-doped tin oxide laser-marking pigment. Fig. 1 shows the paper substrate layer 110 covered by the coating layer 120 from one side only, but the paper substrate layer 110 may be covered by the coating layer 120 from both sides as well.

[0018] The antimony-doped tin oxide laser-marking pigment is an absorber, which locally absorbs laser energy and transforms it into thermal energy, causing change of color, such as darkening, of the material in which the pigment is contained. Therefore, when the security paper 100 is subject to a laser beam, the antimony-doped tin oxide laser-marking pigment causes change

of color of the security paper 100 both within the paper substrate layer 110 and the coating layer 120.

[0019] Titanium white allows for increasing the contrast of the laser-engraved markings with respect to the background color of the paper substrate, for example white color. Moreover, use of titanium white results in achieving laser-engraved markings in shades of grey, which have been found to be less susceptible to bleaching as compared to sepia-shaded markings.

[0020] The antimony-doped tin oxide laser-marking pigment may comprise from 95% to 99% by weight of tin dioxide (SnO_2) and from 1% to 5% by weight of antimony oxide (Sb_2O_3). Such pigment allows achieving particularly legible and clear laser-engraved markings.

[0021] Titanium white may comprise rutile form of titanium dioxide (TiO_2).

[0022] The paper substrate layer may comprise conventional fibres and additives, and in addition preferably from 2,5% to 10%, preferably 5%, by weight of the antimony-doped tin oxide laser-marking pigment, and from 2,5% to 10%, preferably 3,5%, by weight of titanium white.

[0023] The coating layer may be made of a conventional coating mixture based on polyvinyl alcohol, which further comprises from 0,5% to 3%, preferably 2%, by weight of the antimony-doped tin oxide laser-marking pigment.

[0024] Furthermore, during production of the paper web forming the paper substrate layer 110, the antimony-doped tin oxide laser-marking pigment may be applied to the external layer of the paper web which is to be covered by the coating layer 120. Then, the concentration of the antimony-doped tin oxide laser-marking pigment in the paper substrate 110 increases towards the side of the paper substrate 110 coated by the coating layer 120 comprising the antimony-doped tin oxide laser-marking pigment. This allows more efficient production of raised markings.

[0025] The security paper according to the invention may be used to produce various personalized security documents, such as passports, visas, communication documents, marriage status documents, as well as non-personalized security documents, such as banknotes or excise duty documents.

[0026] Fig. 2 shows a structure of a security document 200 comprising the security paper according to the invention. The security document 200 comprises markings 231, 232, 233, which can be personalization markings or general security markings, and which are made by activating by laser beam the antimony-doped tin oxide laser-marking pigment in the coating layer 220 and in the paper substrate layer 210. Due to the fact that the markings are present in both layers 210, 220 of the paper, they have increased visibility in transmitted light, similarly to a watermark, thereby forming a security feature of the document.

[0027] At least part 234 of the laser-engraved markings 233 may be raised above the surface of the coating layer 220. Raised markings provide further security features of the document, as well as allow identification of the marking by vision-impaired persons. The raised markings 234 may be achieved by using higher laser beam power, as explained below.

[0028] The laser-engraved markings 232 may comprise microlettering, i.e. a string of characters having a small font size, as small as about 0,5 mm in height. Microlettering may also form a security feature of the document. Microlettering 232 markings and other high-quality vector graphics may be achieved by using moderate laser power and relatively low laser beam speed.

[0029] Furthermore, at least part of the laser-engraved markings 231 may have different shades. This allows laser-engraving of images with shade-variable background, such as stamps, which may constitute an important security feature of the document. Shade-variable backgrounds 231 may be achieved by varying laser beam power and speed.

[0030] The security document according to the invention may be made by providing a security paper 100 according to the invention and laser engraving the security paper 100 by activating by laser beam the antimony-doped tin oxide laser-marking pigment in the coating layer 120 and in the paper substrate layer 110.

[0031] In one embodiment of the method according to the invention, an Nd:YAG 1064 nm laser is used for activating the antimony-doped tin oxide laser-marking pigment. In this embodiment, the impulse duration of the laser is set to 15ns.

[0032] In order to obtain plain, shaded image, the following laser beam parameters may be used: impulse power from $1{,}2*10^{14}$ to $1{,}8*10^{14}$ [prosz e podać jednostk miary], speed 20000 mm/s, impulse frequency from 700 to 1500 Hz. The shade of the marking may be varied by varying the impulse power and frequency: the higher the impulse power and frequency, the darker the shade of the obtained marking.

[0033] In order to obtain markings of high quality, such as vector graphics or microlettering, the following laser beam parameters may be used: impulse power from $1{,}1*10^{14}$ to $1{,}4*10^{14}$ [prosz podać jednostk miary], speed from 30 to 60 mm/s, impulse frequency 1500 Hz.

[0034] In order to obtain raised markings, the following laser beam parameters may be used: impulse power from $2{,}2*10^{14}$ to $2{,}4*10^{14}$ [proszq podać jednostk miary], speed from 50 to 160 mm/s, impulse frequency 1500 Hz. A higher impulse power leads to higher amount of absorbed energy by the antimony-doped tin oxide laser-marking pigment and raising of marking above the surface of the coating layer.

Claims

1. A security paper for laser engraving, comprising a

paper substrate layer (110) comprising an antimony-doped tin oxide laser-marking pigment and titanium white, the paper substrate layer (110) being coated with a coating layer (120) comprising the antimony-doped tin oxide laser-marking pigment, such that when the security paper (100) is subject to a laser beam, the antimony-doped tin oxide laser-marking pigment causes change of color of the security paper (100) both within the paper substrate layer (110) and the coating layer (120).

2. The security paper according to claim 1, **characterized in that** the antimony-doped tin oxide laser-marking pigment comprises from 95% to 99% by weight of tin dioxide (SnO_2) and from 1% to 5% by weight of antimony oxide (Sb_2O_3).

3. The security paper according to claim 1 or 2, **characterized in that** titanium white comprises rutile form of titanium dioxide (TiO_2).

4. The security paper according to any previous claim, **characterized in that** the paper substrate layer (110) comprises from 2,5% to 10%, preferably 5%, by weight of the antimony-doped tin oxide laser-marking pigment.

5. The security paper according to any previous claim, **characterized in that** the paper substrate layer (110) comprises from 2,5% to 10%, preferably 3,5%, by weight of titanium white.

6. The security paper according to any previous claim, **characterized in that** the coating layer (120) comprises from 0,5% to 3%, preferably 2%, by weight of the antimony-doped tin oxide laser-marking pigment.

7. The security paper according to any previous claim, **characterized in that** the concentration of the antimony-doped tin oxide laser-marking pigment in the paper substrate layer (110) increases towards the side of the paper substrate layer (110) coated by the coating layer (120) comprising the antimony-doped tin oxide laser-marking pigment coating.

8. A security document comprising the security paper according to any of claims 1 to 7 and comprising laser-engraved markings (231, 232, 233) having increased visibility in transmitted light, made by activating by laser beam the antimony-doped tin oxide laser-marking pigment in the coating layer (220) and in the paper substrate layer (210).

9. The security document according to claim 8, **characterized in that** at least part (234) of the laser-engraved markings (233) are raised.

10. The security document according to claim 8 or 9, **characterized in that** the laser-engraved markings (232) comprise microlettering.

11. The security document according to any of claims 8 to 10, **characterized in that** at least part of the laser-engraved markings (231) are of different shades.

12. A method for making security documents, comprising the steps of providing a security paper (100) according to any of claims 1 to 7 and making markings (231, 232, 233) having increased visibility in transmitted light by laser engraving the security paper (100) by activating by laser beam the antimony-doped tin oxide laser-marking pigment in the coating layer (120) and in the paper substrate layer (110).

13. The method according to claim 12, comprising the step of laser engraving the security paper (100) with a first set of laser beam parameters so as to obtain raised markings (234).

14. The method according to claim 12 or 13, comprising the step of laser engraving the security paper with a second set of laser beam parameters so as to obtain microlettering markings (232).

15. The method according to any of claims 12 to 14, comprising the step of varying the laser beam parameters so as to obtain markings of different shades (231).

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

1. A security paper for laser engraving, comprising a paper substrate layer (110) comprising an antimony-oxide-doped tin dioxide laser-marking pigment and titanium white, the paper substrate layer (110) being coated with a coating layer (120) comprising the antimony-oxide-doped tin dioxide laser-marking pigment, such that when the security paper (100) is subject to a laser beam, the antimony-oxide-doped tin dioxide laser-marking pigment causes change of color of the security paper (100) both within the paper substrate layer (110) and the coating layer (120).

2. The security paper according to claim 1, **characterized in that** the antimony-oxide-doped tin dioxide laser-marking pigment comprises from 95% to 99% by weight of tin dioxide (SnO_2) and from 1% to 5% by weight of antimony oxide (Sb_2O_3).

3. The security paper according to claim 1 or 2, **characterized in that** titanium white comprises rutile form of titanium dioxide (TiO_2).

4. The security paper according to any previous claim, **characterized in that** the paper substrate layer (110) comprises from 2,5% to 10%, preferably 5%, by weight of the antimony-oxide-doped tin dioxide laser-marking pigment.

5. The security paper according to any previous claim, **characterized in that** the paper substrate layer (110) comprises from 2,5% to 10%, preferably 3,5%, by weight of titanium white.

6. The security paper according to any previous claim, **characterized in that** the coating layer (120) comprises from 0,5% to 3%, preferably 2%, by weight of the antimony-oxide-doped tin dioxide laser-marking pigment.

7. A security document comprising the security paper according to any of claims 1 to 6 and comprising laser-engraved markings (231, 232, 233) having increased visibility in transmitted light, made by activating the antimony-oxide-doped tin dioxide laser-marking pigment in the coating layer (220) and in the paper substrate layer (210) by a laser beam of parameters such that cause change of color of the security paper (100) both within the paper substrate layer (110) and the coating layer (120).

8. The security document according to claim 7, **characterized in that** at least part (234) of the laser-engraved markings (233) are made by activating the antimony-oxide-doped tin dioxide laser-marking pigment in the coating layer (220) and in the paper substrate layer (210) by a laser beam of parameters such that cause raising of markings above the surface of the coating layer.

9. The security document according to claim 7 or 8, **characterized in that** the laser-engraved markings (232) are made by activating the antimony-oxide-doped tin dioxide laser-marking pigment in the coating layer (220) and in the paper substrate layer (210) by a laser beam of parameters such that cause forming of microlettering markings.

10. The security document according to any of claims 7 to 9, **characterized in that** at least part of the laser-engraved markings (231) are made by activating the antimony-oxide-doped tin dioxide laser-marking pigment in the coating layer (220) and in the paper substrate layer (210) by a laser beam of variable power and speed such that cause forming of shade-variable markings.

11. A method for making security documents, comprising the steps of providing a security paper (100) according to any of claims 1 to 6 and making markings (231, 232, 233) having increased visibility in transmitted light by laser engraving the security paper (100) by activating by laser beam the antimony-oxide-doped tin dioxide laser-marking pigment in the coating layer (120) and in the paper substrate layer (110).

12. The method according to claim 11, comprising the step of laser engraving the security paper (100) with a laser beam of parameters such that cause raising of markings above the surface of the coating layer.

13. The method according to claim 11 or 12, comprising the step of laser engraving the security paper by a laser beam of parameters such that cause forming of microlettering markings.

14. The method according to any of claims 11 to 13, comprising the step of varying the laser beam parameters so as to obtain markings of different shades (231).

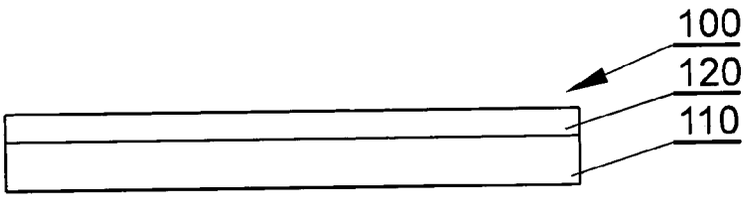

Fig. 1

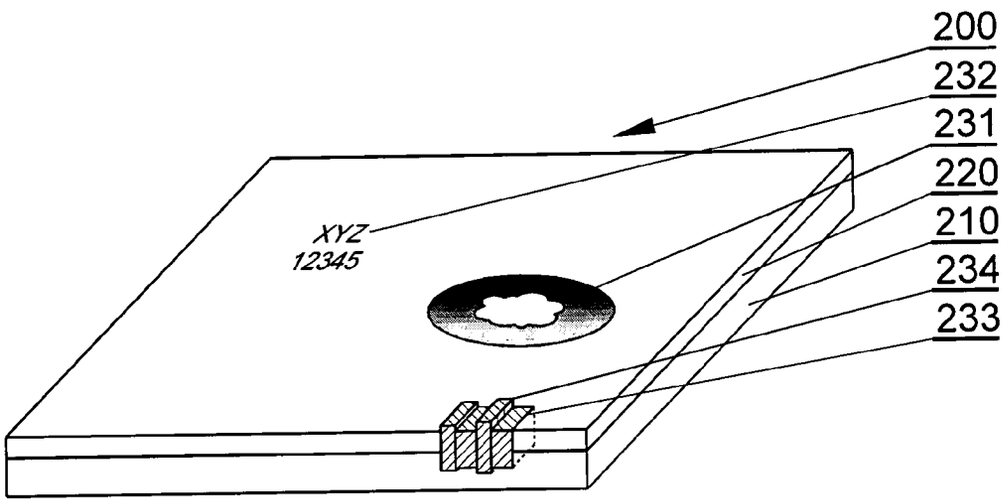

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 09 46 0025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 January 2010	Beins, Ulrika

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

Application Number
EP 09 46 0025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 January 2010	Beins, Ulrika

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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