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(54) Security document and method for protecting a security document against forgery and for the authentication of the security document

(57) The present invention relates to a security document comprising a substrate 1 and an optical security element 5 incorporated in the substrate and relates to a method for checking the authentication of the security document. Moreover, the invention relates to a method for protecting a security document against forgery and for the authentication of the security document. The security document according to the invention comprises a first liquid-crystal layer structure 7, the liquid-crystal molecules thereof having a first predetermined orientation pattern for storing information, a polariser 8, and a second liquid-crystal layer structure 8, the liquid-crystal molecules thereof having a second predetermined orientation pattern for storing information. The information stored in the first and second liquid-crystal layer structures 7, 8 is not visible by the naked eye without an inspection tool. The method for checking the authentication of the optical security element according to the invention is based on the use of a liquid-crystal display, for example a mobile phone or a camera, as a means for providing polarised light. Both the first information stored in the first liquid-crystal layer structure and the second information stored in the second liquid-crystal layer structure are independently visible for the public using the mobile phone or the camera. Thus, the optical security element allows authentication of the security document by observing both the first and second information which can be a text or an image or a combination of text and image.

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Description

[0001] The present invention relates to a security document comprising a substrate and an optical security element incorporated in the substrate and relates to a method for checking the authentication of the security document. Moreover, the invention relates to a method for protecting a security document against forgery and for the authentication of the security document.

[0002] The identification and authentication of security documents, e.g. banknotes, credit cards, identity cards, tickets, stamps etc., is a long-standing problem. In order to solve this goal, security elements have been developed to allow users and/or machines to discriminate between genuine and forged security documents, in particular banknotes, and/or to discriminate among different types of banknotes.

[0003] Special substrates, special inks, the inclusion of watermarks and security threads are commonly used for protecting security documents, in particular banknotes, against forgery. Most of the security elements can be inspected with the naked eye. Another type of security elements are not visible with the naked eye, but can be inspected with a special device. Examples of such security elements are optical security elements based on fluorescent and polarisation effects.

[0004] WO 98/52077 describes an optical security element based on a layer structure consisting of an orientation layer and a layer consisting of liquid-crystal monomers cross-linked with one another. The orientation layer consists of a photo-orientable polymer network which is designated in literature as PPN or LPP layer. The PPN or LLP layer defines in the oriented state regions of alternating orientations. During production of the liquid-crystal layer structure, the liquid-crystal monomers are oriented through the interaction with the PNN layer in different zones. This orientation is fixed by a subsequent cross-linking step, after which a cross-linked, optical structured liquid-crystal (LCP) with a predetermined orientation pattern for storing information is formed. Under observation with the naked eye, the information which has been written in the LLP layer is not visible. Both layers have a transparent appearance. If the substrate on which the layers are located transmits light, then the stored information becomes visible if the optical element is placed between two polariser sheets.

[0005] The above described optical liquid-crystal structure allows storing any kind of information in form of text and/or images for providing optical security elements which can be incorporated in security documents. However, for checking the authentication of the security documents comprising the above optical security elements, polarisers are necessary to make visible the information stored therein.

[0006] When using an optical liquid-crystal structure as described in EP-A 689 084 and WO 9953349 A1, one polariser sheet is necessary on each side of the optical security element to read the stored information so that a quick checking of the authentication is difficult for the user (WO 98/52077). WO 98/52077 teaches removing this disadvantage by additionally integrating one polarising layer in the optical layer structure so that one polarising sheet held over the optical element is sufficient for making the stored information visible.

[0007] It is an object of the present invention to simplify the checking of the authentication of a security document, in particular a banknote, comprising an optical security element for storing information which is not visible with the naked eye. Another object of the invention is providing a method for protecting a security document, in particular a banknote, against forgery and for the authentication of the security document, which simplifies the checking of the authentication of the security document.

[0008] This problem is solved according to the invention with the features of the independent claims. Preferred embodiments are the subject-matter of the dependent claims.

[0009] The security document according to the invention comprises a first liquid-crystal layer structure, a polariser, and a second liquid-crystal layer structure. The liquid-crystal molecules of the first layer structure have a first predetermined orientation pattern for storing information, while the liquid-crystal molecules of the second layer structure have a second predetermined orientation pattern for storing information. The information stored in the first and second liquid-crystal layer structures is not visible with the naked eye without an inspection tool.

[0010] Both the first information stored in the first liquid-crystal layer structure and the second information stored in the second liquid-crystal layer structure are independently visible for the public using an inspection tool. Thus, the optical security element allow authentication of the security document by observing both the first and second information which can be a text or an image or a combination of text and image.

[0011] The method for checking the authentication of the optical security element according to the invention is based on the use of a liquid-crystal display as a means for providing polarised light. Liquid-crystal displays emitting polarised light are well known. Since the screens of mobile telephones and cameras or other devices, e.g. a mobile TV, are liquid-crystal displays, mobile phones or cameras can be used by the public for making visible the stored information. Since the security document of the invention does not require a very special inspection tool, the inspection is simplified for the user.

[0012] The first information becomes visible when placing the optical security element of the security document on the liquid-crystal display in an orientation in which one of the sides of the optical security element is lying on the liquid-crystal display, while the second information becomes visible when placing the optical security element on the liquid-crystal display in an orientation in which the other of the sides of the optical security element is lying on the liquid-crystal display.

[0013] According to a preferred embodiment of the in-

vention, the first predetermined orientation pattern is different from the second predetermined orientation pattern so that the first and second information distinguish from each other. However, it is basically possible to store the same information, e.g. text and/or image, in both liquid-crystal structures which can be inspected from both sides of the security document.

[0014] It is an important aspect of the invention that the substrate of the security document comprises a cut-out and the optical security element is located in the cut-out of the substrate. The optical security element can be placed on the upper or lower side of the substrate or can be incorporated in the substrate. Preferably, the optical security element is inserted into the substrate during the paper manufacturing process.

[0015] The above designated liquid-crystal layer structures as such are disclosed in e.g. EP-A 689 084, WO 9953349 A1 and WO 98/52077. Each of the first and second liquid layer structures comprises an anisotropic layer comprising cross-linked liquid-crystal monomers and an orientation layer arranged on the anisotropic layer of the first and second liquid-crystal layer structure, respectively, so that the liquid-crystal molecules of the liquid-crystal layer structures align with the information stored in the orientation layer. Both the orientation layers of the first and second liquid-crystal layer structures comprise a photo-oriented polymer network (PPN).

[0016] The optical security element of the invention is transparent under normal lighting conditions. The security element can be combined with other security features having surface grating effects, in particular with holograms, diffractive optical elements (DOE) zero order gratings etc. These security features can be incorporated in an additional layer in the polariser between the first and second liquid-crystal layer structures.

[0017] For the purpose of illustrating the present invention, a preferred embodiment of the invention will now be described below with reference to the accompanying drawings.

Fig. 1 shows a banknote comprising the optical security element of the security document according to the invention

Fig. 2 shows in a simplified schematic representation a layer structure of the optical security element of the security document according to the invention,

Fig. 3A illustrates the inspection of the first information stored in the first optical security element of the security document according to the invention,

Fig. 3B illustrates the inspection of the second information stored in the second optical security element and

Fig. 3C illustrates the inspection of the optical security element under normal light conditions.

[0018] Fig. 1 shows the front side of a banknote comprising an optical security element according to the invention. The banknote comprises a substrate 1 made of a flexible material, e.g. the substrate is made of paper. A graphical design printing 2 is provided on the front side and the backside of the banknote. The banknote comprises conventional security elements, e.g. a security thread 3 made of a metal strip and a hologram 4.

[0019] The optical security element 5 of the banknote is a plastic band which has under normal lighting conditions a transparent appearance. The plastic band of the optical security element 5 is located in a cutout 6 of the substrate 1 of the banknote. Thus, under normal lighting conditions the optical security element appears as a window in the banknote. As will be described hereinafter, only under special lighting conditions, the information stored in the optical security element becomes visible for the public.

[0020] The plastic band of the optical security element is incorporated in the paper of the substrate during the paper manufacturing process. A method for incorporating a plastic band in the paper of a banknote is described for example in AT 412 078 B.

[0021] Fig. 2 shows in a simplified schematic representation the layer structure of the optical security element. The security element comprises a first liquid-crystal layer structure 7 and a second liquid-crystal layer structure 8 as well as polarizing sheet 9 arranged between the first and second liquid-crystal layer structures 7, 8.

[0022] The first liquid-crystal layer structure 7 comprises an anisotropic layer consisting of cross-linked liquid-crystal monomers 7A (LCP layer). The orientation of the molecular arrangement of the LCP layer is predetermined by the orientation of an orientation layer 7B which adjoins the LCP layer 7A. The orientation layer 7B is a photo-oriented polymer network (PPN) whose orientation varies locally over its surface. The orientation is determined by selective exposure to linearly polarized UV light. This liquid-crystal layer structure allows storing of information, i.e. a first image in the preferred embodiment. A method for producing the above liquid-crystal layer structure is described for example in EP-A 689 084, WO 9953349 A1, US-A 5 389 698, and WO 98/52077.

[0023] The second liquid-crystal layer structure 8 has the same structure as the first liquid-crystal layer structure 7. Both layer structures 7, 8 are hybrid structures consisting of cross-linked liquid-crystal monomers 7A, 8A (LCP layer) and a photo-oriented polymer network (PPN) 7B, 8B. In the preferred embodiment, the second liquid-crystal layer structure 8 stores a second image. In the preferred embodiment, the directions of orientation of the first and second liquid-crystal layer structures 7, 8 include a right angle.

[0024] Fig. 3A to 3C illustrate the inspection of the op-

tical security element. In Fig. 3A to 3C, the first and second liquid-crystal layer structures 7, 8 (Fig. 2) showing the first and second images are designated with "1" and "2", respectively.

[0025] Under normal lighting conditions, the first and second images are not visible for the public when observing both the upper side and the lower side of the banknote (Fig. 3C) and the optical security element is transparent. Under special lighting conditions, however, both images become visible.

[0026] It is an important aspect of the invention that the user does not need a very special tool rather than the screen (LCD) of a mobile phone or a camera for making visible the images.

[0027] The second image becomes visible when placing the optical security element of the banknote with its lower side on the screen (LCD) and observing the upper side of the banknote with the naked eye (Fig. 3A). Accordingly, the first image becomes visible when placing the optical security element with its upper side on the screen (LCD) and observing the lower side of the banknote with the naked eye (Fig. 3B). The image is visible independent of the orientation of the optical security element on the screen. By rotating the security element on the screen, the image changes from positive to negative and vice versa.

Claims

1. Security document comprising
a substrate (1) and an optical security element (5) incorporated in the substrate,
characterized in that the optical security element (5) comprises:

a first liquid-crystal layer structure (7), the liquid-crystal molecules having a first predetermined orientation pattern for storing information,
a polariser (8) and
a second liquid-crystal layer structure (8), the liquid-crystal molecules having a second predetermined orientation pattern for storing information.

2. Security document according to claim 1, **characterized in that** the first predetermined orientation pattern of the first liquid-crystal layer structure (7) being different from the second predetermined orientation pattern of the second liquid-crystal layer structure (8).

3. Security document according to claim 1 or 2, **characterized in that** the first liquid-crystal layer structure (7) and the second liquid-crystal layer structure (8) have different directions of orientation.

4. Security document according to claim 3, **characterized in that** the directions of orientation of the first liquid-crystal layer structure (7) and the second liquid-crystal layer structure (8) include a right angle.

5. Security document according to any one of claims 1 to 4, **characterized in that** the first liquid-crystal layer structure (7) comprises an anisotropic layer (7A) comprising cross-linked liquid-crystal monomers and the second liquid-crystal layer structure (8) comprises an anisotropic layer (8A) comprising cross-linked liquid-crystal monomers.

6. Security document according to any one of claims 1 to 5, **characterized in that** the first liquid-crystal layer structure (7) comprises an orientation layer (7B) arranged on the anisotropic layer (7A) of the first liquid-crystal layer structure and the second liquid-crystal layer structure (8) comprises a second orientation layer (8B) arranged on the anisotropic layer (8A) of the second liquid-crystal layer structure so that the liquid-crystal molecules of the first and second liquid-crystal layer structures (7, 8) align with the information stored in the orientation layer.

7. Security document according to claim 6, **characterized in that** the orientation layer (7B) of the first liquid-crystal layer structure (7) comprises a photo-oriented polymer network (PPN) and the orientation layer (8B) of the second liquid-crystal layer structure (8) comprises a photo-oriented polymer network (PPN).

8. Security document according to any one of claims 1 to 7, **characterized in that** the substrate (1) comprises a cutout (6) and the optical element (5) is located in the cutout of the substrate.

9. Method for checking the authentication of the security document according to any one of claims 1 to 8 comprising the steps of:

providing a liquid-crystal display (LCD) for emitting polarized light
placing the optical security element of the security document on the liquid-crystal display (LCD) in an orientation in which one of the sides of the optical security element is lying on the liquid-crystal display,
observing the optical security element with the naked eye.

10. Method according to claim 9 comprising the steps of:

placing the optical security element on the liquid-crystal display (LCD) in an orientation in which the other of the sides of the optical security element is lying on the liquid-crystal display,
observing the optical security element with the

naked eye.

11. Method according to any one of claims 9 to 10 comprising the steps of:

providing a mobile telephone or a camera comprising a liquid-crystal display for transmitting polarized light, the optical security element being placed on the liquid-crystal display of the mobile phone or camera.

12. Method for protecting of a security document against forgery and for the authentication of the security document comprising the steps of:

incorporating an optical security element in the substrate of the security document,
the optical element comprising:

a first liquid-crystal layer structure, the liquid-crystal molecules having a first predetermined orientation for storing information,
a polariser,
a second liquid-crystal layer structure, the liquid-crystal molecules having a second predetermined orientation for storing information,
the first predetermined orientation for storing information being different from second predetermined orientation for storing information,
providing a liquid-crystal display (LCD) for emitting polarized light,
placing the optical security element of the security document on the liquid-crystal display in an orientation in which one of the sides of the optical security element is lying on the liquid-crystal display,
observing the optical security element with the naked eye, and
placing the optical security element of the security document on the liquid-crystal display in an orientation in which the other of the sides of the optical security element is lying on the liquid-crystal display,
observing the optical security element with the naked eye.

13. Method according to claim 12 comprising the step of:

providing a mobile telephone or a camera comprising a liquid-crystal display for transmitting polarized light, the optical security element being placed on the liquid-crystal display of the mobile phone or camera.

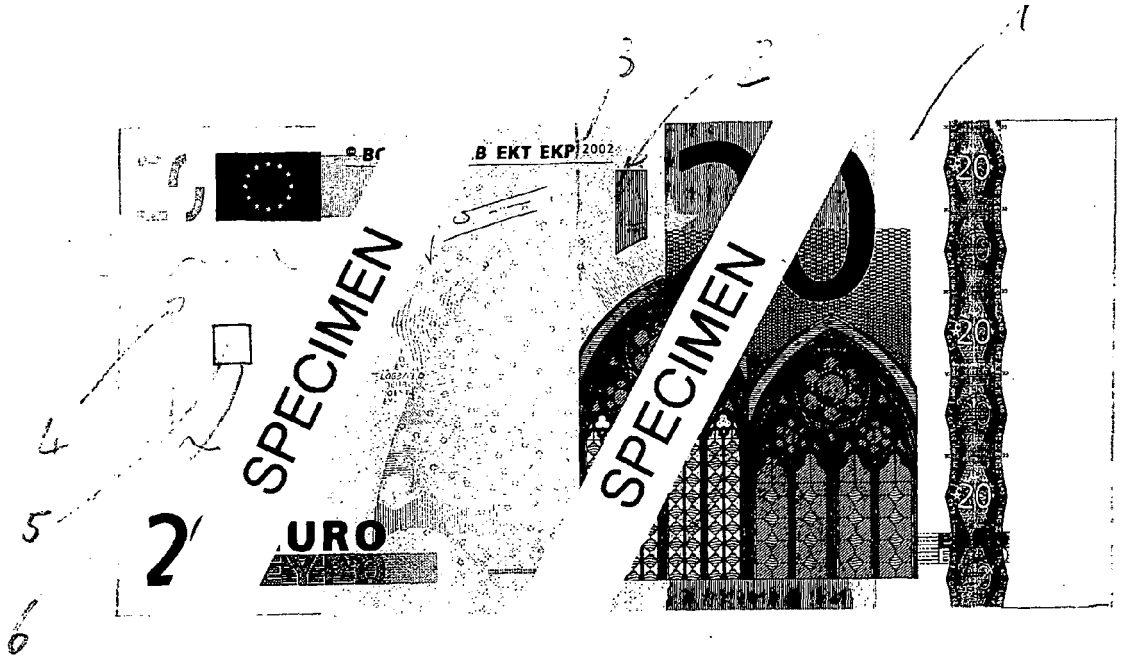


Fig. 1

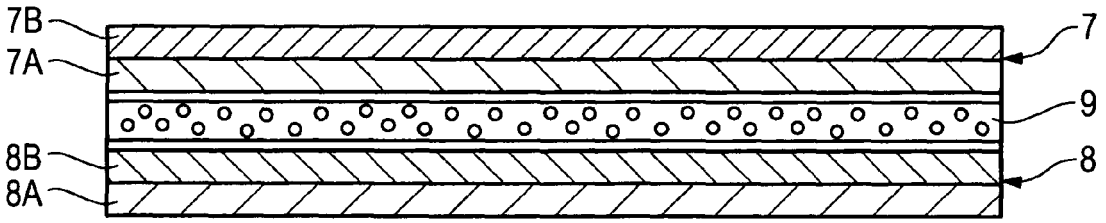


Fig. 2

Fig. 3A

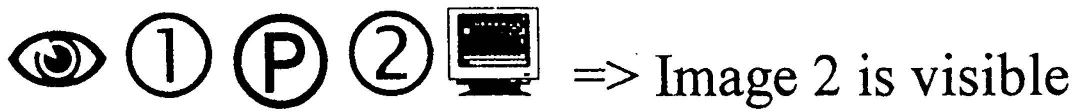
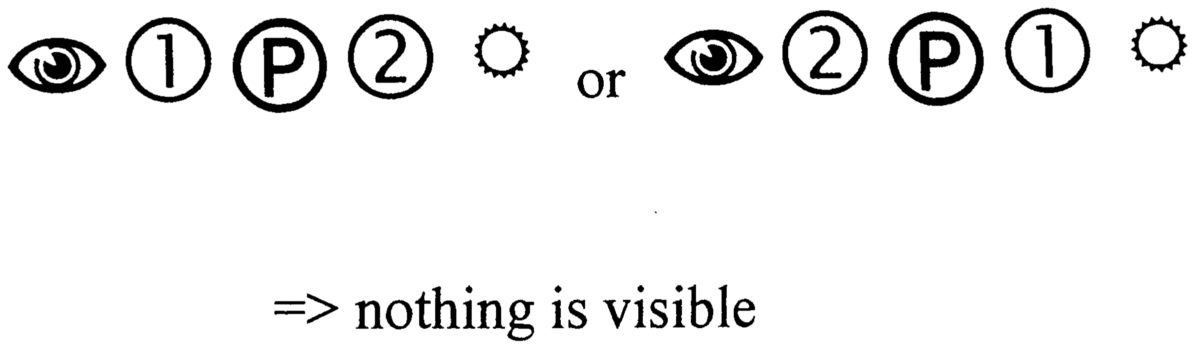


Fig. 3B

Fig. 3C



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EUROPEAN SEARCH REPORT

Application Number
EP 11 00 5575

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B42D
G07D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 December 2011	Callan, Feargel

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

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