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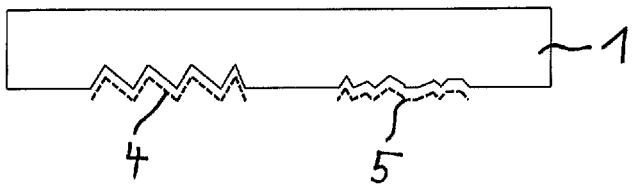
(54) Title: SECURITY ELEMENT, VALUE DOCUMENT SUBSTRATE, VALUE DOCUMENT EQUIPPED THEREWITH, AND PRODUCTION METHOD

(54) Bezeichnung: SICHERHEITSELEMENT, WERTDOKUMENTSUBSTRAT, MIT DEMSELBEN AUSGESTATTETES WERTDOKUMENT UND HERSTELLUNGSVERFAHREN

FIG 3



(57) Abstract: The invention relates to a method for producing a value document substrate, or a security element suitable for protecting value documents, comprising a) the provision of a substrate; b1) the printing of the substrate with metallic pigment flakes suitable for forming a reflective layer in a first substrate region, and the printing of the substrate with effect pigments that assume a different hue depending on the viewing angle in a second substrate region; b2) the step of embossing the first substrate region and the second substrate region such that (i) the substrate in the first substrate region has a relief structure that forms a diffractive structure, and the substrate in the second substrate region has a relief structure that forms a micro-mirror arrangement, or (ii) the substrate in the first substrate region has a relief structure that forms a micro-mirror arrangement, and the substrate in the second substrate region has a relief structure that forms a diffractive structure.

(57) Zusammenfassung: Die Erfindung betrifft ein Verfahren zum Herstellen eines Wertdokumentsubstrats oder eines zur Absicherung von Wertdokumenten geeigneten Sicherheitselements, umfassend a) das Bereitstellen eines Substrats; b1) das Bedrucken des Substrats mit für die Bildung einer Reflexionsschicht geeigneten, plättchenförmigen Metallpigmenten in einem ersten Substratbereich und das Bedrucken des Substrats mit Effektpigmenten, die je nach Betrachtungswinkel einen anderen Farbton annehmen, in einem zweiten Substratbereich; b2) den Schritt des Verprägens des ersten Substratbereichs und des zweiten Substratbereichs, sodass (i) das Substrat im ersten Substratbereich eine Reliefstruktur, die eine diffraktive

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[Fortsetzung auf der nächsten Seite]

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Erklärungen gemäß Regel 4.17:

— *hinsichtlich der Berechtigung des Anmelders, ein Patent zu beantragen und zu erhalten (Regel 4.17 Ziffer ii)*

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)*

Struktur bildet, aufweist und das Substrat im zweiten Substratbereich eine Reliefstruktur, die eine Mikrospiegelanordnung bildet, aufweist, oder (ii) das Substrat im ersten Substratbereich eine Reliefstruktur, die eine Mikrospiegelanordnung bildet, aufweist und das Substrat im zweiten Substratbereich eine Reliefstruktur, die eine diffraktive Struktur bildet, aufweist.

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Security element, value document substrate, value document equipped therewith, and production method

[0001] The invention relates to a method for manufacturing a value-document substrate and a security element suitable for safeguarding value documents. The invention relates furthermore to a security element and value-document substrate obtainable according to the method and, in addition, a value document comprising the security element or value-document substrate.

[0002] Value documents, such as bank notes, branded articles or identity documents, for safeguarding purposes, are often provided with security elements which allow a test of the authenticity of the value documents and at the same time serve as protection from unauthorized reproduction. A special role in authentication assurance is played by security elements with viewing angle-dependent effects, because these cannot be reproduced even with the most modern copiers. The security elements are equipped here with optically variable elements which convey a different pictorial impression to the viewer from different viewing angles, showing for example a different color impression or brightness impression and/or a different graphic motif depending on the viewing angle.

[0003] In this connection, e.g. from WO 2009/080263 A2 it is known to employ security elements with multilayer thin-film elements whose color impression for the viewer changes with the viewing angle (in the following designated as color-shift effect). The color-shift effect in such thin-film elements is based on viewing angle-dependent interference effects through multiple reflections in the different sublayers of the element. The path difference of the light reflected at the different layers, on the one hand, depends on the optical thickness of a dielectric spacer layer which establishes the spacing between a semitransparent absorber layer and a reflective layer, and, on the other hand, varies with the respective viewing angle. Because the path difference lies in the order of magnitude of the wavelength of the visible light, due to elimination and amplification of particular wavelengths there results an angle-dependent color impression for the viewer. By a suitable choice of material and thickness of the dielectric spacer layer a plurality of different color-shift effects can be designed.

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[0004] Starting out therefrom, some embodiments of the present disclosure aim to provide a simplified method for manufacturing a value-document substrate and a security element having a high forgery resistance and attractive visual appearance and suitable for safeguarding value documents. Some embodiments of the present disclosure aim to provide the supplying of a value- document substrate and a security element having a high forgery resistance and attractive visual appearance.

[0005] Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each of the appended claims.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

In one aspect, there is provided a method for manufacturing a value-document substrate suitable for a polymer bank note or foil-composite bank note, comprising

a) supplying a plastic substrate or a foil/paper/foil composite substrate;

b1) printing the substrate in a first substrate region with platelet-shaped metal pigments suitable for the formation of a reflective layer and printing the substrate in a second substrate region with effect pigments which depending on the viewing angle take on a different color tone;

b2) the step of embossing the first substrate region and the second substrate region, so that (i) the substrate in the first substrate region has a relief

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structure which forms a diffractive structure, and the substrate in the second substrate region has a relief structure which forms a micromirror arrangement, or (ii) the substrate in the first substrate region has a relief structure which forms a micromirror arrangement and the substrate in the second substrate region has a relief structure which forms a diffractive structure.

Summary

[0006] 1. (First aspect of the invention) Method for manufacturing a value-document substrate or a security element suitable for safeguarding value documents, comprising

a) supplying a substrate;

b1) printing the substrate in a first substrate region with platelet-shaped metal pigments suitable for the formation of a reflective layer and printing the substrate in a second substrate region with effect pigments which depending on the viewing angle take on a different color tone;

b2) the step of embossing the first substrate region and the second substrate region, so that (i) the substrate in the first substrate region has a relief structure which forms a diffractive structure, and the substrate in the second substrate region has a relief structure which forms a micromirror arrangement, or (ii) the substrate in the first substrate region has a relief structure which forms a micromirror arrangement and the substrate in the second substrate region has a relief structure which forms a diffractive structure.

The dimensions of the structure elements of the diffractive structure preferably are in the order of magnitude of the light wavelength, further preferably in a region greater than 100 nm and less than 1 μm, a region greater than 300 nm and less than 1 μm being particularly preferred. The dimensions of the structure elements of the micromirror arrangement preferably are in a region greater than 1 μm and less than 40 μm, a region greater than 1 μm and less than 30 μm being particularly preferred. The

dimensions of the structure elements of the micromirror arrangement have, for example, a height of up to 15 μm and a lateral extent of up to 30 μm. Preferably, in the step of embossing b2) there can be additionally produced tactile substrate embossings, e.g. by intaglio printing method. Further, it is preferred that the tactile substrate embossings as well as the relief structures forming a micromirror arrangement or a diffractive structure are produced in one working operation. The formulation "produced in one working operation" is to be understood such that all embossed structures to be incorporated in the substrate, i.e. tactile substrate embossings and microoptical structures such as relief structures forming micromirror arrangements and/or diffractive structures, are present in one single embossing tool, e.g. one intaglio printing plate or one (intaglio) printing cylinder or steel-printing cylinder, which is used for manufacturing.

[0007] 2. (Preferred configuration) Method according to section 1, wherein step b1) is carried out before step b2), wherein in step b2) both the platelet-shaped metal pigments suitable for the formation of a reflective layer in the first substrate region and the effect pigments taking on a different color tone depending on the viewing angle in the second substrate region adapt to the relief structure of the substrate in the respective substrate region.

[0008] 3. (Preferred configuration) Method according to section 1, wherein step b2) is carried out before step b1), wherein in step b1) both the platelet-shaped metal pigments suitable for the formation of a reflective layer in the first substrate region and the effect pigments taking on a different color tone depending on the viewing angle in the second substrate region adapt to the relief structure of the substrate in the respective substrate region.

[0009] 4. (Preferred configuration) Method according to any of sections 1 to 3, wherein the step of embossing b2) is effected by means of blind printing, preferably by means of an intaglio printing apparatus.

[0010] 5. (Preferred configuration) Method according to any of sections 1 to 4, which is a method for manufacturing a security element suitable for safeguarding

value documents, wherein the substrate supplied in step a) is a foil substrate provided with an embossable lacquer.

[0011] 6. (Preferred configuration) Method according to section 5, wherein the security element suitable for safeguarding value documents is an (endless) strip, an (endless) thread or a patch or label.

[0012] 7. (Preferred configuration) Method according to any of sections 1 to 4, which is a method for manufacturing a value-document substrate, wherein the substrate supplied in step a) is chosen from the group consisting of a paper substrate, a paper-like substrate, a plastic substrate, a foil/paper/foil composite substrate and a paper/foil/paper composite substrate.

[0013] 8. (Preferred configuration) Method according to section 7, wherein the value-document substrate is suitable for manufacturing a value document, such as a bank note, in particular a paper bank note, polymer bank note or foil-composite bank note, or an identity card.

[0014] 9. (Second aspect of the invention) Value-document substrate or security element, obtainable by the method according to any of sections 1 to 8.

[0015] 10. (Third aspect of the invention) Value document comprising the value-document substrate or security element according to section 9.

[0016] 11. (Preferred configuration) Value document according to section 10, wherein the value document is a bank note, in particular a paper bank note, a polymer bank note or a foil-composite bank note, or an identity card.

[0017] 12. (Fourth aspect of the invention) Method for manufacturing a value-document substrate or a security element suitable for safeguarding value documents, wherein the value-document substrate or the security element has tactile substrate embossings as well as microoptical structures, wherein the method comprises:
a) supplying a substrate;
b) the step of embossing a first substrate region in such a fashion that tactile substrate embossings are produced, and the step of embossing a second substrate region in such

a fashion that microoptical structures are produced, wherein the step of embossing the first substrate region and the step of embossing of second substrate region are carried out in one working operation.

[0018] 13. (Preferred configuration) Method according to section 12, wherein the microoptical structures are based on a relief structure forming a micromirror arrangement and/or are based on a relief structure forming a diffractive structure.

Detailed description of the invention

[0019] The value document stated in the present description can be a bank note, in particular a paper bank note, a polymer bank note or a foil-composite bank note, a share, a bond, a deed, a voucher, a cheque, a high-value admission ticket, but also an ID card, such as a credit card, a bank card, a cash payment card, an authorization card, a national identity card or a passport personalization page.

[0020] According to the invention, the manufacture of a value-document substrate or of a security element suitable for safeguarding value documents is effected by printing technology.

[0021] The method according to the invention for manufacturing a value-document substrate or a security element suitable for safeguarding value documents comprises
a) supplying a substrate;
b1) printing the substrate in a first substrate region with platelet-shaped metal pigments suitable for the formation of a reflective layer and printing the substrate in a second substrate region with effect pigments which depending on the viewing angle take on a different color tone;
b2) the step of embossing the first substrate region and the second substrate region, so that (i) the substrate in the first substrate region has a relief structure which forms a diffractive structure, and the substrate in the second substrate region has a relief structure which forms a micromirror arrangement, or (ii) the substrate in the first substrate region has a relief structure which forms a micromirror arrangement and the substrate in the second substrate region has a relief structure which forms a diffractive structure.

[0022] Here, step b1) can be effected before step b2), or vice versa. In the case that the pigments used are so small that they readily adapt to the relief structures, it is preferred that the step of embossing b2) is carried out before the step of printing the substrate with the pigments b1). In the case that larger pigments are used, it is preferred that the step of printing the substrate with the pigments b1) is carried out before the step of embossing b2).

[0023] The relief structure forming a diffractive structure is in particular a hologram structure. The dimensions of the structure elements of the diffractive structure preferably are in the order of magnitude of the light wavelength, further preferably in a region greater than 100 nm and less than 1 μm, a region greater than 300 nm and less than 1 μm being particularly preferred.

[0024] The relief forming a micromirror arrangement herein is also referred to as a microoptical relief structure. The manufacture of a microoptical relief structure is known in the prior art (e.g. see WO 2014/060089 A2). The dimensions of the structure elements of the micromirror arrangement preferably are in a region greater than 1 μm and less than 40 μm, a region greater than 1 μm and less than 30 μm being particularly preferred. The dimensions of the structure elements of the micromirror arrangement have, for example, a height of up to 15 μm and a lateral extent of up to 30 μm. Here, the height as well as the lateral extent of the structure elements of the micromirror arrangement are preferably greater than 1 μm.

[0025] Suitable platelet-shaped metal pigments for producing a reflective layer obtainable by printing technology are known from, e.g. WO 2013/186167 A2, WO 2010/069823 A1, WO 2005/051675 A2 (see therein e.g. the description from page 11, line 10 to page 12, last but one section) and WO 2011/064162 A2. The platelet-shaped metal pigments described therein have the advantage, that they adapt to a ground having relief structure, in particular to a relief having microstructures and/or nanostructures, so well that the difference over a conventional metallization obtainable by means of vapor deposition can virutally not be recognized any more. The simple production of the reflective layer by printing technology makes it possible to do without elaborate method steps, such as printing the carrier with a soluble washing ink

in the form of a desired gap within the reflective layer to be produced, producing a metallization by vapor deposition and removing the washing ink together with the metallization applied above the washing ink.

[0026] The printing ink based on platelet-shaped metal pigments and usable according to the invention for producing a reflective layer obtainable by printing technology is based preferably on the metal pigment compositions described in WO 2005/051675 A2 (see therein e.g. description from page 11, line 10 to page 12, the last but one section). The pigments are based here on a metal which is chosen preferably from the group consisting of aluminium, stainless steel, nichrome, gold, silver, platinum and copper. The metal is particularly preferably aluminum, the average particle diameter being preferably in a region of 2 to 50 μm, further preferably in a region of 5 to 15 μm, measured with a Coulter LS130 laser diffraction granulometer. Such a printing ink enables the supplying of a "silver" mirror layer. In addition, the metal pigment compositions can be colored (e.g. yellow).

[0027] The effect pigments usable according to the invention, which depending on the viewing angle take on a different color tone, have in particular an interference layer structure which typically comprises a reflective layer, a partly transmissive layer or absorber layer and one or several interjacent dielectric spacer layers. The dielectric spacer layers are based, for example, on mica, on SiO_2 or on Al_2O_3. Such interference layers are referred to, corresponding to the number of dielectric layers, as single- or multi-layered. Printing inks with pigments of such thin-film interference layers are distributed for example under the name Iriodin® (single-layer) or Colorcrypt® (multilayer) by the Merck KGaA company. Printing inks with multilayer interference layer pigments are further distributed under the name OVI® (OVI = optically variable ink) by the SICPA company. A special case are magnetically orientable OVI pigments which are aligned in a preferential direction by means of a magnetic field during or after printing the substrate. A subgroup of interference layers or interference layer pigments are cholesteric or other liquid crystals which can also be used. These are present for example as liquid-crystalline silicone polymers or also as pigments in so-called STEP® inks (STEP = Shimmery Twin Effect Protection).

[0028] The effect pigments usable according to the invention, which depending on the viewing angle take on a different color tone, can further be based on the effect pigment compositions with color-shift effect described in WO 2011/064162 A2. The pigments have a longest dimension from end to end ("longest dimension of edge length") in a region of 15 nm to 1000 nm and are based on a transition metal which is chosen from the group consisting of Cu, Ag, Au, Zn, Cd, Ti, Cr, Mn, Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt. The transition metal is preferably Ag. The aspect ratio (i.e. the ratio of the longest dimension from end to end in relation to the thickness) is preferably at least 1.5, in particular in a region of 1.5 to 300. The ratio of binding agent and metal pigment is preferably below 10:1, in particular below 5:1. In dependence on the choice of the aspect ratio of the pigment, its longest dimension from end to end and the adjustment of the ratio of pigment/binding agent, the color upon viewing the printed layer in transmission and the color upon viewing in reflection can be adjusted (e.g. blue in transmission and silver, gold, bronze, copper or violet in reflection; moreover, also violet, magenta, pink, green or brown in transmission and various colors in reflection which depend on the choice of the ratio of pigment/binding agent). Colors with gold/blue color change between reflection and transmission (in other words, between viewing in incident light and in transmitted light) are stated, e.g., in the Examples 1, 2 and 3 in Table 1 of WO 2011/064162 A2. Furthermore, Example 4 shows a color with gold/violet color change, Example 5 a color with green-gold/magenta color change, Example 7 a color with violet/green color change and Example 8 a color with silver/opaque color change.

[0029] Preferably, in the step of embossing b2) according to the first aspect of the invention there can be additionally produced tactile substrate embossings, e.g. by intaglio printing method. In particular, both the tactile substrate embossings and the relief structures forming a micromirror arrangement or a diffractive structure are produced in one working operation. Analogously, a further aspect of the invention (i.e. the fourth aspect in the summary of the invention above) is a method for manufacturing a value-document substrate or a security element suitable for safeguarding value documents, the value-document substrate or the security element having both tactile substrate embossings and microoptical structures, the method

comprising:

a) supplying a substrate;

b) the step of embossing a first substrate region in such a fashion that tactile substrate embossings are produced, and the step of embossing a second substrate region in such a fashion that microoptical structures are produced, wherein the step of embossing the first substrate region and the step of embossing of second substrate region are carried out in one working operation.

According to a preferred configuration, the microoptical structures are based on a relief structure forming a micromirror arrangement and/or on a relief structure forming a diffractive structure.

[0030] For generating a microoptical structure, e.g. a hologram embossing, and a tactile substrate embossing or intaglio printing embossing in one working operation, preferably directly in the course of a sheet processing, in particular two variants are expedient:

[0031] Variant 1): At the location of the later microoptical structure (e.g. of the later hologram) there is applied an embossing lacquer onto the substrate. The embossing lacquer can be e.g. thermoplastic and/or UV-curable and can further also be already pigmented. Preferably, these are 100%-systems, i.e. non-aqueous and solvent-free formulations. Oil-based systems are possible in particular for paper substrates. With security elements (in particular security foils) which are suitable for an application in the window region (in particular of an opening or gap) of a value document, the embossing lacquer should preferably be transparent, but the embossing lacquer must not necessarily be colorless. For application of the embossing lacquer (in particular in advance) in principle any printing method is suitable. A curing is effected directly in the course of the embossing, preferably throughout the substrate. In case of a sufficiently high viscosity, as in a thermoplastic system, the curing can also be effected immediately after the embossing. Subsequently, at least the microoptical region is overprinted with an effect-pigmented printing ink in which the pigments effect a mirror reflection and adapt to the holographic structures. If suitable effect pigments were already added to the embossing lacquer, the lacquer does not have to be overprinted subsequently.

[0032] Variant 2): The embossing lacquer is not applied in advance, but using the intaglio printing plate. The intaglio printing plate already carries the microoptical information and is subjected to the embossing lacquer in these regions. The embossing lacquer can also be, besides a UV-curable system, an oil-based system. With security elements (in particular security foils) which are suitable for an application in the window region (in particular of an opening or gap) of a value document, the embossing lacquer should be transparent, but not necessarily colorless. In this case an effect-pigmented printing ink in which the pigments ideally effect a mirror reflection is also conceivable. E.g., this can be silver particles, copper particles, nanoparticles or thin aluminium platelets. By leafing pigments as well as non-leafing pigments and by the orientation enforced by the embossing the microoptical feature is produced. The curing can be effected directly in the course of the embossing, preferably throughout the substrate or in the case of a sufficiently high viscosity, as in a thermoplastic system, also immediately after the embossing. If needed, at least the microoptical region subsequently is overprinted with an effect-pigmented printing ink in which the pigments effect a mirror reflection and adapt to the holographic structures.

[0033] The intaglio printing plate preferably can carry further colored inks, i.e. be color-giving, the regions which are to reproduce the holographic structures not being color-giving. On account of the higher forgery resistance, however, an overlap is ideal because of the perfect register situation.

[0034] In this way, an exactly registered combination of steel-printing embossing and hologram embossing can be advantageously guaranteed. Furthermore, an increase of the cost efficiency is possible because lower material costs arise and a more efficient manufacturing process is effected. Less working operations lead to less rejects and less set-up time. Furthermore, a very thin embossing lacquer layer thickness is achievable, because the substrate can be simultaneously embossed. Furthermore, this achieves better mechanical stabilities.

Preferred variant A:

[0035] A preferred steel-printing cylinder according to a variant A comprises one or several regions with a microoptical embossing and one or several regions for tactile

substrate embossings (which are color-giving and/or non-color-giving). The region with a microoptical embossing is suitable in particular for producing lens structures, micromirror arrangements and/or holograms or hologram-like structures.

[0036] The substrate has an embossing lacquer, e.g. a thermoplastic, which can be present partially or, where applicable, over the full area.

[0037] The embossing lacquer is a transparent, UV-curable system which is cured at the moment of embossing or immediately after the embossing. An exposure can here be effected through the substrate. The embossing lacquer can already be provided with metal pigments or subsequently can be overprinted with a metal-pigmented printing ink. In the case of a lacquer already provided with metal pigments a leafing-UV-curable system should be especially advantageous, because the leafing pigments float on top and the embossing can thus be optimally mold into the pigments. Providing the substrate with a primer layer, where applicable with a UV primer, is optional.

Preferred variant A with leafing printing ink:

[0038] A preferred steel-printing cylinder according to a variant A with leafing printing ink comprises one or several regions with a microoptical embossing and one or several regions for tactile substrate embossings (which are color-giving and/or non-color-giving). The region with a microoptical embossing is suitable in particular for producing lens structures, micromirror arrangements and/or holograms or hologram-like structures.

[0039] The substrate has an embossing lacquer, e.g., a thermoplastic, which can be present partially or, where applicable, over the full area and has leafing pigments.

[0040] In the case of a lacquer already provided with metal pigments a leafing-UV-curable system should be especially advantageous, because the leafing pigments float on top and the embossing can thus be optimally mold into the flexible pigments. At the moment of embossing, the lacquer is not yet (fully) cured. An exposure is effected preferably immediately with the embossing through the substrate.

Preferred variant B:

[0041] A preferred steel-printing cylinder according to a variant B comprises one or several regions with a microoptical embossing and one or several regions for tactile substrate embossings (which are color-giving and/or non-color-giving). The region with a microoptical embossing is suitable in particular for producing lens structures, micromirror arrangements and/or holograms or hologram-like structures.

[0042] Not the substrate, but the regions having microoptical embossing and being present in the steel-printing cylinder have an embossing lacquer, e.g., a thermoplastic. The embossing lacquer can be present, where applicable, additionally in the regions for tactile substrate embossings formed in the steel-printing cylinder.

[0043] The embossing lacquer is a transparent, UV-curable system which is cured at the moment of embossing or immediately after the embossing. The embossing lacquer can further be oil-based or be dual-cure. The embossing lacquer is processable by steel-printing. An exposure can here be effected through the substrate. The embossing lacquer can already be provided with metal pigments or subsequently can be overprinted with a metal-pigmented printing ink. Providing the substrate with a primer layer, where applicable with a UV primer, is optional.

Preferred variant "A + B":

[0044] A preferred steel-printing cylinder according to a variant "A + B" comprises one or several regions with a microoptical embossing and one or several regions for tactile substrate embossings (which are color-giving and/or non-color-giving). The region with a microoptical embossing is suitable in particular for producing lens structures, micromirror arrangements and/or holograms or hologram-like structures.

[0045] The substrate has an embossing lacquer, e.g. a thermoplastic, which can be present partially or, where applicable, over the full area. Additionally, the regions having microoptical embossing and being present in the steel-printing cylinder have an embossing lacquer, e.g. a thermoplastic. The embossing lacquer can be present, where applicable, additionally in the regions for tactile substrate embossings formed in the steel-printing cylinder.

[0046] In particular the embossing lacquer, e.g. a thermoplastic, being present on the substrate can be present, where applicable, in pre-gelled fashion and selectively be provided with effect-pigmented printing ink. In this way, the substrate is partially pre-impregnated in the region of the microoptical structures and higher layer thicknesses are realizable.

[0047] The embossing lacquer is a transparent, UV-curable system which is cured at the moment of embossing or immediately after the embossing. An exposure can here be effected through the substrate. The embossing lacquer can already be provided with metal pigments or subsequently can be overprinted with a metal-pigmented printing ink. In the case of a lacquer already provided with metal pigments a leafing-UV-curable system should be especially advantageous, because the leafing pigments float on top and the embossing can thus be optimally mold into the pigments. Providing the substrate with a primer layer, where applicable with a UV primer, is optional.

[0048] The variant "A + B" corresponds to a two-layer embossing lacquer system. The first lacquer layer is optimized for the substrate, is applied onto the substrate and at the moment of embossing can already be partially cured or partially gelled. Thus, it is already perfectly anchored in the ground and the substrate is partially pre-impregnated for the following lacquer layer in the region of the fine holographic structures. The lacquer on the embossing tool, in particular on the intaglio printing plate, can now be processed in the so-called casting method. Now it cannot penetrate any longer and anchors perfectly in the first lacquer. The variant "A + B", on account of the higher optical quality (in particular a lower blistering), enables higher speeds in the plant. Furthermore, deeper microoptical structures are realizable.

[0049] Suitable non-leafing pigments are, e.g., PVD aluminium platelets whose surface is untreated or polar. In suitable leafing pigments, the polarity of the polar or oxidized pigment surface is reversed with long-chained alkyl-phosphorous-acids or mono-/diphosphoric esters as well as long-chained alkoxy silanes, i.e. made non-polar (for instance comparable with the effect of tensides, the polar part anchored on the pigment surface either covalent or via acid-base interaction). By the platelet structure being as perfect as possible the pigments can optimally orientate (i.e. align the

mirrors). For this purpose, leafing pigments are to be chosen preferably as thin as possible, non-leafing pigments preferably rather thicker. Normally, the pigments have a D50 of 10 µm, the thickness is in the nanometer region.

[0050] In variant B and in variant "A+B", after the application the microoptical embossing can be overprinted with a solvent-based ink, preferably with non-leafing pigments.

[0051] In variant B it is preferred to use non-leafing pigments when the embossing lacquer itself is provided with platelet-shaped pigments (the pigments orientate themselves on the embossing tool). As mobility is insufficient or hardly possible in the embossing lacquer after the application, in the case of a direct pigmentation it is expedient to resort to metal nanoparticles.

[0052] In variant "A+B", the embossing lacquer portion already applied on the substrate can be equipped with perfect non-leafing pigments or perfect leafing pigments. In the end, what is important here is as perfect a mirror as possible.

[0053] In this case it is an advantage to employ on the embossing tool an embossing lacquer portion with a very high-pigmented embossing lacquer (in particular non-leafing), i.e. lacquer with very high pigment content, so that non-leafing and leafing practically cannot be differentiated any more. This is possible here, because via the substrate there is contributed a further portion of embossing lacquer for the embossed structures.

[0054] Special embodiment examples as well as advantages of the invention will be explained hereinafter with reference to the Figures, in whose representation a reproduction that is true to scale and to proportion has been dispensed with in order to increase the clearness.

There are shown:

[0055] Figures 1 to 3 an example of the manufacture of a value-document substrate according to the invention;

[0056] Figures 4 to 7 an example of the manufacture of a security element according to the invention;

[0057] Figure 8 a schematic representation of a bank note with a security element according to the invention;

[0058] Figure 9 a schematic representation of a further bank note with a security element according to the invention.

[0059] The invention is first explained in more detail on the basis of examples of security elements for safeguarding bank notes. Figure 8 shows for this purpose a schematic representation of a bank note 14 having a transparent window region 16 (represented by dashed lines) which is provided with a security element 15 according to the invention in the form of a patch or label.

[0060] The bank note 14 can be based, e.g. on a (e.g. transparent) plastic substrate, with the bank note not having any printing ink in the region 16 neither on the front side nor on the back side, so that the region 16 is recognizable to the viewer as a transparent window region.

[0061] The bank note 14 can alternatively be based on a foil/paper/foil composite substrate, with the central paper layer having a gap (in particular filled with transparent adhesive or filler) in the region 16. Foil/paper/foil composite substrates are known from WO 2004/028825 A2.

[0062] According to a further alternative, the bank note 14 is based on a paper/foil/paper composite substrate, with the external paper layers respectively having a gap (e.g. see WO 2006/066431 A1) in the region 16.

[0063] According to a further alternative, the bank note 14 is based on a paper substrate which has a continuous gap in the region 16. The continuous gap is covered, on at least one side of the paper substrate, by a transparent foil (e.g. see WO 2011/015622 A1).

[0064] The security element 15 shown in Figure 8 includes a central, color-shift motif 17 formed by a micromirror arrangement, which is surrounded by a motif 16 formed by a hologram.

[0065] Figure 9 shows a schematic representation of a further bank note 18 based on a paper substrate, which on its front side is provided with a security element according to the invention in the form of a strip 19 (represented in dashed lines). In the present example, the strip 19 has a width of 8 mm and has a color-shift motif 21 formed by a micromirror arrangement and a motif 20 formed by a hologram.

[0066] The structure and the manufacture of a security element 19 of the invention are hereinafter explained in more detail in connection with the Figures 4 to 7. Figure 7 shows the security element 19 represented in Figure 9 in a cross-sectional view along the dashed line A-A'.

[0067] According to Figure 4, a carrier 6 in the form of a (e.g. transparent) plastic foil, e.g. a PET foil, is provided with an embossable lacquer 7. The embossable lacquer 7 is, e.g. a UV-curing lacquer or a thermoplastic lacquer.

[0068] According to Figure 5, the surface of the embossable lacquer 7 is provided, by means of embossing, with a relief structure formed by a microstructure in the partial region 8 and with a relief structure formed by a nanostructure in the partial region 9.

[0069] According to Figure 6, the embossing lacquer 7 is printed with the printing ink known from WO 2005/051675 A2 in the partial region 9. The printing ink is based on platelet-shaped metal pigments (in particular Al pigments) and leads to the production of a reflective layer 11, in the present case a “silver” mirror layer.

[0070] Furthermore, in the partial region 8 the embossing lacquer 7 is printed with effect pigments, in the present example OVI® ink, which take on a different color tone depending on the viewing angle. In this way, the layer 10 having color-shift effect is obtained by printing technology.

[0071] According to Figure 7, the obtained layer structure is provided with a (e.g. transparent) interlayer or primer layer 12 (e.g. a UV lacquer) and a heat seal lacquer 13 suitable for adhesively bonding the security element to a value-document substrate.

[0072] In Figures 4 to 7, the manufacture of a security element of the invention in the form of a strip was described (see reference sign 19 in Figure 9). The security strip 19 shown in Figure 9 has a color-shift motif 21 formed by a micromirror arrangement and a motif 20 formed by a hologram. The motif 21 formed by a micromirror arrangement here corresponds to the region designated with the reference sign 10 in Figure 6. The motif 20 formed by a hologram corresponds to the region designated with the reference sign 11 in Figure 6.

[0073] The security element shown in Figure 7 can alternatively have the shape of a patch or label (see e.g. the patch designated with the reference sign 15 in Figure 8).

[0074] In the embodiment example shown in Figures 4 to 7, there is first effected the step of embossing (see Figure 5), then the embossed regions are printed with pigments (see Figure 6). According to an alternative embodiment example, not shown in the Figures, there is first effected the step of printing with pigments and subsequently the step of embossing.

[0075] Figures 1 to 3 describe an example of manufacturing a value-document substrate according to the invention, in the present case a security paper suitable for manufacturing bank notes.

[0076] According to Figure 1, in a first step there is effected the supplying of a paper substrate 1.

[0077] According to Figure 2, the surface of the paper substrate 1 is provided, by means of blind embossing using an intaglio printing apparatus, with a relief structure formed by a microstructure in the partial region 2 and with a relief structure formed by a nanostructure in the partial region 3.

[0078] According to Figure 3, the embossed paper substrate 1 is printed with the printing ink known from WO 2005/051675 A2 in the partial region 3. The printing ink

is based on platelet-shaped metal pigments (in particular Al pigments) and leads to the production of a reflective layer 5, in the present case a "silver" mirror layer.

[0079] Furthermore, in the partial region 2 the embossed paper substrate 1 is printed with effect pigments, in the present example OVI® ink, which take on a different color tone depending on the viewing angle. In this way, the layer 4 having color-shift effect is obtained by printing technology.

[0080] In the embodiment example shown in Figures 1 to 3, there is first effected the step of embossing the paper substrate (see Figure 2), then the embossed regions of the paper substrate are printed with pigments (see Figure 3). According to an alternative embodiment example, not shown in the Figures, there is first effected the step of printing the paper substrate with pigments and subsequently the step of embossing the paper substrate.

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Claims

1. A method for manufacturing a value-document substrate suitable for a polymer bank note or foil-composite bank note, comprising

a) supplying a plastic substrate or a foil/paper/foil composite substrate;

b1) printing the substrate in a first substrate region with platelet-shaped metal pigments suitable for the formation of a reflective layer and printing the substrate in a second substrate region with effect pigments which depending on the viewing angle take on a different color tone;

b2) the step of embossing the first substrate region and the second substrate region, so that (i) the substrate in the first substrate region has a relief structure which forms a diffractive structure, and the substrate in the second substrate region has a relief structure which forms a micromirror arrangement, or (ii) the substrate in the first substrate region has a relief structure which forms a micromirror arrangement and the substrate in the second substrate region has a relief structure which forms a diffractive structure.

2. The method according to claim 1, wherein step b1) is carried out before step b2), wherein in step b2) both the platelet-shaped metal pigments suitable for the formation of a reflective layer in the first substrate region and the effect pigments taking on a different color tone depending on the viewing angle in the second substrate region adapt to the relief structure of the substrate in the respective substrate region.

3. The method according to claim 1, wherein step b2) is carried out before step b1), wherein in step b1) both the platelet-shaped metal pigments suitable for the formation of a reflective layer in the first substrate region and the effect pigments taking on a different color tone depending on the viewing angle in the second substrate region adapt to the relief structure of the substrate in the respective substrate region.

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4. The method according to any one of claims 1 to 3, wherein the step of embossing b2) is effected by means of blind printing, preferably by means of an intaglio printing apparatus.

5. The method according to any one of claims 1 to 4, wherein in the step of embossing b2) tactile substrate embossings are additionally produced, and wherein the tactile substrate embossings as well as the relief structures forming the micromirror arrangement or the diffractive structure are produced in one working operation.

6. A value-document substrate, obtainable by the method according to any of claims 1 to 5.

7. A value document comprising the value-document substrate according to claim 6.

FIG 1

FIG 2

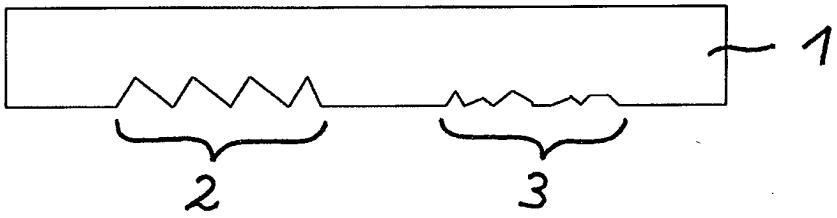

FIG 3

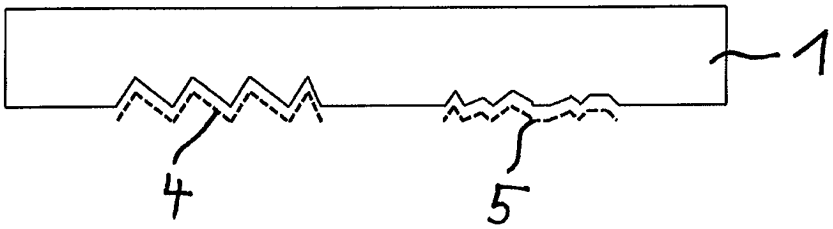

FIG 4

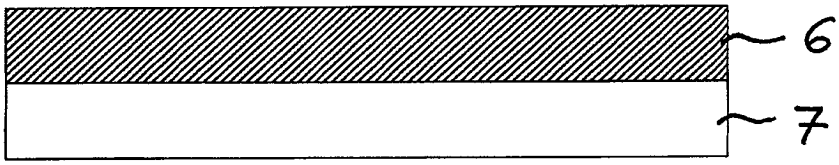

FIG 5

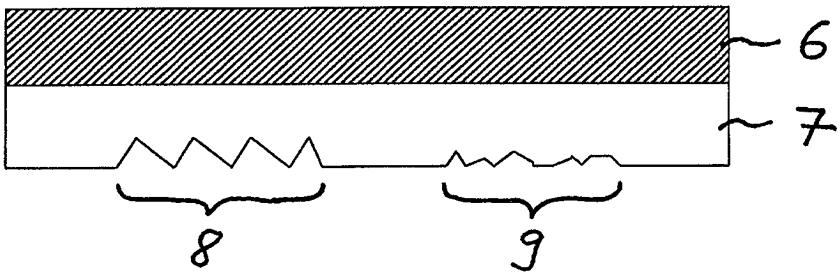

FIG 6

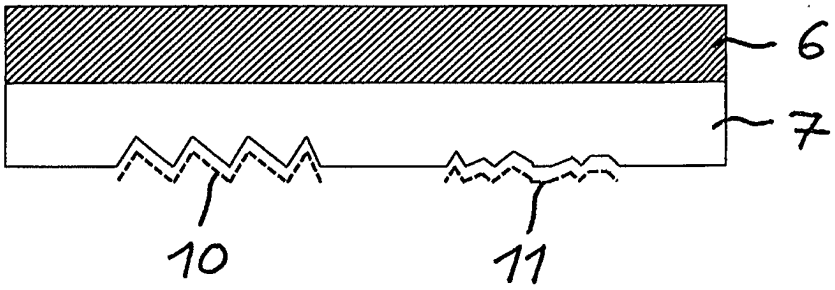

FIG 7

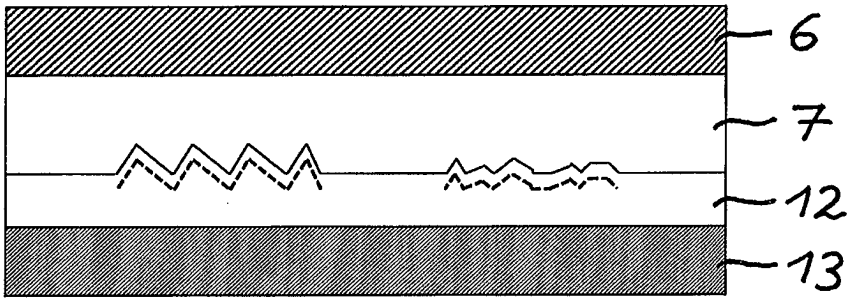

FIG 8

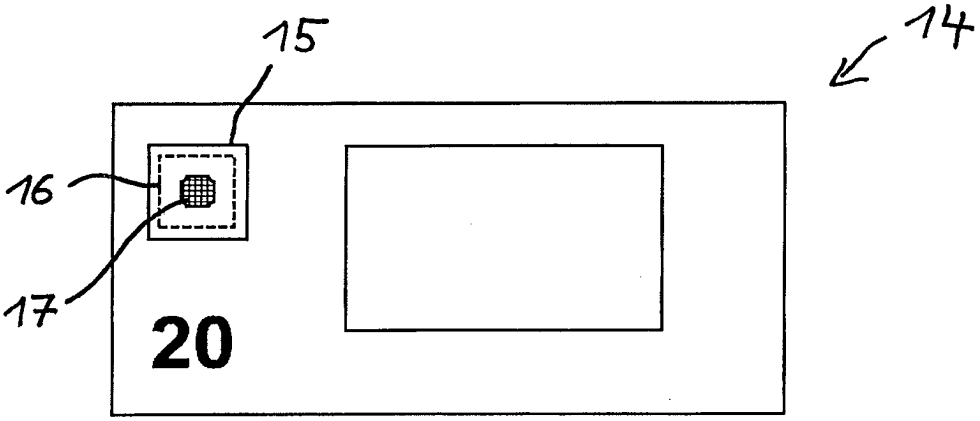

FIG 9