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(54) OPTICAL ANTI-COUNTERFEITING ELEMENT, ANTI-COUNTERFEITING PRODUCT, AND MANUFACTURING METHOD FOR OPTICAL ANTI-COUNTERFEITING ELEMENT

(57) The present invention provides an optical anti-counterfeiting element, an anti-counterfeiting product and a manufacturing method of an optical anti-counterfeiting element. The optical anti-counterfeiting element includes a substrate layer and an optical layer; the optical layer is disposed on one side of the substrate layer and connected with the substrate layer; the optical layer includes a micro-structure layer; and the micro-structure layer includes a first area, having a plurality of first micro-structures, and a second area, having a plurality of second micro-structures, when observed from one side of the optical anti-counterfeiting element, the first area has a white feature, the second area has an interference optical discoloration feature, and the specific volume of the second micro-structure is greater than that of the first micro-structure. The present invention solves the problem that an optical anti-counterfeiting element in the relevant art has poor anti-counterfeiting performance.

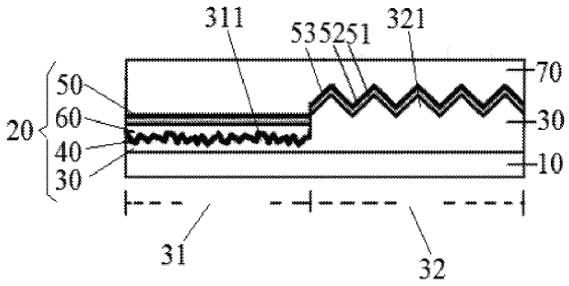

Fig. 2

EP 4 431 305 A1

Description

Cross-Reference to Related Application

[0001] This application claims priority to Chinese Patent Application No. 202111335319.6 filed to the China National Intellectual Property Administration on November 11, 2021 and entitled "Optical Anti-Counterfeiting Element, Anti-Counterfeiting Product and Manufacturing Method of Optical Anti-Counterfeiting Element".

Technical Field

[0002] The present invention relates to the technical field of optical anti-counterfeiting, and in particular to an optical anti-counterfeiting element, an anti-counterfeiting product and a manufacturing method of the optical anti-counterfeiting element.

Background

[0003] In order to prevent counterfeiting generated by means of scanning, copying and the like, an optical anti-counterfeiting element containing an optical anti-counterfeiting technology is widely used in various high-safety or high-added-value printed matters such as banknotes, credit cards, passports, securities and product packages. Although the optical anti-counterfeiting element improves anti-counterfeiting performance, the anti-counterfeiting performance of the optical anti-counterfeiting element is still easy to imitate.

[0004] That is, the optical anti-counterfeiting element in the relevant art has the problem of poor anti-counterfeiting performance.

Summary

[0005] A main objective of the present invention is to provide an optical anti-counterfeiting element, an anti-counterfeiting product and a manufacturing method of the optical anti-counterfeiting element, to solve the problem that the optical anti-counterfeiting element in the relevant art has poor anti-counterfeiting performance.

[0006] In order to achieve the purpose, according to an embodiment of the present invention, an optical anti-counterfeiting element is provided, which includes a substrate layer and an optical layer; the optical layer is disposed on one side of the substrate layer and connected with the substrate layer; the optical layer includes a micro-structure layer; and the micro-structure layer includes a first area having a plurality of first micro-structures, and a second area having a plurality of second micro-structures, when observed from one side of the optical anti-counterfeiting element, the first area has a white feature, the second area has an interference optical discoloration feature, and the specific volume of the second micro-structure is greater than that of the first micro-structure.

[0007] In an embodiment, the optical layer further includes: a metal layer, which is connected with one side, away from the substrate layer, of the first area; and an interference optical variable layer, which is connected with at least one side, away from the substrate layer, of the second area.

[0008] In an embodiment, the optical layer further includes a protective layer, which is connected with one side, away from the substrate layer, of the metal layer.

[0009] In an embodiment, the interference optical variable layer is connected with one side, away from the metal layer, of the protective layer.

[0010] In an embodiment, the interference optical variable layer includes an absorption layer, a dielectric layer and a reflection layer which are stacked in sequence, and the absorption layer is connected with at least one side, away from the substrate layer, of the second area.

[0011] In an embodiment, a material of the absorption layer includes at least one of nickel, chromium, aluminum, silver, copper, tin and titanium; and/or a material of the dielectric layer includes at least one of magnesium fluoride, silicon dioxide, zinc sulfide, titanium nitride, titanium dioxide, titanium monoxide, titanium trioxide, trititanium pentoxide, tantalum pentoxide, niobium pentoxide, cerium dioxide, bismuth trioxide, dichromium trioxide, iron oxide, hafnium dioxide or zinc oxide; and a material of the reflection layer includes at least one of aluminum, silver, tin, nickel and titanium.

[0012] In an embodiment, the metal layer includes at least one of aluminum, silver, tin, nickel and titanium; and/or the thickness of the metal layer is greater than 10 nm and smaller than or equal to 80 nm.

[0013] In an embodiment, the specific volume of the first micro-structure is greater than or equal to 0 and smaller than or equal to 0.5 um^3/um^2; and/or the specific volume of the second micro-structure is greater than 0.4 um^3/um^2 and smaller than 2 um^3/um^2.

[0014] In an embodiment, all the first micro-structures are achromatic white micro-structures.

[0015] In an embodiment, at least two of the plurality of achromatic white micro-structures are different in size, at least two of the plurality of achromatic white micro-structures are different in height, and the achromatic white micro-structure is a projection or a groove.

[0016] In an embodiment, the length of the achromatic white micro-structure is greater than 1 um and smaller than 10 um; and/or the depth of the achromatic white micro-structure is greater than 0.1 um and smaller than 5 um.

[0017] In an embodiment, the achromatic white micro-structure is a micro reflector, the length of the micro reflector is greater than or equal to 5 um and smaller than or equal to 10 um; and/or the depth of the micro reflector is greater than 1 um and smaller than or equal to 4 um.

[0018] In an embodiment, the first area includes: a first sub-area, which is continuously disposed around the periphery of the second area, and the first micro-structure in the first sub-area is an achromatic white micro-structure; and a second sub-area, which is continuously dis-

posed around the periphery of the first sub-area, and the first micro-structure in the second sub-area is a non-achromatic white micro-structure.

[0019] In an embodiment, the plurality of non-achromatic white micro-structures are periodically arranged; or the plurality of non-achromatic white micro-structures are arranged in a non-periodic manner.

[0020] In an embodiment, the section structure of the non-achromatic white micro-structure along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure.

[0021] In an embodiment, the plurality of second micro-structures are periodically arranged; or the plurality of second micro-structures are arranged in a non-periodic manner.

[0022] In an embodiment, the section structure of the second micro-structure along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure.

[0023] According to another embodiment of the present invention, an anti-counterfeiting product is provided, which includes the optical anti-counterfeiting element described above.

[0024] In an embodiment, the anti-counterfeiting product further includes a carrier, the optical anti-counterfeiting element is disposed on the carrier, and at least part of the surface, bearing the optical anti-counterfeiting element, of the carrier is white.

[0025] According to still another embodiment of the present invention, a manufacturing method of an optical anti-counterfeiting element is provided, and the optical anti-counterfeiting element described above is manufactured by the manufacturing method of the optical anti-counterfeiting element. The manufacturing method of the optical anti-counterfeiting element includes: S10: a micro-structure layer having a first area and a second area is formed on the surface of a substrate layer, a first micro-structure is formed on the first area, and a second micro-structure with specific volume greater than that of the first micro-structure is formed on the second area; S20: a meal layer is formed on the surface, away from the substrate layer, of the micro-structure layer; S30: a protective layer for protecting the first area is formed on the surface, away from an optical layer, of the metal layer; S40: the metal layer at the second area is removed; and S50: an interference optical variable layer is formed on the surface of one side away from the substrate layer, so as to form the optical anti-counterfeiting element.

[0026] By adoption of the technical solution of the present invention, the optical anti-counterfeiting element includes the substrate layer and the optical layer; the optical layer is disposed on one side of the substrate layer and connected with the substrate layer; the optical layer includes the micro-structure layer; and the micro-structure layer includes the first area and the second area, the first area has a plurality of first micro-structures, the second area has a plurality of second micro-structures, when observed from one side of the optical anti-counterfeiting element, the first area has a white feature, the second area has an interference optical discoloration feature, and the specific volume of the second micro-structure is greater than that of the first micro-structure.

[0027] The optical features of the two areas are different through the arrangement of the first area and the second area, the first area with the white feature plays a role of set off, and the second area with the interference optical discoloration feature may show different color effects at different observation angles. Meanwhile, the second area with interference optical discoloration feature is in a preset shape, when the optical anti-counterfeiting element is observed in an inclined view, only a specific image has a discoloration effect, and other areas are white, so that extremely strong visual feature and anti-counterfeiting performance are achieved. The specific volume of the second micro-structure is greater than that of the first micro-structure, so that the second micro-structure occupies a larger space under the condition of the same weight, and the sizes of the micro-structures of the first area and the second area are different on the basis of not increasing the weight of the optical anti-counterfeiting element, so that the first area and the second area generate different optical features.

Brief Description of the Drawings

[0028] The drawings forming a part of the present invention in the specification are adopted to provide a further understanding to the present invention. Schematic embodiments of the present invention and descriptions thereof are adopted to explain the present invention and not intended to form improper limits to the present invention. In the drawings:

Fig. 1 illustrates a schematic structure diagram of an optical anti-counterfeiting element of Embodiment 1 of the present invention.

Fig. 2 illustrates a structure diagram of a sectional view at an angle of an optical anti-counterfeiting element in Fig. 1.

Fig. 3 illustrates a schematic structure diagram of an optical anti-counterfeiting element of Embodiment 2 of the present invention.

Fig. 4 illustrates a structure diagram of a sectional view at an angle of an optical anti-counterfeiting element in Fig. 3.

[0029] The drawings include the following reference signs.

10. Substrate layer; 20. Optical layer; 30. Micro-structure

layer; 31. First area; 311. First micro-structure; 312. First sub-area; 313. Second sub-area; 32. Second area; 321. Second micro-structure; 40. Metal layer; 50. Interference optical variable layer; 51. Absorption layer; 52. Dielectric layer; 53. Reflection layer; 60. Protective layer; and 70. Functional coating.

Detailed Description of the Embodiments

[0030] It is to be noted that the embodiments and features in the embodiments of the present invention may be combined with each other without conflict. The present invention will be described in detail below with reference to the accompanying drawings and the embodiments.

[0031] It is to be noted that, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by those of ordinary skill in the art to which this present invention belongs.

[0032] In the present invention, unless stated to the contrary, the orientation term such as "upper, lower, top, bottom" or the like, generally refers to the direction shown in the drawings, or to the vertical, perpendicular, or gravitational direction of components; likewise, for ease of understanding and description, "inner and outer" refer to inner and outer relative to the profile of the components, but the above orientation terms are not intended to limit the present invention.

[0033] In order to solve the problem of poor anti-counterfeiting performance of an optical anti-counterfeiting element in the relevant art, the present invention provides an optical anti-counterfeiting element, an anti-counterfeiting product and a manufacturing method of an optical anti-counterfeiting element.

[0034] In existing optical anti-counterfeiting technologies, optical effects such as diffraction and non-diffraction formed by a micro-structure are widely applied due to high brightness and obvious dynamic effect. In order to increase the brightness of images, the micro-structure optical anti-counterfeiting technology generally adopts a metal reflection layer, such as aluminum. The optical anti-counterfeiting technology, namely holographic technology, which is the most widely applied to optical films at present is an optical technology developed by utilizing a diffraction effect formed by the micro-structure. The holographic technology is adopted for anti-counterfeiting threads of the 5th set of 5-yuan, 10-yuan, 20-yuan, 50-yuan and 100-yuan RMB (1999 Edition). In addition, a multi-layer interference optical variable technology is increasingly paid attention by people due to different color effects at different observation angles. The color change of the interference optical variable effect is definitely describable, for example, color A is shown under observation in a front view, color B is shown under observation in an inclined view, so that the anti-counterfeiting performance is higher than that of hologram. The multi-layer interference optical variable technology generally adopts a vapor deposition method to realize evaporation of a multi-layer interference plating layer.

[0035] A classical multi-layer interference plating layer generally includes a reflection layer, a dielectric layer and an absorption layer. The reflection layer is generally prepared from a high-brightness metal material, the dielectric layer is generally prepared from a transparent inorganic or organic material, and the absorption layer is also called as a semitransparent layer and is generally prepared from a thin metal material with good absorptivity. The multi-layer interference optical variable technology is adopted by security threads of the 5th set of 100-yuan RMB (2015 edition) and those of 10-yuan, 20-yuan and 50-yuan RMB (2019 edition), and magenta color is shown under observation in a front view and green color is shown under observation in an inclined view. Particularly, security threads of 50-yuan RMB adopt the technology combining the optical micro-structure and the interference optical variable layer 50, so that under observation in an inclined view, a comprehensive anti-counterfeiting feature combining the rolling strip effect shown by the micro-structure and the interference optical variable effect is visible.

[0036] The optical anti-counterfeiting element of the present invention adopts the combination of the optical micro-structure and the interference optical variable layer 50, the area with interference optical discoloration feature is a preset shape, for example, letters or numbers or other images with specific information, the application of the interference optical variable plating layer may play a complementing role, namely, under observation in an inclined view, specific images have a discoloration effect. It can be imagined that if in the optical anti-counterfeiting element, only a specific image shows a discoloration effect (that is, where the interference optical variable plating layer is strictly located), and other areas are white, the optical anti-counterfeiting element is applied on a substrate with white feature (such as banknote paper), and strong visual feature and anti-counterfeiting performance are achieved.

[0037] As shown in Figs. 1-4, the optical anti-counterfeiting element includes a substrate layer 10 and an optical layer 20; the optical layer 20 is disposed on one side of the substrate layer 10 and connected with the substrate layer 10; the optical layer 20 includes a micro-structure layer 30; and the micro-structure layer 30 includes a first area 31 and a second area 32, the first area 31 has a plurality of first micro-structures 311, the second area 32 has a plurality of second micro-structures 321, when observed from one side of the optical anti-counterfeiting element, the first area 31 has a white feature, the second area 32 has an interference optical discoloration feature, and the specific volume of the second micro-structure 321 is greater than that of the first micro-structure 311.

[0038] The optical features of the two areas are different through the arrangement of the first area 31 and the second area 32, the first area 31 with the white feature plays a role of set off, and the second area 32 with the interference optical discoloration feature may show dif-

ferent color effects at different observation angles. Meanwhile, the second area 32 with interference optical discoloration feature is in a preset shape, when the optical anti-counterfeiting element is observed in an inclined view, only a specific image has a discoloration effect, and other areas are white, so that extremely strong visual feature and anti-counterfeiting performance are achieved. The specific volume of the second micro-structure 321 is greater than that of the first micro-structure 311, so that the second micro-structure 321 occupies a larger space under the condition of the same weight, and the sizes of the micro-structures of the first area 31 and the second area 32 are different on the basis of not increasing the weight of the optical anti-counterfeiting element, so that the first area 31 and the second area 32 generate different optical features.

Embodiment 1

[0039] In the specific embodiment shown in Fig. 1, the second area 32 has an interference optical discoloration feature, and the second area 32 is a pentagram area, which has a relief and a discoloration feature changing with inclination change, and the discoloration area is heavily coincident with the pentagram area with the relief feature. Lines of tip of the pentagram area may be very fine, for example, smaller than 20 um. If the optical anti-counterfeiting element is pasted on a white protected product, the pentagram is extremely eye-catching, coupled with its relief sense and discoloration effect, so the product has excellent anti-counterfeiting performance.

[0040] As shown in Fig. 2, the thickness of the second area 32 is greater than that of the first area 31. Then, the second area 32 protrudes out of the first area 31, making the interference optical discoloration feature at the second area 32 more significant.

[0041] As shown in Fig. 2, the optical layer 20 further includes a metal layer 40 and an interference optical variable layer 50, the metal layer 40 is connected with one side, away from the substrate layer 10, of the first area 31; and the interference optical variable layer 50 is connected with at least one side, away from the substrate layer 10, of the second area 32. A first micro-structure 311 on the first area 31 shows a relatively high whiteness due to arrangement of the metal layer 40, so that white feature at the first area 31 is realized. The interference optical variable layer 50 is disposed at the second area 32, so that the second area 32 may realize an interference optical discoloration feature, meanwhile, the second area 32 has no metal layer 40, the interference optical discoloration feature at the second area 32 may not be affected, so that the first area 31 and the second area 32 have an obvious difference, which increases the anti-counterfeiting performance of the optical anti-counterfeiting element.

[0042] As shown in Fig. 2, the optical layer 20 further includes a protective layer 60, and the protective layer 60 is connected with one side, away from the substrate layer 10, of the metal layer 40. The protective layer 60 provides no additional optical effect and plays a protection role on the metal layer 40.

[0043] As shown in Fig. 2, the interference optical variable layer 50 is further disposed at the first area 31, and the interference optical variable layer 50 is connected with one side, away from the metal layer 40, of the protective layer 60. This arrangement facilitates the formation of the interference optical variable layer 50 on the optical anti-counterfeiting element, although the first area 31 has the interference optical variable layer 50, the first area 31 has the metal layer 40, the interference optical variable layer 50 located at the first area 31 cannot produce an interference optical discoloration feature under the action of the metal layer 40, but only the first area 31 forms the white feature.

[0044] As shown in Fig. 2, the interference optical variable layer 50 includes an absorption layer 51, a dielectric layer 52 and a reflection layer 53 which are stacked in sequence, and the absorption layer 51 is connected with at least one side, away from the substrate layer 10, of the second area 32. The reflection layer is generally prepared from a high-brightness metal material, the dielectric layer 52 is generally prepared from a transparent inorganic or organic material, and the absorption layer 51 is also called as a semitransparent layer and is generally prepared from a thin metal material with good absorptivity, so that interference optical discoloration feature may be formed at the second area.

[0045] Specifically, a material of the absorption layer 51 includes at least one of nickel, chromium, aluminum, silver, copper, tin and titanium. A material of the absorption layer 51 may include one of nickel, chromium, aluminum, silver, copper, tin and titanium, or a mixture of nickel, chromium, aluminum, silver, copper, tin and titanium.

[0046] Specifically, a material of the dielectric layer 52 includes at least one of magnesium fluoride, silicon dioxide, zinc sulfide, titanium nitride, titanium dioxide, titanium monoxide, titanium trioxide, trititanium pentoxide, tantalum pentoxide, niobium pentoxide, cerium dioxide, bismuth trioxide, dichromium trioxide, iron oxide, hafnium dioxide or zinc oxide. A material of the dielectric layer 52 may be one of magnesium fluoride, silicon dioxide, zinc sulfide, titanium nitride, titanium dioxide, titanium monoxide, dititanium trioxide, trititanium pentoxide, tantalum pentoxide, niobium pentoxide, cerium dioxide, bismuth trioxide, dichromium trioxide, iron oxide, hafnium dioxide or zinc oxide, or may be formed by mixing magnesium fluoride, silicon dioxide, zinc sulfide, titanium nitride, titanium dioxide, titanium monoxide, dititanium trioxide, trititanium pentoxide, tantalum pentoxide, niobium pentoxide, cerium dioxide, bismuth trioxide, dichromium trioxide, iron oxide, hafnium dioxide or zinc oxide.

[0047] Specifically, a material of the reflection layer 53 includes at least one of aluminum, silver, tin, nickel and titanium. A material of the reflection layer 53 may be one of aluminum, silver, tin, nickel and titanium, and also may

be formed by mixing aluminum, silver, tin, nickel and titanium.

[0048] Specifically, the metal layer 40 includes at least one of aluminum, silver, tin, nickel and titanium. A material of the metal layer 40 may be one of aluminum, silver, tin, nickel and titanium, and also may be formed by mixing aluminum, silver, tin, nickel and titanium, only if the metal layer 40 has high reflection performance.

[0049] Specifically, the thickness of the metal layer 40 is greater than 10 nm and smaller than or equal to 80 nm. If the thickness of the metal layer 40 is smaller than 10 nm, the thickness of the metal layer 40 is too small, then it is not easy for uniform application, and meanwhile, the metal layer 40 is easy to remove. If the thickness of the metal layer 40 is greater than 80 nm, the thickness of the metal layer 40 is too large, the firmness with the micro-structure layer 30 is poor, and the cost is increased. The thickness of the metal layer 40 is limited within the range of 10 nm to 80 nm, so that the metal layer 40 is not easy to remove, and meanwhile, the bonding firmness of the metal layer 40 and the micro-structure layer 30 is ensured.

[0050] Specifically, the specific volume of the first micro-structure 311 is greater than or equal to 0 and smaller than or equal to 0.5 um^3/um^2. If the specific volume of the first micro-structure 311 is greater than 0.5 um^3/um^2, the specific volume of the first micro-structure 311 is too large, the volume of the first micro-structure 311 at the same mass is too large, which is not conducive to producing the white feature.

[0051] Specifically, the specific volume of the second micro-structure 321 is greater than 0.4 um^3/um^2 and smaller than 2 um^3/um^2. If the specific volume of the second micro-structure 321 is greater than 0.4 um^3/um^2, the specific volume of the second micro-structure 321 is too small, the volume of the second micro-structure 321 at the same mass is too small, which is not conducive for the second micro-structure 321 to produce the relief feature. If the specific volume of the second micro-structure 321 is greater than 2 um^3/um^2, the volume of the second micro-structure 321 at the same mass is too large, which is conducive for the interference optical variable layer 50 to produce an interference optical variable feature. While when the specific volume of the second micro-structure 321 is controlled to be greater than or equal to 0.4 um^3/um^2 and smaller than 2 um^3/um^2, the second area 32 may produce a good interference optical variable feature.

[0052] Specifically, all the first micro-structures 311 are achromatic white micro-structures. By disposing the first micro-structures 311 as the achromatic white micro-structures, light of a specific color may be eliminated, so that the first area 31 shows a white feature.

[0053] Specifically, at least two of the plurality of achromatic white micro-structures are different in size, at least two of the plurality of achromatic white micro-structures are different in height, and the achromatic white micro-structure is a projection or a groove. Thus, the degree of freedom in designing the first micro-structure 311 in the first area 31 is relatively high, which is conductive to manufacturing of the first micro-structure 311.

[0054] Specifically, the length of the achromatic white micro-structure is greater than 1 um and smaller than 10 um. If the length of the achromatic white micro-structure is smaller than 1 um, the length of the achromatic white micro-structure is too small, which is conductive to manufacturing of the achromatic white micro-structure. If the length of the achromatic white micro-structure is greater than 10 um, the length of the achromatic white micro-structure is too large, and the achromatic effect is poor. When the length of the achromatic white micro-structure is limited within the range of 1 um to 10 um, while the achromatic effect of the achromatic white micro-structure is guaranteed, the manufacturing of the achromatic white micro-structure is also facilitated.

[0055] Specifically, the depth of the achromatic white micro-structure is greater than 0.1 um and smaller than 5 um. If the depth of the achromatic white micro-structure is smaller than 0.1 um, the height of the achromatic white micro-structure is too small, which is conductive to manufacturing of the achromatic white micro-structure. If the depth of the achromatic white micro-structure is greater than 5 um, the height of the achromatic white micro-structure is too large, which is not conductive to miniaturization, lightness and thinness of the optical anti-counterfeiting element. When the depth of the achromatic white micro-structure is limited within the range of 0.1 um to 5 um, while the manufacturing of the achromatic white micro-structure is facilitated, lightness and thinness of the optical anti-counterfeiting element is guaranteed.

[0056] Specifically, the achromatic white micro-structure is a micro reflector, and the length of the micro reflector is greater than or equal to 5 um and smaller than 10 um. By disposing the achromatic white micro-structure as a micro reflector, a reflection feature for light may be achieved, meanwhile, its intrinsic feature may eliminate light with a specific color, and finally, a while feature is shown.

[0057] Specifically, the depth of the micro reflector is greater than 1 um and smaller than or equal to 4 um.

[0058] Alternatively, the plurality of second micro-structures 321 are periodically arranged, that is, the plurality of second micro-structures 321 may be arranged in a preset period, such as in a matrix.

[0059] Of course, the plurality of second micro-structures 321 may also be arranged in a non-periodic manner, and the plurality of second micro-structures 321 are arranged in a non-periodic manner. That is, the plurality of second micro-structures 321 may be arranged randomly without a rule.

[0060] Specifically, the section structure of the second micro-structure 321 along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure. The second micro-structure 321 may be one

of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure, and also may be formed by several of them.

[0061] An anti-counterfeiting product includes the optical anti-counterfeiting element described above. The anti-counterfeiting product with the optical anti-counterfeiting element described above has the advantages of high anti-counterfeiting performance and difficulty in imitating.

[0062] Specifically, the anti-counterfeiting product further includes a carrier, the optical anti-counterfeiting element is disposed on the carrier, and at least part of the surface, bearing the optical anti-counterfeiting element, of the carrier is white. By applying the optical anti-counterfeiting element on the carrier with the white surface, the anti-counterfeiting product has extremely strong visual feature and anti-counterfeiting performance.

[0063] According to still another embodiment of the present invention, a manufacturing method of an optical anti-counterfeiting element is provided, and the optical anti-counterfeiting element described above is manufactured by the manufacturing method of the optical anti-counterfeiting element. The manufacturing method of the optical anti-counterfeiting element includes: S10: a micro-structure layer 30 having a first area 31 and a second area 32 is formed on the surface of a substrate layer 10, a first micro-structure 311 is formed on the first area 31, and a second micro-structure 321 with specific volume greater than that of the first micro-structure 311 is formed on the second area 32; S20: a meal layer 40 is formed on the surface, away from the substrate layer 10, of the micro-structure layer 30; S30: a protective layer 60 for protecting the first area 31 is formed on the surface, away from the micro-structure layer 30, of the metal layer 40; S40: the metal layer 40 at the second area 32 is removed; and S50: an interference optical variable layer 50 is formed on the surface of one side away from the substrate layer 10, so as to form the optical anti-counterfeiting element.

[0064] S10: an optical layer 20 having a first area 31 and a second area 32 is formed on the surface of the substrate layer 10; and the specific volume of the second micro-structure 321 is greater than that of the first micro-structure 311, and the first micro-structure 311 is a chromatic white micro-structure.

[0065] The substrate layer 10 may be at least partially transparent, may also be a colored dielectric layer, may be a transparent medium film with a functional coating on the surface, and may also be a multi-layer film formed by compounding. The substrate layer 10 is generally formed by a film material having good physical and chemical resistance and high mechanical strength, for example, a plastic film such as a polyethylene terephthalate (PET) film, a polyethylene naphthalate (PEN) film, or a polypropylene (PP) film may be used to form the substrate layer 10, and the substrate layer 10 is preferably formed by the PET material. A bonding enhancement layer may be included on the substrate layer 10 to enhance bonding of the substrate layer 10 to the optical layer 20. A release layer may also be included on the substrate layer 10 to achieve separation of the substrate layer 10 from the optical layer 20 of the final product.

[0066] The micro-structure layer 30 may be formed by performing batch copying through processing modes such as ultraviolet casting, mould pressing and nano-imprinting. For example, the micro-structure layer 30 may be formed by thermoplastic resin through the mould pressing process, that is, the thermoplastic resin coated on the substrate layer 10 in advance is heated to be softened and deformed when passing through a high-temperature metal template, so that a specific optical micro-structure is formed, and then cooling and molding are performed. The micro-structure layer 30 may also be formed by a radiation curing casting process, namely, a radiation curing resin is applied to the substrate layer 10, an original template is pushed thereon, meanwhile, irritating of radioactive rays such as ultraviolet rays or electron beams is carried out, so that the material is cured, and then the original template is removed to form the micro-structure layer 30.

[0067] The specific volume of the second micro-structure is greater than that of the first micro-structure for the need for subsequent removal. Preferably, the specific volume of the first micro-structure is greater than or equal to 0 um^3/um^2 and smaller than 0.5 um^3/um^2, and the specific volume of the second micro-structure is greater than 0.4 um^3/um^2 and smaller than 2 um^3/um^2.

[0068] The morphology of the achromatic white micro-structure is generally random arrangement of projections and/or grooves of different depths and sizes, the transverse feature size is generally greater than 1 um and smaller than 10 um, and the depth feature size is generally greater than 0.1 um and smaller than 5 um. For example, it may be formed by a micro reflector with the transverse size of 5-10 um and the depth of 1-4 um.

[0069] The specific morphology of the second micro-structure is set as desired. For example, a pentagram with relief feature as shown in Fig. 1 is formed, and its section may be of a blazed grating structure with the width of 5-10 um and depth of 1-2 um.

[0070] S20: a meal layer 40 is formed on the surface, away from the substrate layer 10, of the micro-structure layer 30.

[0071] The effect of the metal layer 40 is to enable the achromatic white micro-structure to show a relatively high degree of whiteness. The material of the metal layer 40 is required to have high reflectivity feature, and may be one or more of aluminum, silver, tin, and titanium. Aluminum is preferred because of its low cost and its ease of reaction with acids or bases to be locally removed. In the embodiment, aluminum is selected as the metal layer 40. The thickness of the metal layer 40 is generally greater than 10 nm and smaller than 80 nm, preferably greater than 20 nm and smaller than 50 nm. If the metal layer is too thin, the brightness is insufficient; and if the metal

layer 40 is too thick, the fastness to the optical micro-structure layer is poor, and the cost also increases.

[0072] The metal layer 40 may generally be formed on the optical micro-structure layer by physical and/or chemical vapor deposition methods, for example, including, but not limited to, thermal evaporation, magnetron sputtering, MOCVD, etc. Preferably, the metal layer 40 is formed on the optical micro-structure layer in a conformal coverage manner with uniform surface density.

[0073] S30: a protective layer 60 for protecting the first area 31 is formed on the surface, away from the micro-structure layer 30, of the metal layer 40.

[0074] The amount of the protective layer 60 is required to be such that the minimum thickness on the first micro-structure 311 is significantly greater than that on the second micro-structure 321. The minimum thickness of the protective layer 60 on the first micro-structure 311 is generally located at the very top of the second micro-structure 321. Thus, the protective layer 60 provides significantly greater protection to the metal layer 40 of the first area 31 than to the metal layer 40 of the second area 32. It is generally required that the coating amount per unit area of the protective layer 60 is greater than 0.1 g/m2 and smaller than 0.6 g/m2. The smaller the viscosity before application of the protective layer 60, the more advantageous the leveling, and therefore, the viscosity of protective glue is generally smaller than 100 cP, preferably smaller than 50 cP. The component of the protective layer 60 may be varnish or ink containing polyester, polyurethane, acrylic resin, or a combination thereof as a main resin.

[0075] S40: the metal layer 40 at the second area 32 is removed.

[0076] The protective layer 60 provides significantly greater protection to the metal layer 40 of the first area 31 than to the metal layer 40 of the second area 32. Therefore, in a certain period of time, the corrosive atmosphere may reach and corrode the metal layer 40 of the second area 32 through weak points of the protective layer 60 of the second area 32; and in the time, the protective layer 60 effectively protects the metal layer 40 of the first area 31. In this way, the metal layer 40 accurately located on the first area 31 is obtained. In the embodiment, the metal layer 40 is aluminum, and then the corrosive atmosphere may be acid liquor or alkali liquor. Generally, after the metal layer 40 on the second area 32 is corroded, the protective layer 60 on the plating layer also floats. Sometimes, after the metal layer 40 on the second area 32 is corroded, the protective layer 60 may partially or even completely remain on the micro-structure layer 30, which does not affect the implementation of subsequent processes.

[0077] S50: an interference optical variable layer 50 is formed on the surface of one side away from the substrate layer 10, so as to form the optical anti-counterfeiting element.

[0078] In the embodiment, the interference optical variable layer 50 generally consists of an absorption layer 51, a dielectric layer 52 and a reflection layer 53. Observed from one side of the absorption layer 51, the interference optical variable layer 50 shows different color features, and therefore, the order of formation of the interference optical variable layer 50 is generally the absorption layer 51, the dielectric layer 52 and the reflection layer 53. The reflection layer 53 is generally a thicker metal material with good reflection performance, showing non-transparent or substantially non-transparent feature in perspective observation; the dielectric layer 52 is generally a completely transparent or substantially completely transparent compound material; and the absorption layer 51 is generally a thinner metal material, which shows semi-transparent feature during light transmission. The reflection layer 53 may be made of aluminum, silver, copper, tin, chromium, nickel, titanium, or alloy thereof, and is preferably aluminum because aluminum is relatively low in cost and easy to remove by acid liquor or alkali liquor; the dielectric layer 52 may be composed of MgF_2, SiO_2, ZnS, TiN, TiO_2, TiO, Ti_2O_3, Ti_3O_5, Ta_2O_5, Nb_2O_5, CeO_2, Bi_2O_3, Cr_2O_3, Fe_2O_3, HfO_2 or ZnO; and the absorption layer 51 may be composed of nickel, chromium, aluminum, silver, copper, tin, titanium or alloy thereof, and preferably nickel and chromium. The thickness of the reflection layer 53 is generally selected from 10 nm to 80 nm, preferably 20 nm to 50 nm. The thickness of the absorption layer 51 is generally 3-10 nm. The thickness of the dielectric layer 52 is determined by the desired optically variable colors, and is generally 200-600 nm.

[0079] At this point, a semi-finished optical anti-counterfeiting element with the first micro-structure area showing the optical features of the metal layer 40 and the second area 32 showing the optical features of the second plating layer is obtained.

[0080] S50: other functional coatings 70 are applied, such as anti-aging glue, to protect the optical plating layer, and/or hot melt glue, to play the role of bonding with other substrate layers 10.

Embodiment 2

[0081] The difference from Embodiment 1 is that the specific structure of the first area 31 is different.

[0082] As shown in Fig. 3, the first area 31 includes a first sub-area 312 and a second sub-area 313, the first sub-area 312 is continuously disposed around the periphery of the second area 32, and the first micro-structure 311 in the first sub-area 312 is an achromatic white micro-structure; and the second sub-area 313 is continuously disposed around the periphery of the first sub-area 312, and the first micro-structure 311 in the second sub-area 313 is a non-achromatic white micro-structure.

[0083] The second sub-area 313 has a rainbow holographic feature, and the second area 32 is a pentagram area, which has a relief feature and a discoloration feature changing with inclination change. The discoloration area is heavily coincident with the pentagram area with the relief feature. The first sub-area 312 is disposed

around the edge of the pentagram, and the line width of the first sub-area 312 is strictly equal at each position. Lines of the first sub-area 312 may be very fine, for example, smaller than 20 um. If the optical anti-counterfeiting element is pasted on a white protected product, the pentagram is extremely eye-catching, coupled with its relief sense and discoloration effect, so the product has excellent anti-counterfeiting performance. In addition, the rainbow holographic effect of the second sub-area 313 also further enhances the visual effect and anti-counterfeiting performance.

[0084] Of course, the second area 32 may also be of other shapes.

[0085] Alternatively, the plurality of non-achromatic white micro-structures are periodically arranged; or the non-achromatic white micro-structures may be arranged in a period, such as in a matrix.

[0086] Of course, the plurality of non-achromatic white micro-structures are arranged in a non-periodic manner, that is, the plurality of non-achromatic white micro-structures are arranged randomly.

[0087] Alternatively, the section structure of the non-achromatic white micro-structure along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure.

[0088] Fig. 4 illustrates a possible structure diagram of a sectional view of an illustrative optical anti-counterfeiting element shown in Fig. 3 along X-X. The optical anti-counterfeiting element includes a substrate layer 10, a micro-structure layer 30, a metal layer 40, a protective layer 60, an interference optical variable layer 50 and other functional coatings 70. The substrate layer 10 and the micro-structure layer 30 generally consist of a transparent material. The micro-structure layer 30 includes a first area 31 and a second area 32, and the specific volume of the second micro-structure 321 is greater than that of the first micro-structure 311. In the embodiment, the first area 31 includes a first sub-area 312 with achromatic white micro-structures and a second sub-area 313 with rainbow holographic micro-structures. The metal layer 40 is disposed on the first area 31, and the interference optical variable layer 50 is disposed on the second area 32. Observed from the side of the substrate layer 10 of the optical anti-counterfeiting element, namely, the lower side, the first sub-area 312 of the first area 31 shows the white feature outwards, and the second sub-area 313 shows the rainbow holographic feature outwards. The second area 32 shows the image formed by the second micro-structure 321 and a discoloration feature changing with inclination change. The interference optical variable layer 50 may be disposed full-width but does not exhibit visual features due to shielding by the metal layer 40 in the first area 31. The metal layer 40 is adjacent to the protective layer 60. The protective layer 60 is a natural product in the manufacturing process and generally does not provide additional optical effects. Other functional coatings 70 may be provided as desired, such as a bonding layer that bonds to a protected main product.

[0089] The foregoing is merely preferred embodiments of the present invention and is not intended to limit the present invention, and various modifications and variations of the present invention may be available for those skilled in the art. Any modifications, equivalent replacements, improvements and the like made within the spirit and principle of the present invention shall fall within the scope of protection of the present invention.

Claims

1. An optical anti-counterfeiting element, comprising a substrate layer (10) and an optical layer (20), the optical layer (20) is disposed on one side of the substrate layer (10) and connected with the substrate layer (10), the optical layer (20) comprises a micro-structure layer (30), and the micro-structure layer (30) comprises:

   a first area (31), the first area (31) has a plurality of first micro-structures (311);
   a second area (32), the second area (32) has a plurality of second micro-structures (321),
   when observed from one side of the optical anti-counterfeiting element, the first area (31) has a white feature, the second area (32) has an interference optical discoloration feature, and the specific volume of the second micro-structure (321) is greater than that of the first micro-structure (311).

2. The optical anti-counterfeiting element as claimed in claim 1, wherein the optical layer (20) further comprises:

   a metal layer (40), and the metal layer (40) is connected with one side, away from the substrate layer (10), of the first area (31);
   an interference optical variable layer (50), and the interference optical variable layer (50) is connected with at least one side, away from the substrate layer (10), of the second area (32).

3. The optical anti-counterfeiting element as claimed in claim 2, wherein the optical layer (20) further comprises a protective layer (60), and the protective layer (60) is connected with one side, away from the substrate layer (10), of the metal layer (40).

4. The optical anti-counterfeiting element as claimed in claim 3, wherein the interference optical variable layer (50) is connected with the side, away from the metal layer (40), of the protective layer (60).

5. The optical anti-counterfeiting element as claimed in claim 2, wherein the interference optical variable layer (50) comprises an absorption layer (51), a dielectric layer (52) and a reflection layer (53) which are stacked in sequence, and the absorption layer (51) is connected with at least one side, away from the substrate layer (10), of the second area (32).

6. The optical anti-counterfeiting element as claimed in claim 5, wherein

a material of the absorption layer (51) comprises at least one of nickel, chromium, aluminum, silver, copper, tin and titanium; and/or
a material of the dielectric layer (52) comprises at least one of magnesium fluoride, silicon dioxide, zinc sulfide, titanium nitride, titanium dioxide, titanium monoxide, titanium trioxide, trititanium pentoxide, tantalum pentoxide, niobium pentoxide, cerium dioxide, bismuth trioxide, dichromium trioxide, iron oxide, hafnium dioxide or zinc oxide; and/or
a material of the reflection layer (53) comprises at least one of aluminum, silver, tin, nickel and titanium.

7. The optical anti-counterfeiting element as claimed in claim 2, wherein
the metal layer (40) comprises at least one of aluminum, silver, tin, nickel and titanium; and/or the thickness of the metal layer (40) is greater than 10 nm and smaller than or equal to 80 nm.

8. The optical anti-counterfeiting element as claimed in claim 1, wherein

the specific volume of the first micro-structure (311) is greater than or equal to 0 and smaller than or equal to 0.5 um^3/um^2; and/or
the specific volume of the second micro-structure (321) is greater than 0.4 um^3/um^2 and smaller than 2 um^3/um^2.

9. The optical anti-counterfeiting element as claimed in any of claims 1-8, wherein all the first micro-structures (311) are achromatic white micro-structures.

10. The optical anti-counterfeiting element as claimed in claim 9, wherein at least two of the plurality of achromatic white micro-structures are different in size, at least two of the plurality of achromatic white micro-structures are different in height, and the achromatic white micro-structure is a projection or a groove.

11. The optical anti-counterfeiting element as claimed in claim 9, wherein

the length of the achromatic white micro-structure is greater than 1 um and smaller than 10 um; and/or
the depth of the achromatic white micro-structure is greater than 0.1 um and smaller than 5 um.

12. The optical anti-counterfeiting element as claimed in claim 9, wherein the achromatic white micro-structure is a micro reflector,

the length of the micro reflector is greater than or equal to 5 um and smaller than or equal to 10 um; and/or
the depth of the micro reflector is greater than 1 um and smaller than or equal to 4 um.

13. The optical anti-counterfeiting element as claimed in any of claims 1-8, wherein the first area (31) comprises:

a first sub-area (312), the first sub-area (312) is continuously disposed around the periphery of the second area (32), and the first micro-structure (311) in the first sub-area (312) is an achromatic white micro-structure;
a second sub-area (313), the second sub-area (313) is continuously disposed around the periphery of the first sub-area (312), and the first micro-structure (311) in the second sub-area (313) is a non-achromatic white micro-structure.

14. The optical anti-counterfeiting element as claimed in claim 13, wherein

the plurality of non-achromatic white micro-structures are periodically arranged; or
the plurality of non-achromatic white micro-structures are arranged in a non-periodic manner.

15. The optical anti-counterfeiting element as claimed in claim 13, wherein the section structure of the non-achromatic white micro-structure along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure.

16. The optical anti-counterfeiting element as claimed in any of claims 1-8, wherein

the plurality of second micro-structures (321) are periodically arranged; or
the plurality of second micro-structures (321) are arranged in a non-periodic manner.

17. The optical anti-counterfeiting element as claimed in any of claims 1-8, wherein the section structure of

the second micro-structure (321) along the extension direction is at least one of a flat structure, a sinusoidal structure, a rectangular grating structure, a trapezoidal grating structure, a blazed grating structure and an arc-shaped grating structure.

18. An anti-counterfeiting product, comprising the optical anti-counterfeiting element as claimed in any one of claims 1-17.

19. The anti-counterfeiting product as claimed in claim 18, wherein the anti-counterfeiting product further comprises a carrier, the optical anti-counterfeiting element is disposed on the carrier, and at least part of the surface, bearing the optical anti-counterfeiting element, of the carrier is white.

20. A manufacturing method of an optical anti-counterfeiting element, wherein the optical anti-counterfeiting element as claimed in any of claims 1-17 is manufactured by adopting the manufacturing method of the optical anti-counterfeiting element, and the manufacturing method of the optical anti-counterfeiting element comprises:

S10: forming a micro-structure layer (30) having a first area (31) and a second area (32) on the surface of a substrate layer (10), forming a first micro-structure (311) on the first area (31), and forming a second micro-structure (321) with specific volume greater than that of the first micro-structure (311) on the second area (32);
S20: forming a meal layer (40) on the surface, away from the substrate layer (10), of the micro-structure layer (30);
S30: forming a protective layer (60) for protecting the first area (31) on the surface, away from the micro-structure layer (30), of the metal layer (40);
S40: removing the metal layer (40) at the second area (32);
S50: forming an interference optical variable layer (50) on the surface of one side away from the substrate layer (10), so as to form the optical anti-counterfeiting element.

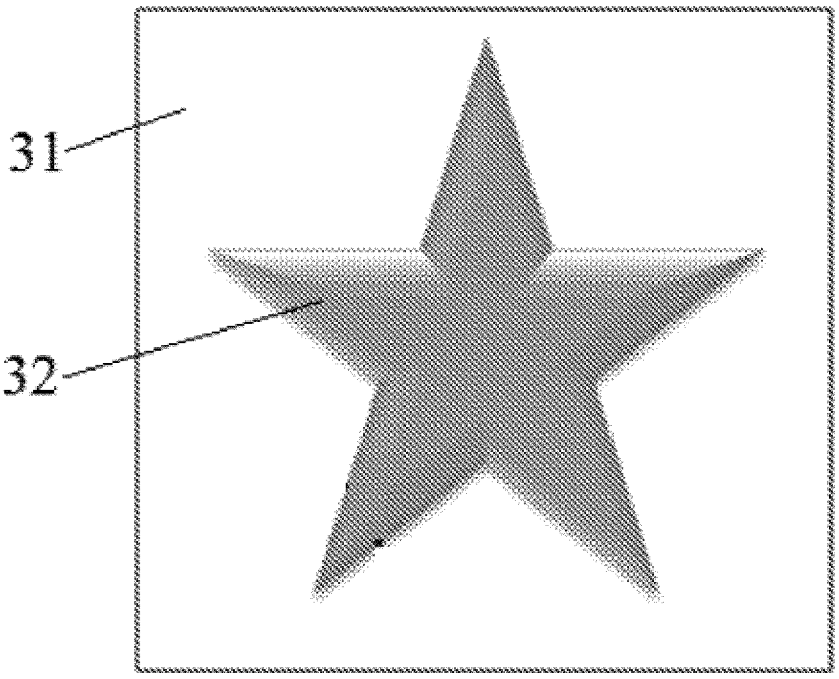

Fig. 1

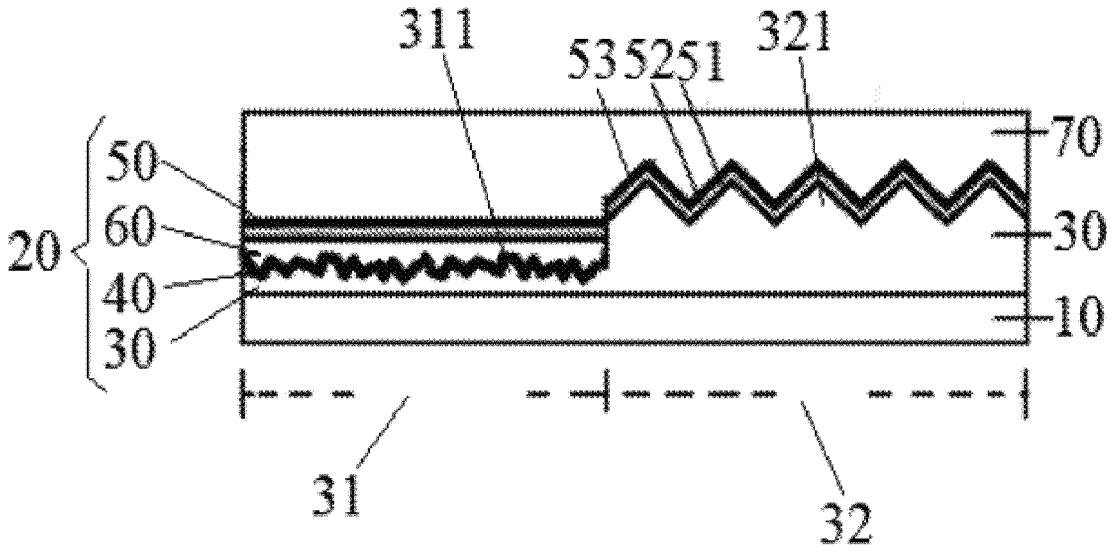

Fig. 2

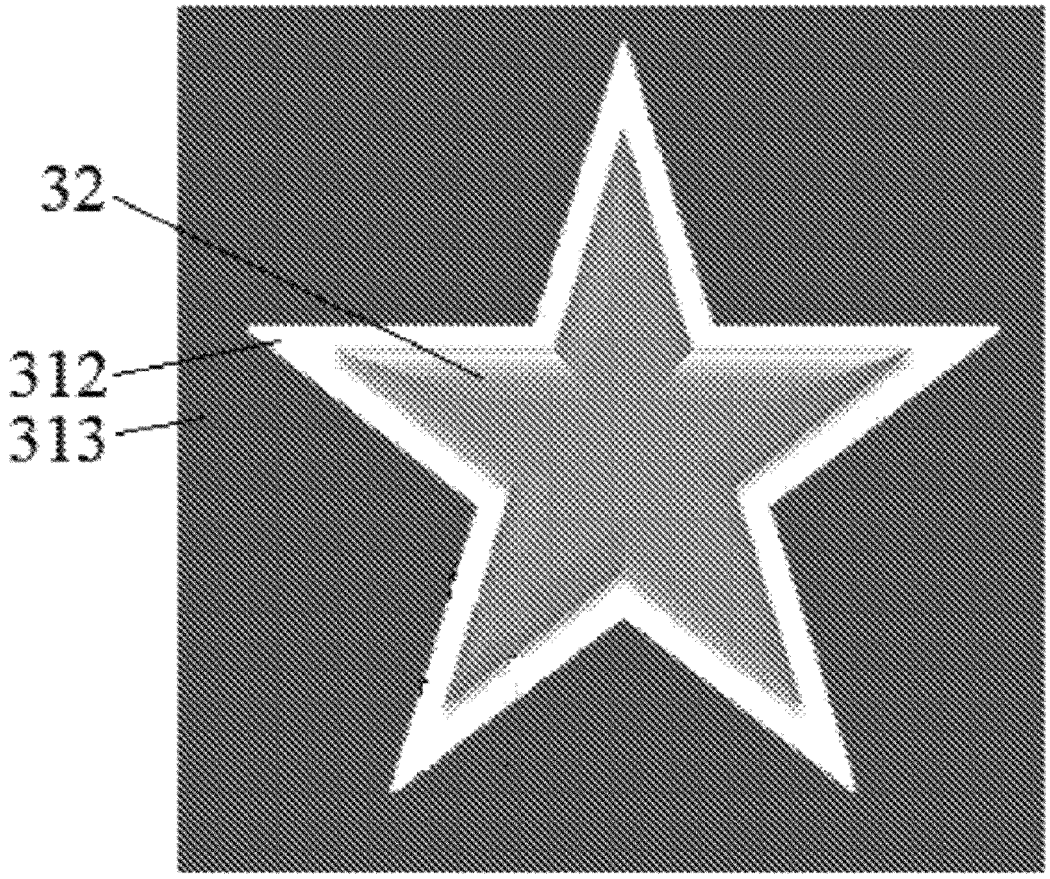

Fig. 3

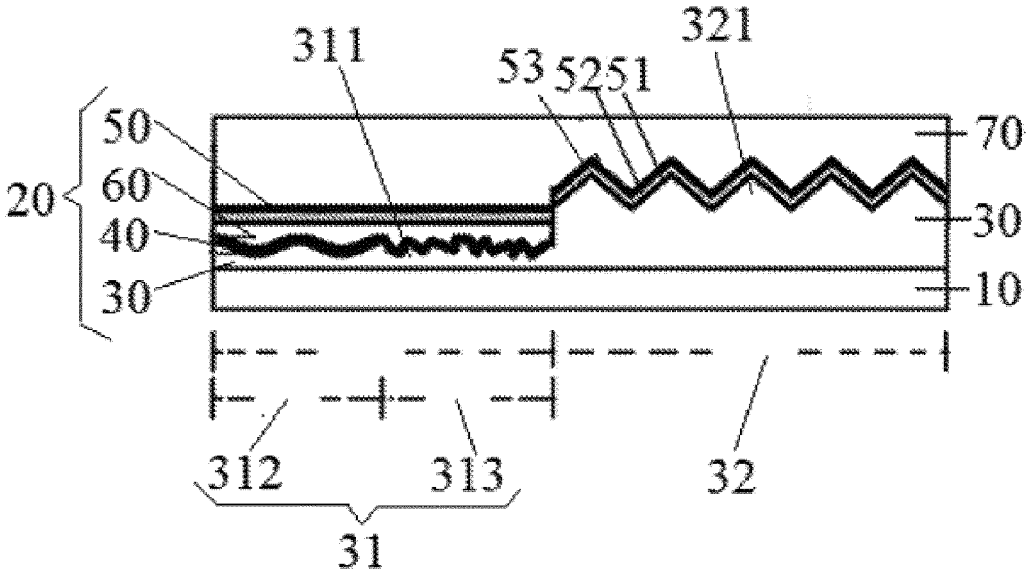

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/110653

A. CLASSIFICATION OF SUBJECT MATTER

B42D 25/30(2014.01)i; B42D 25/40(2014.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B42D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, CNKI, CJFD: 安全, 光学, 防伪, 衍射, 浮雕, 微透镜, 反射镜, 反射层, 介质层, 吸收层, 起伏结构层, 微结构, 镀层, 金属层, 凹部, 图文, 全息, 干涉, 变色; ENTXT, VEN, DWPI: security, optical, anti-counterfeit, diffract, reflection, relief, microstructure, micro-depression, image, lens, color, hologram, metal, absorption layer, medium layer.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 111890817 A (ZHONGCHAO SPECIAL SECURITY TECHNOLOGY CO., LTD. et al.) 06 November 2020 (2020-11-06) description, paragraphs 6-75 and 105-156, and figures 1-20	1-8,16-20
A	CN 102501500 A (ZHONGCHAO SPECIAL SECURITY TECHNOLOGY CO., LTD. et al.) 20 June 2012 (2012-06-20) entire document	1-20
A	CN 109895526 A (ZHONGCHAO SPECIAL SECURITY TECHNOLOGY CO., LTD. et al.) 18 June 2019 (2019-06-18) entire document	1-20
A	EP 3800060 A1 (HUECK FOLIEN GMBH) 07 April 2021 (2021-04-07) entire document	1-20
A	US 2012187674 A1 (ZAHEDI LOESSL FARIBORZ MARTIN) 26 July 2012 (2012-07-26) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 October 2022	**27 October 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/110653

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	111890817	A	06 November 2020	WO	2020224352	A1	12 November 2020
				EP	3967511	A1	16 March 2022
				CN	111890817	B	22 March 2022
CN	102501500	A	20 June 2012	CN	102501500	B	24 September 2014
CN	109895526	A	18 June 2019	CN	109895526	B	22 June 2022
EP	3800060	A1	07 April 2021	CA	3155087	A1	08 April 2021
				WO	2021063691	A1	08 April 2021
US	2012187674	A1	26 July 2012	EP	2485901	A1	15 August 2012
				DE	102009048870	B3	24 February 2011
				WO	2011042010	A1	14 April 2011

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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