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CHI et al.

(54) **OPTICAL COMPONENT, IMAGING LENS AND ELECTRONIC DEVICE**

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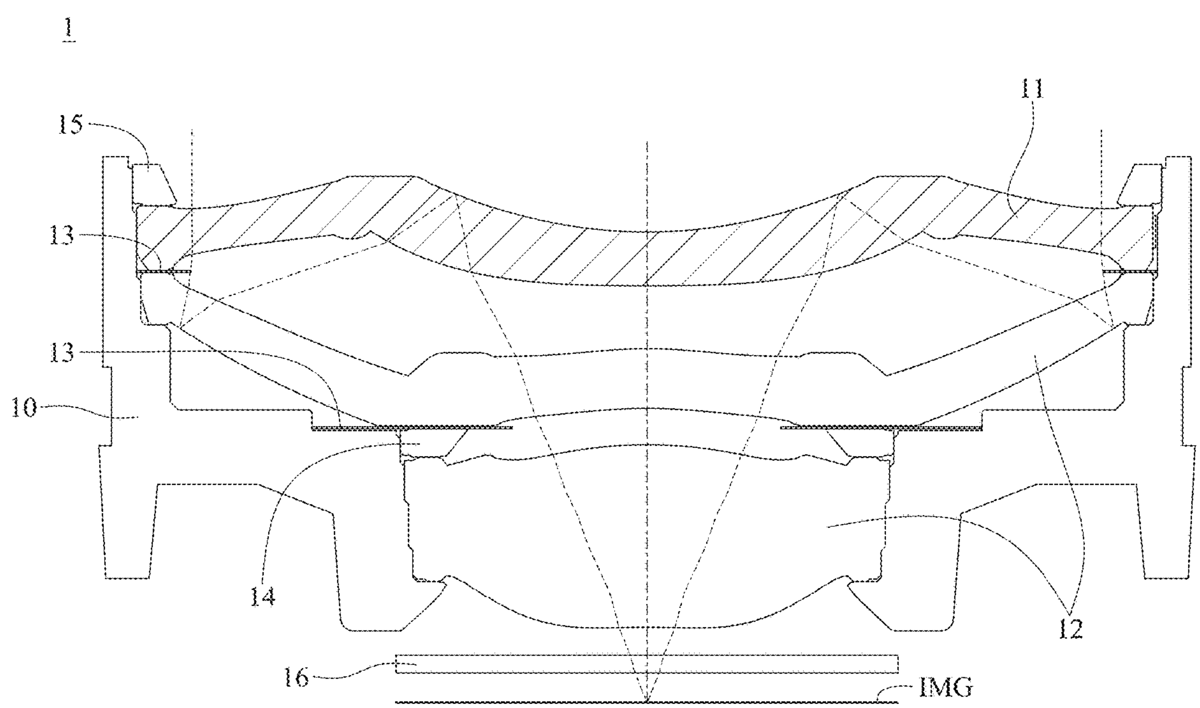
CPC ***G02B 1/11*** (2013.01); ***G02B 13/18*** (2013.01)

(57) **ABSTRACT**

An optical component includes a substrate and an anti-reflective film. The substrate has an aspherical surface through which light passes. The anti-reflective film is disposed at least on the aspherical surface and includes a nanostructure layer and an intermediate layer. The nanostructure layer includes ridge-like protrusions that are non-directionally extended. A bottom of the ridge-like protrusions is closer to the substrate than a top of the ridge-like protrusions. The ridge-like protrusions gradually taper from the bottom toward the top. An average structural height of the ridge-like protrusions ranges from 108 to 368 nm. The intermediate layer is between the nanostructure layer and the substrate. A main component of the nanostructure layer is aluminum oxide. The nanostructure layer includes a metallic doping agent at least partially distributed inside the ridge-like protrusions. The metallic doping agent includes at least one of titanium, vanadium, chromium, titanium oxide, vanadium oxide, and chromium oxide.



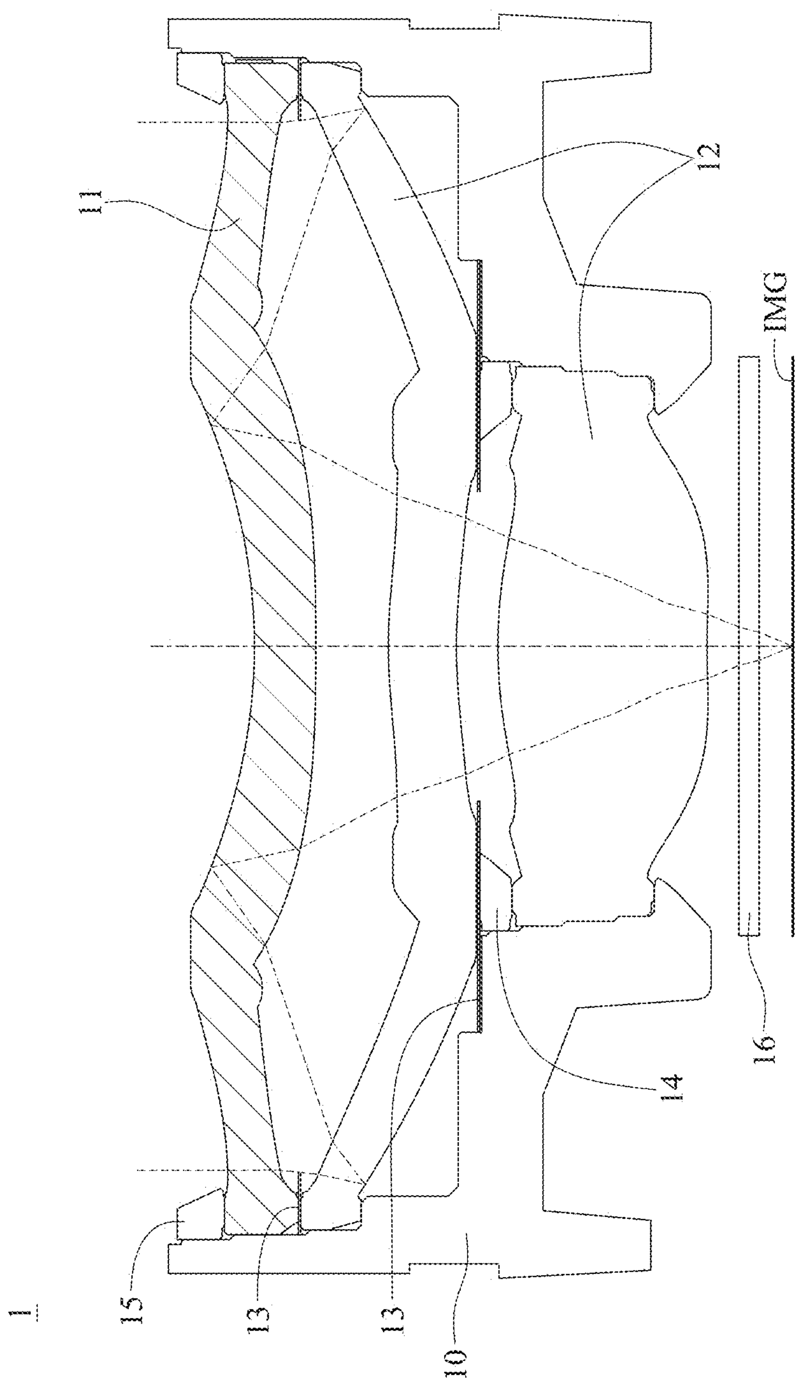


FIG. 1

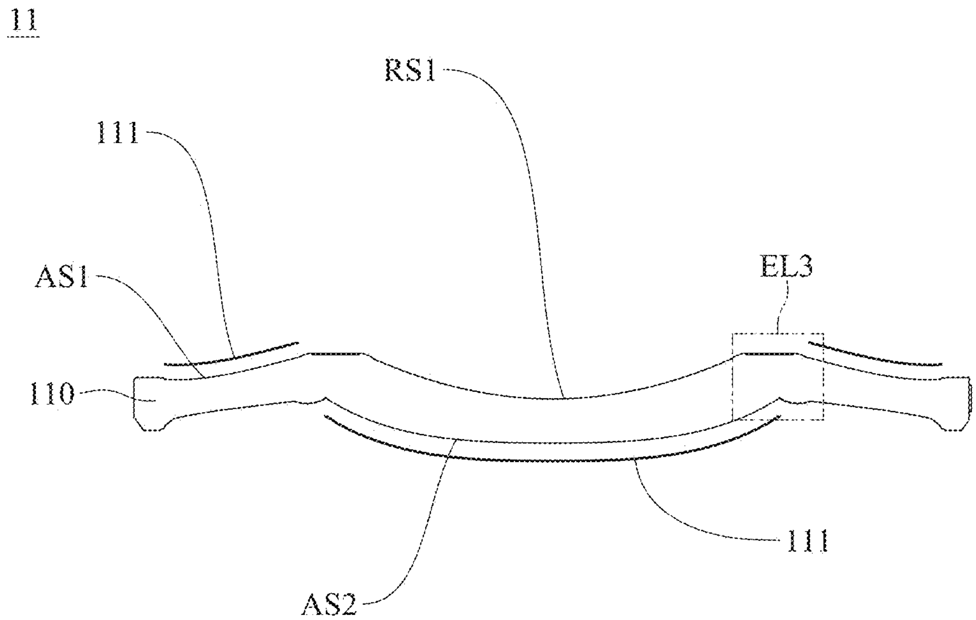


FIG. 2

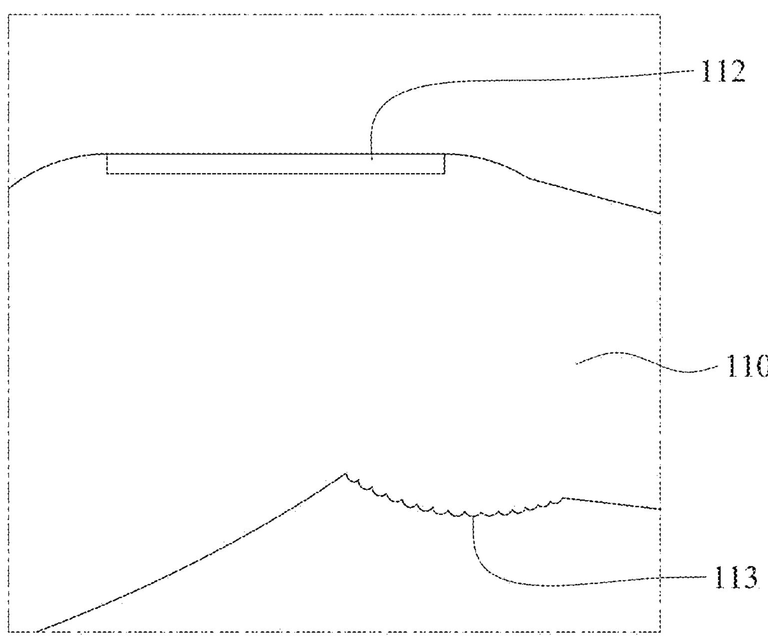


FIG. 3

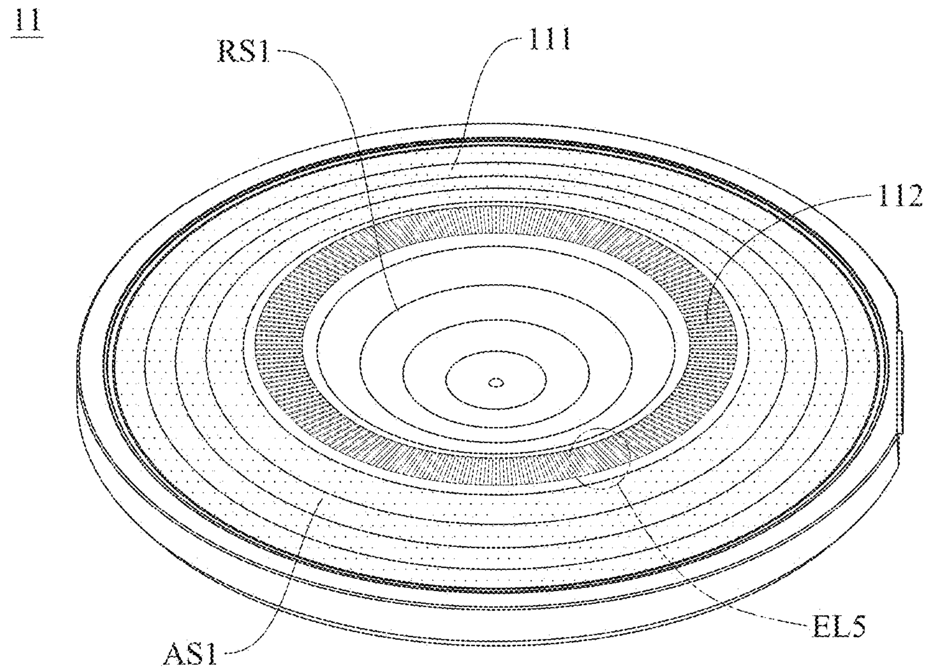


FIG. 4

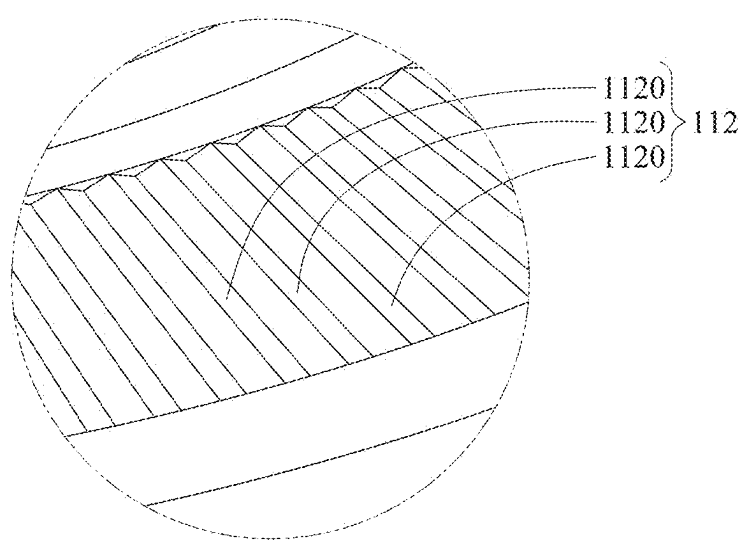


FIG. 5

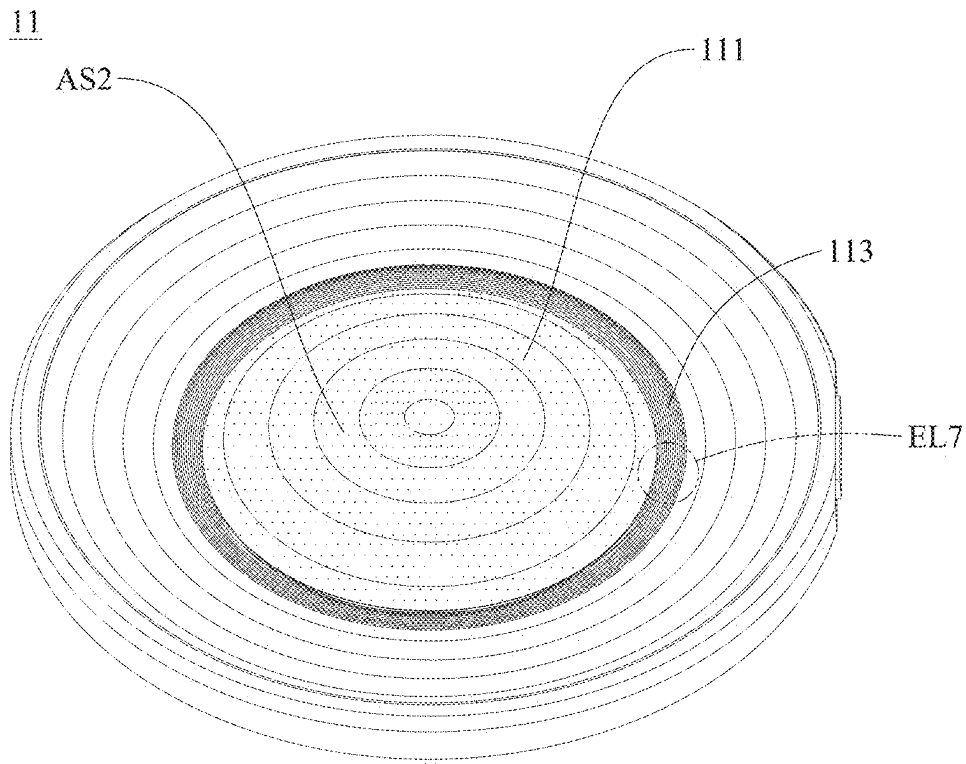


FIG. 6

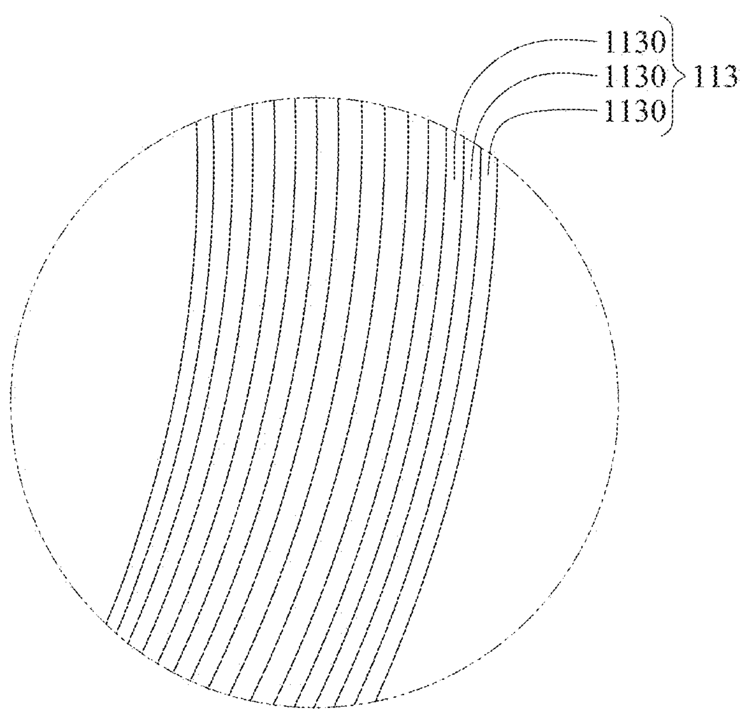


FIG. 7

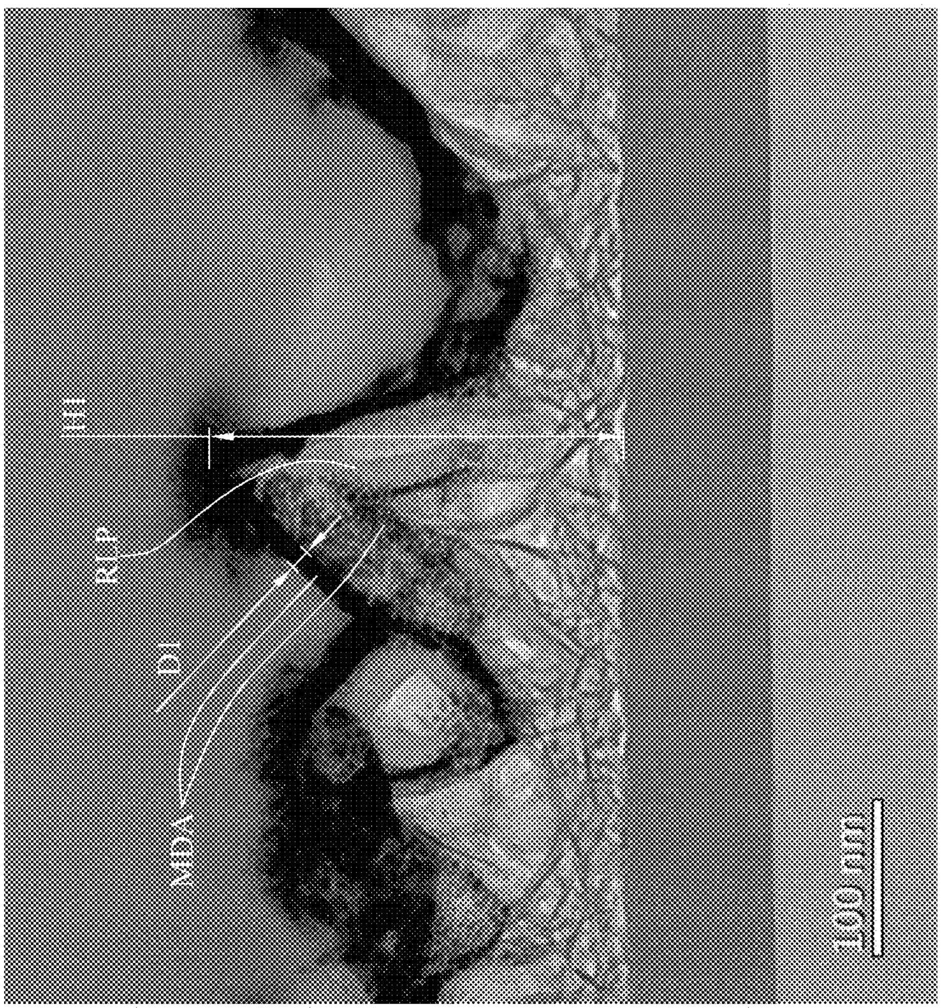


FIG. 8

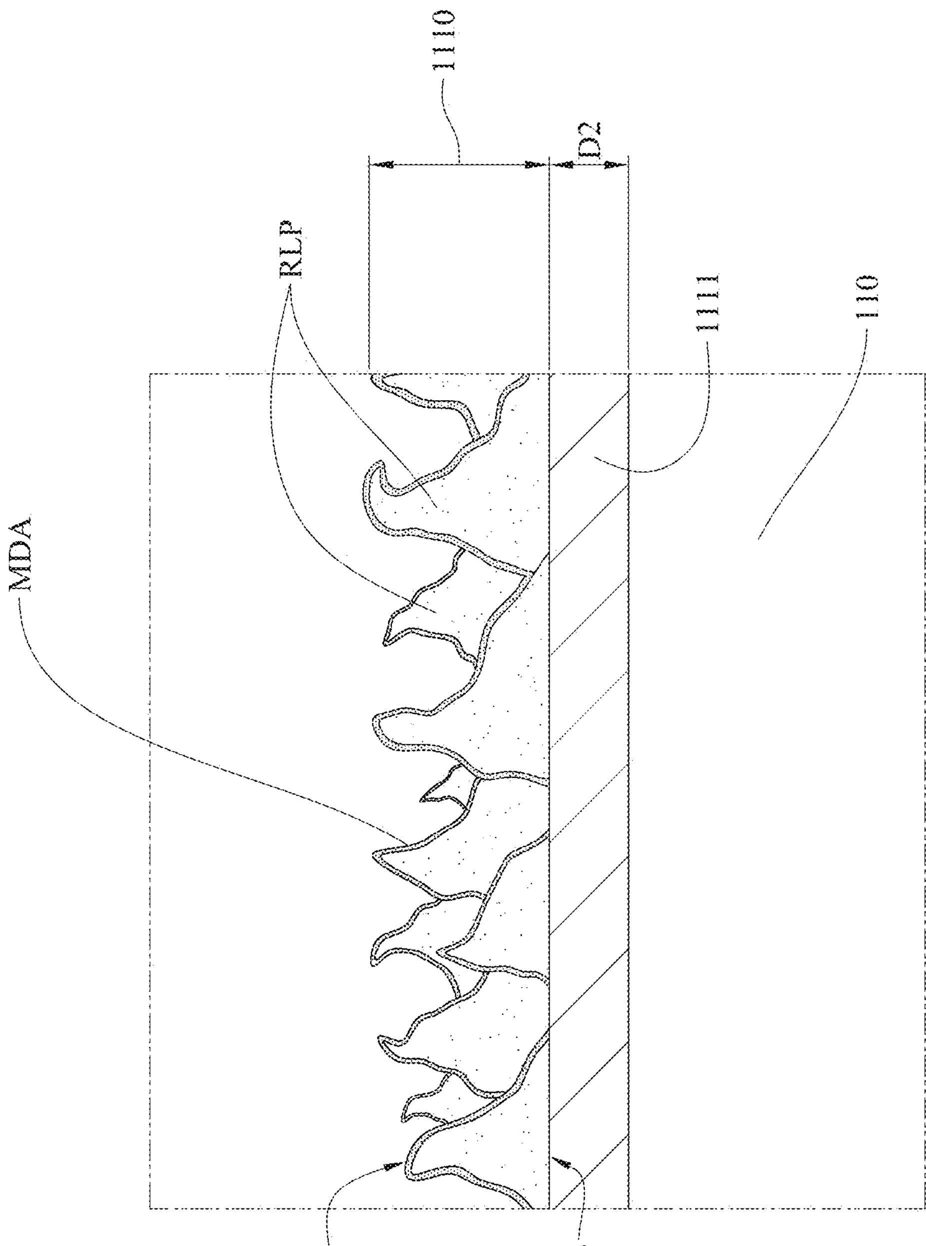


FIG. 9

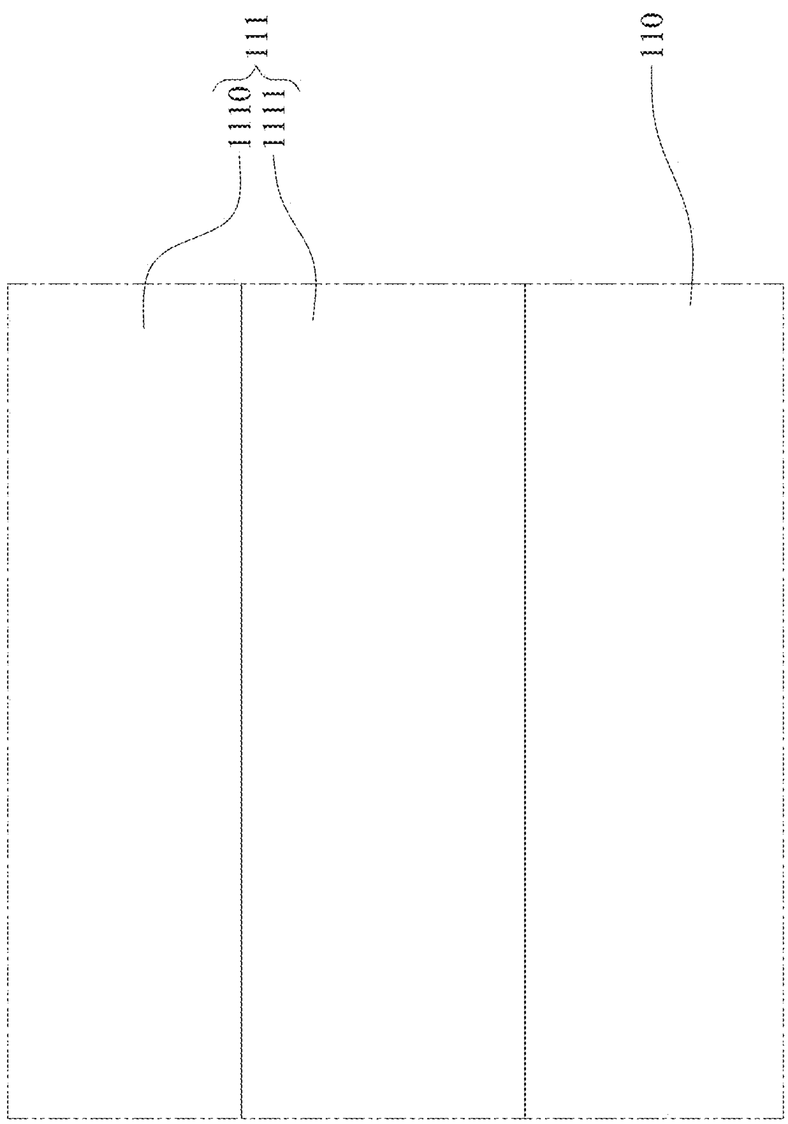


FIG. 10

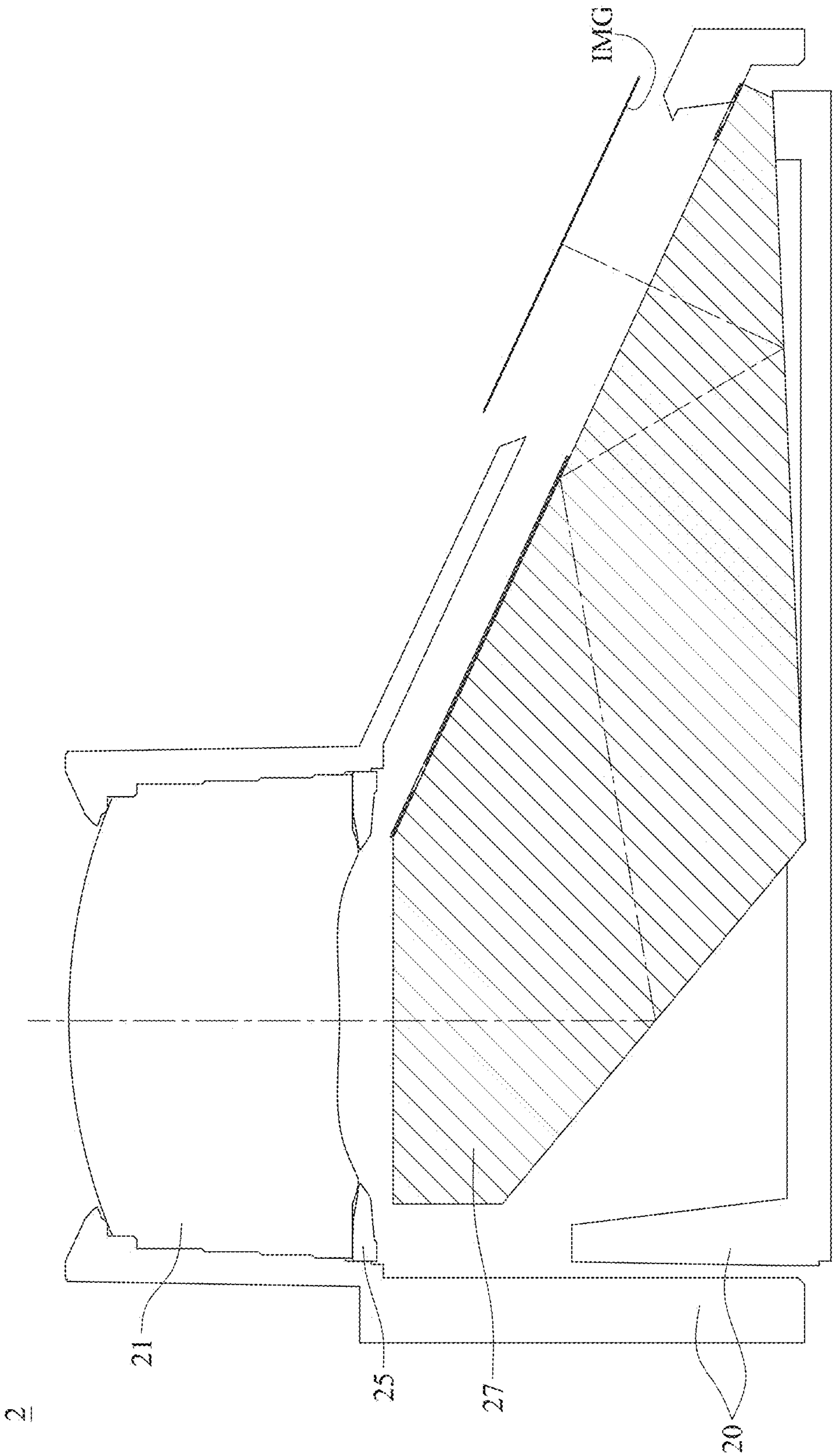


FIG. 11

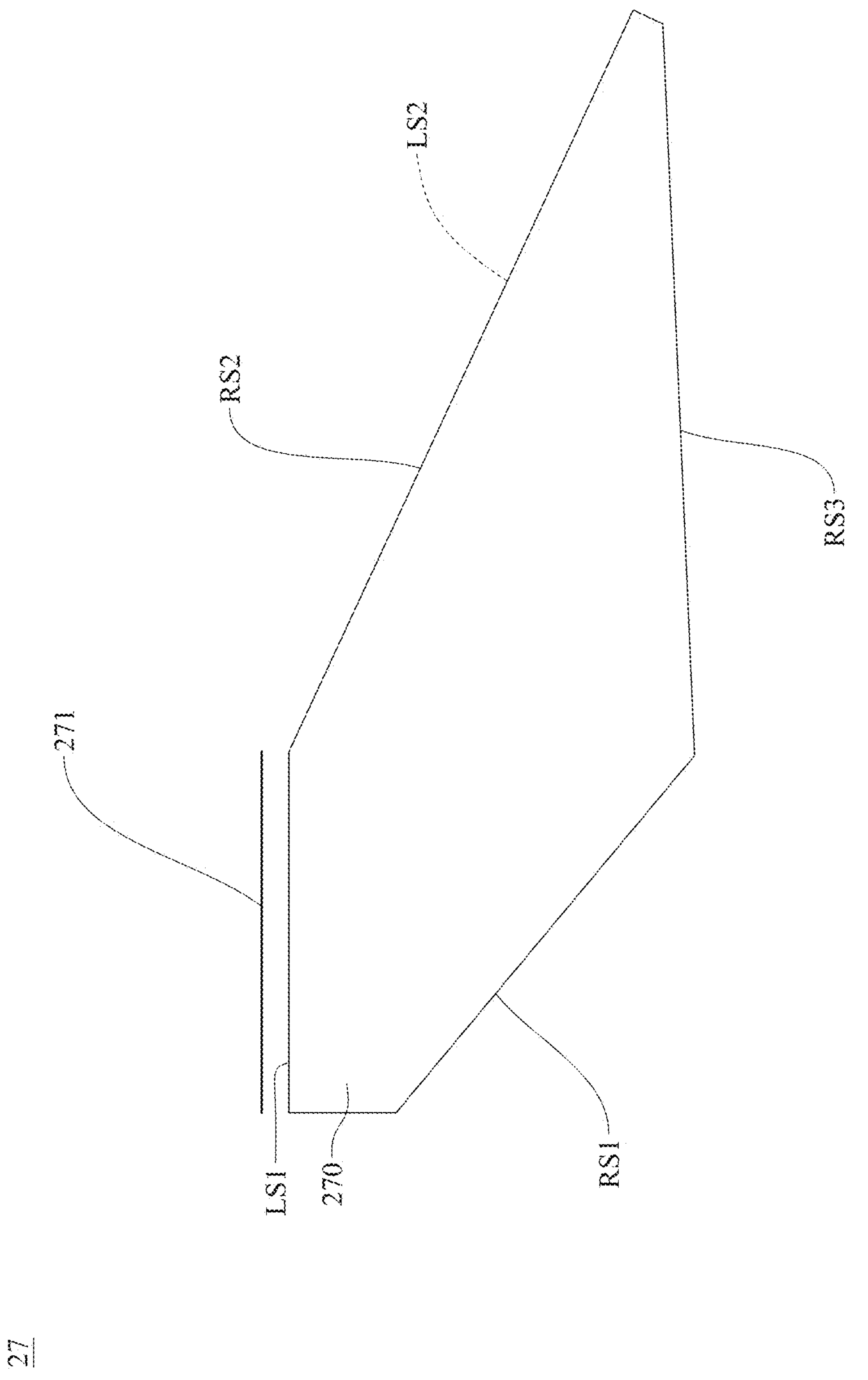


FIG. 12

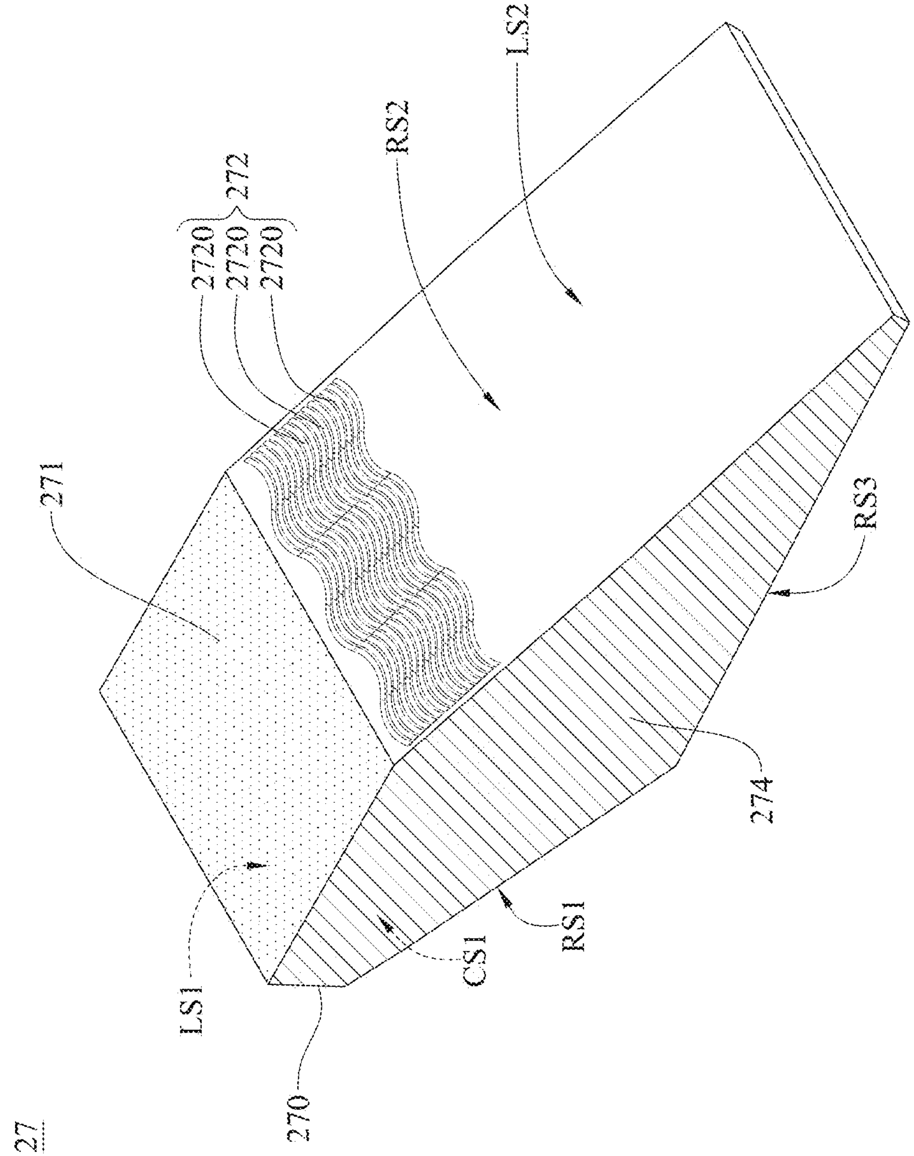


FIG. 13

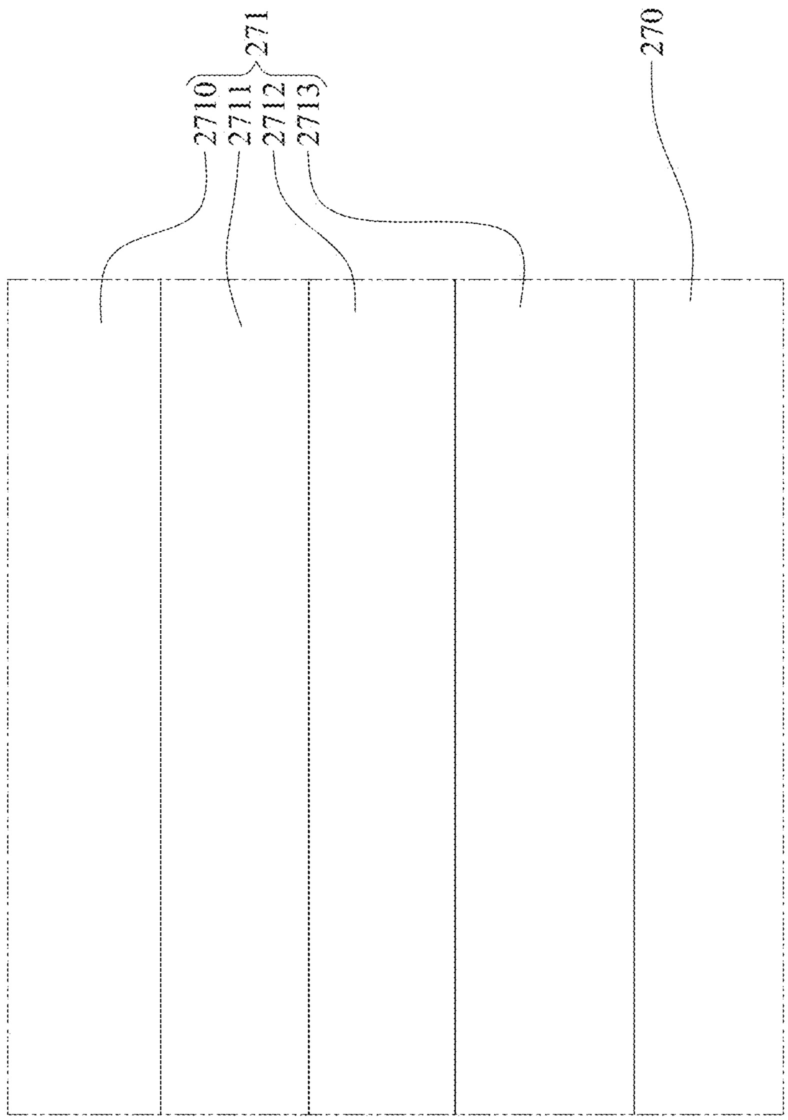


FIG. 14

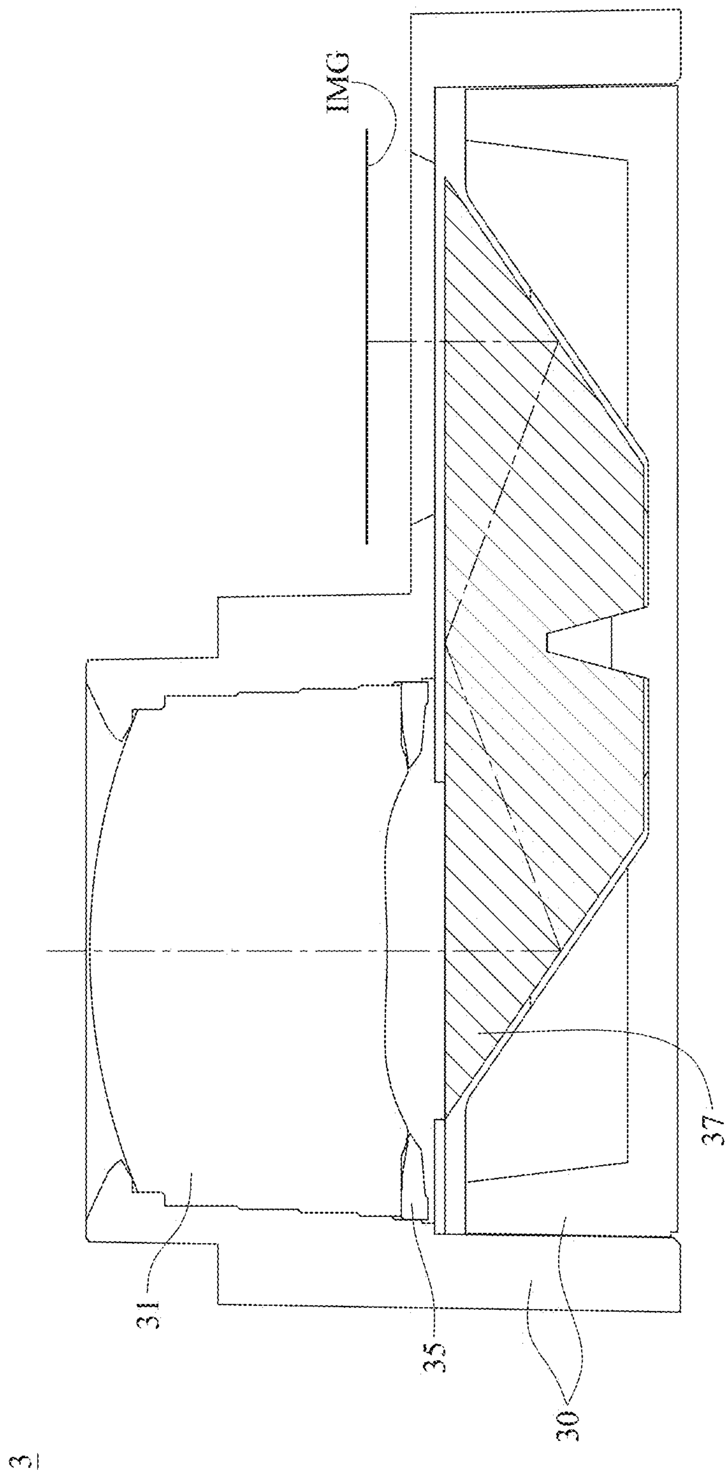


FIG. 15

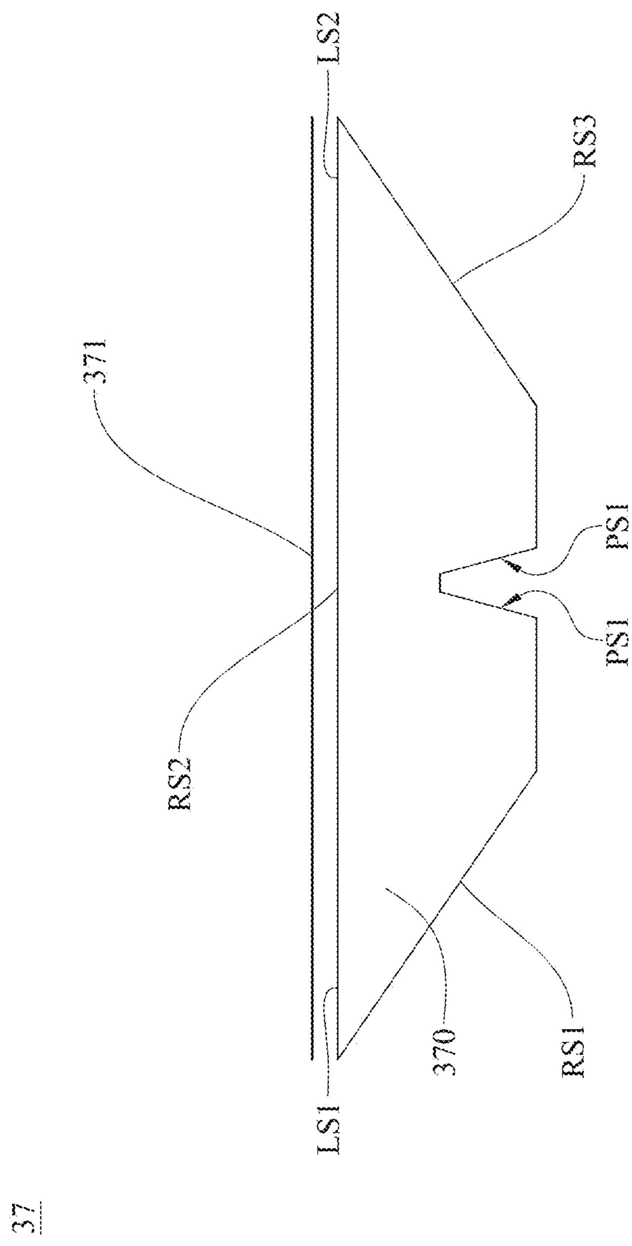


FIG. 16

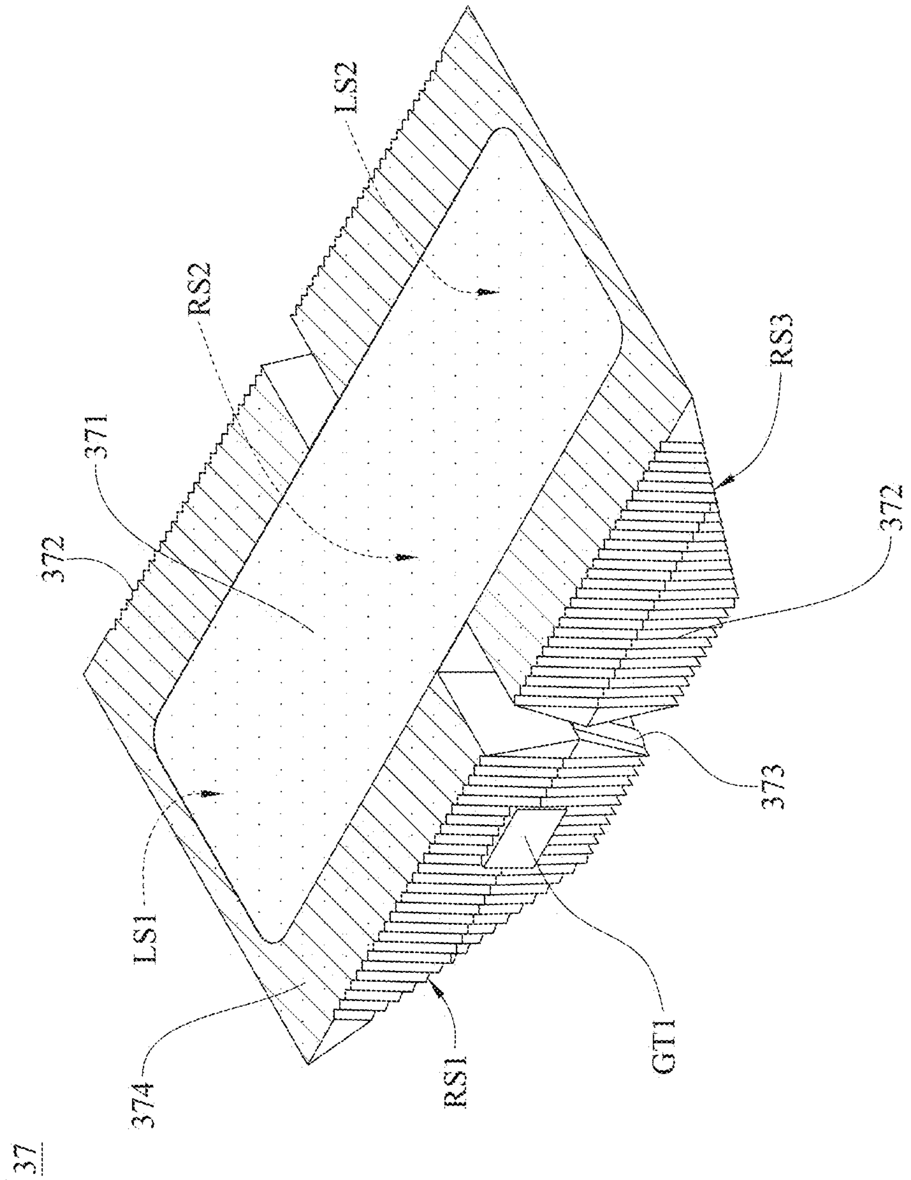


FIG. 17

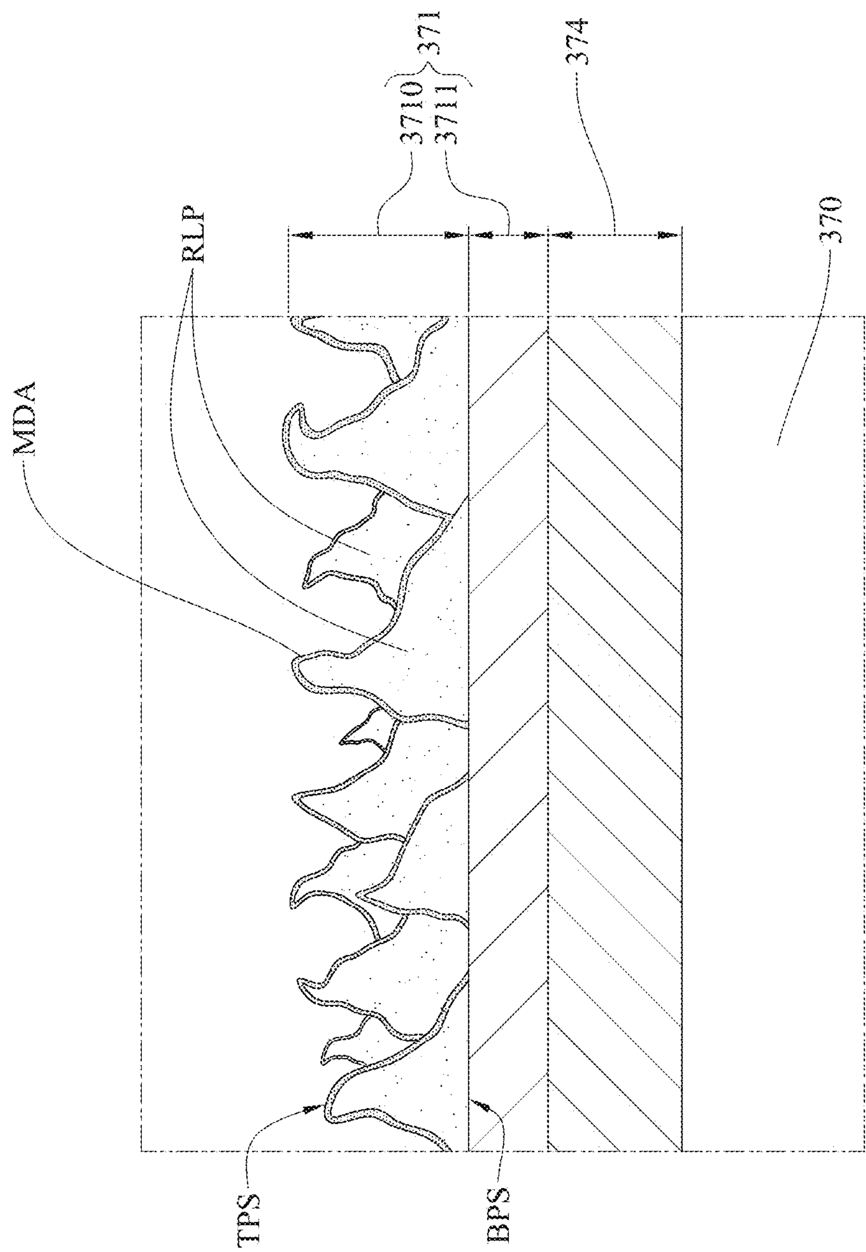


FIG. 18

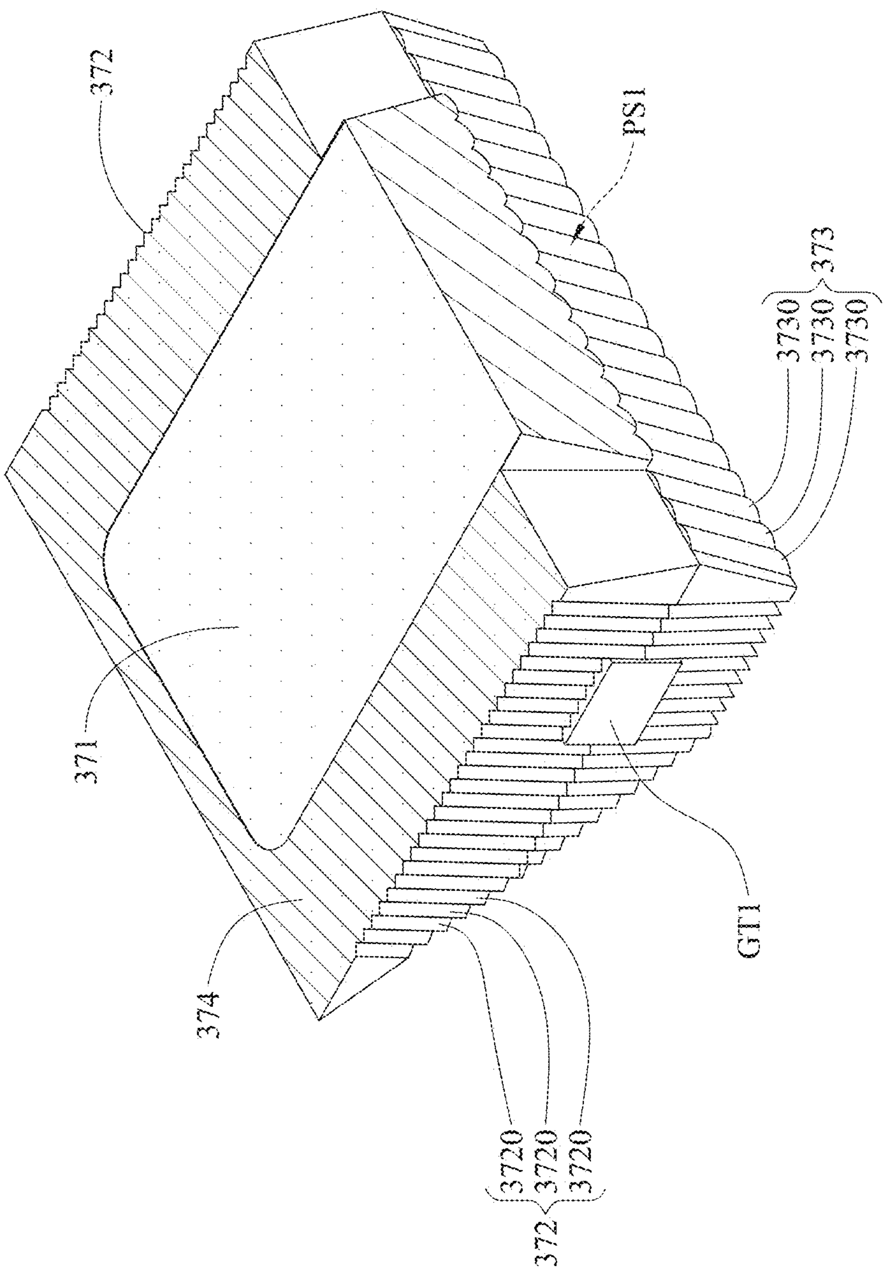


FIG. 19

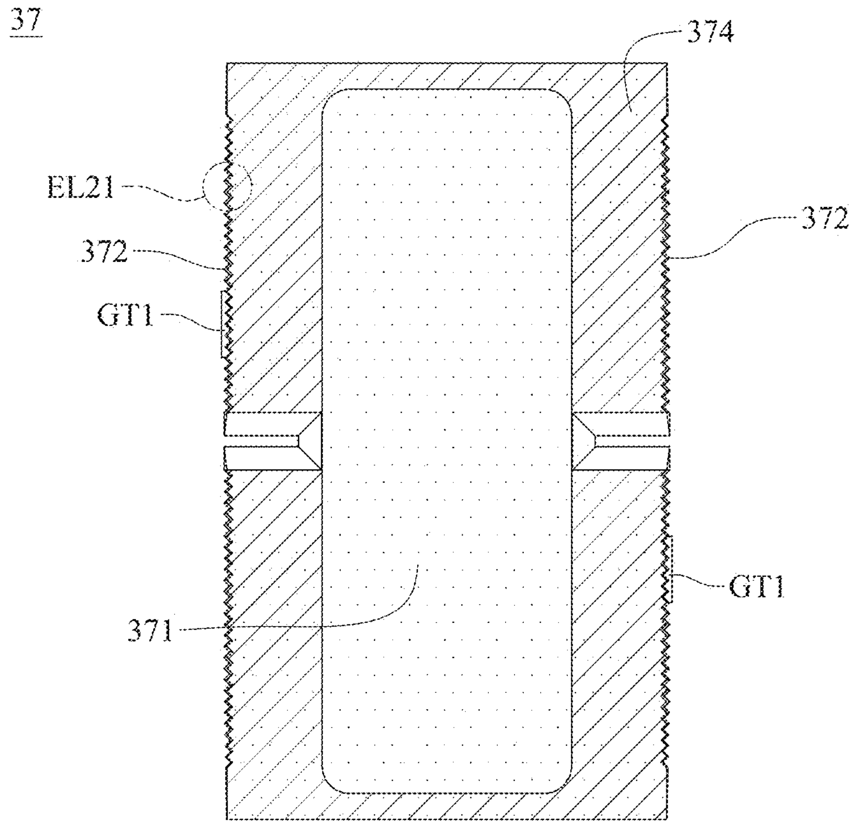


FIG. 20

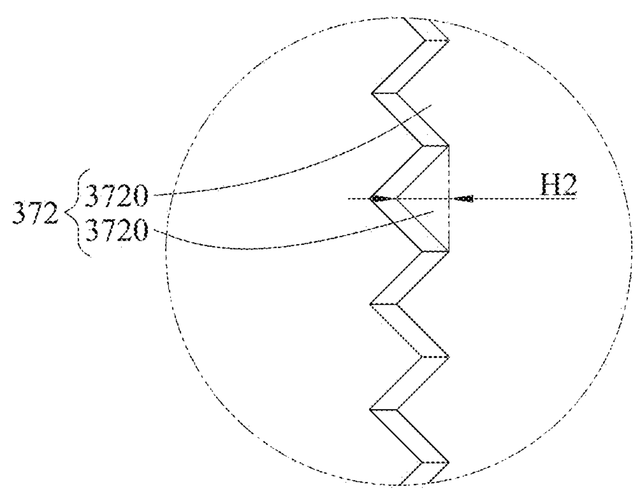


FIG. 21

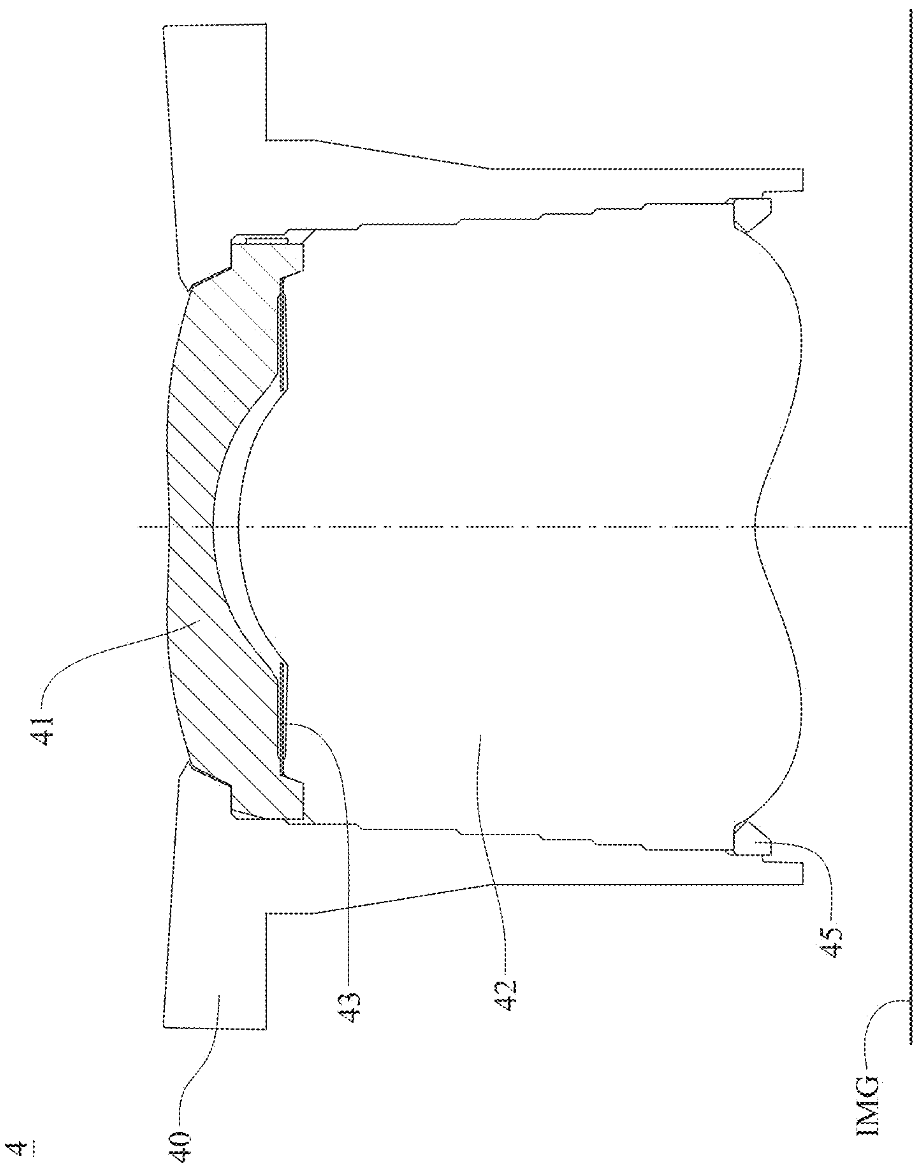


FIG. 22

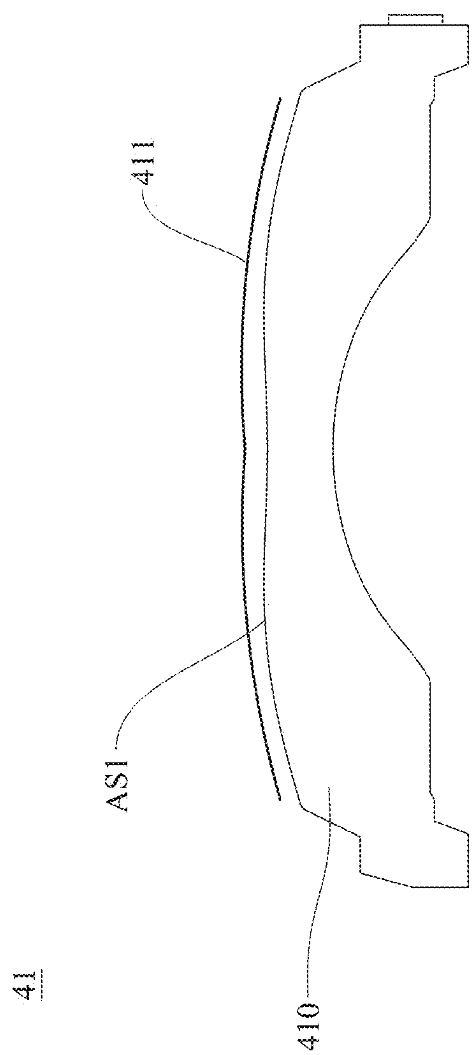


FIG. 23

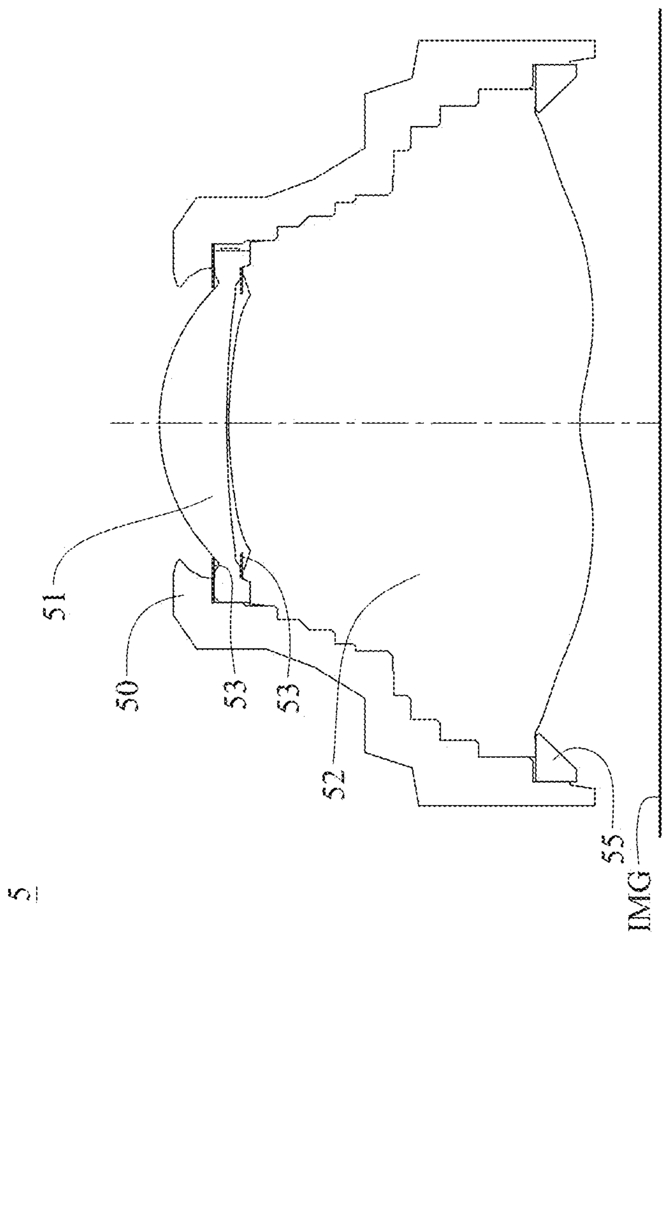


FIG. 24

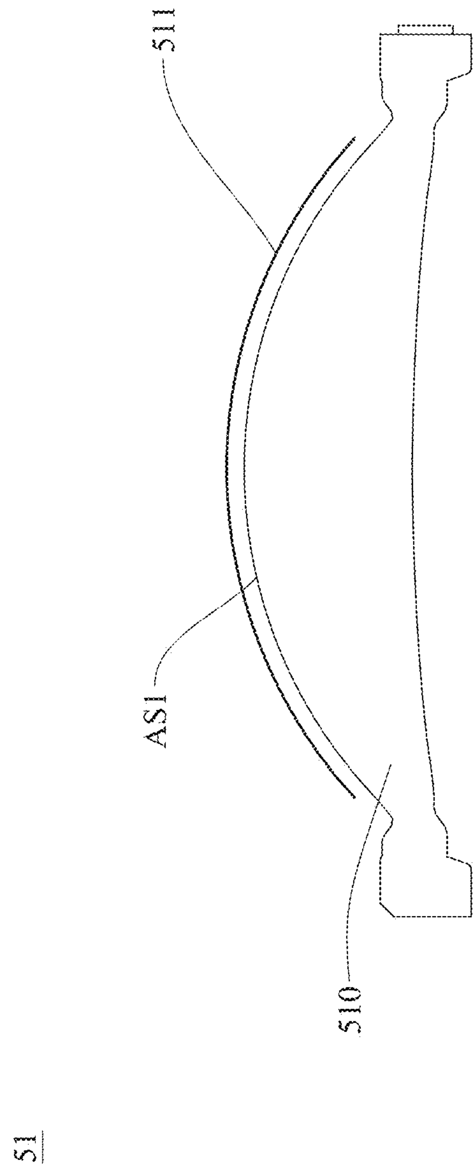


FIG. 25

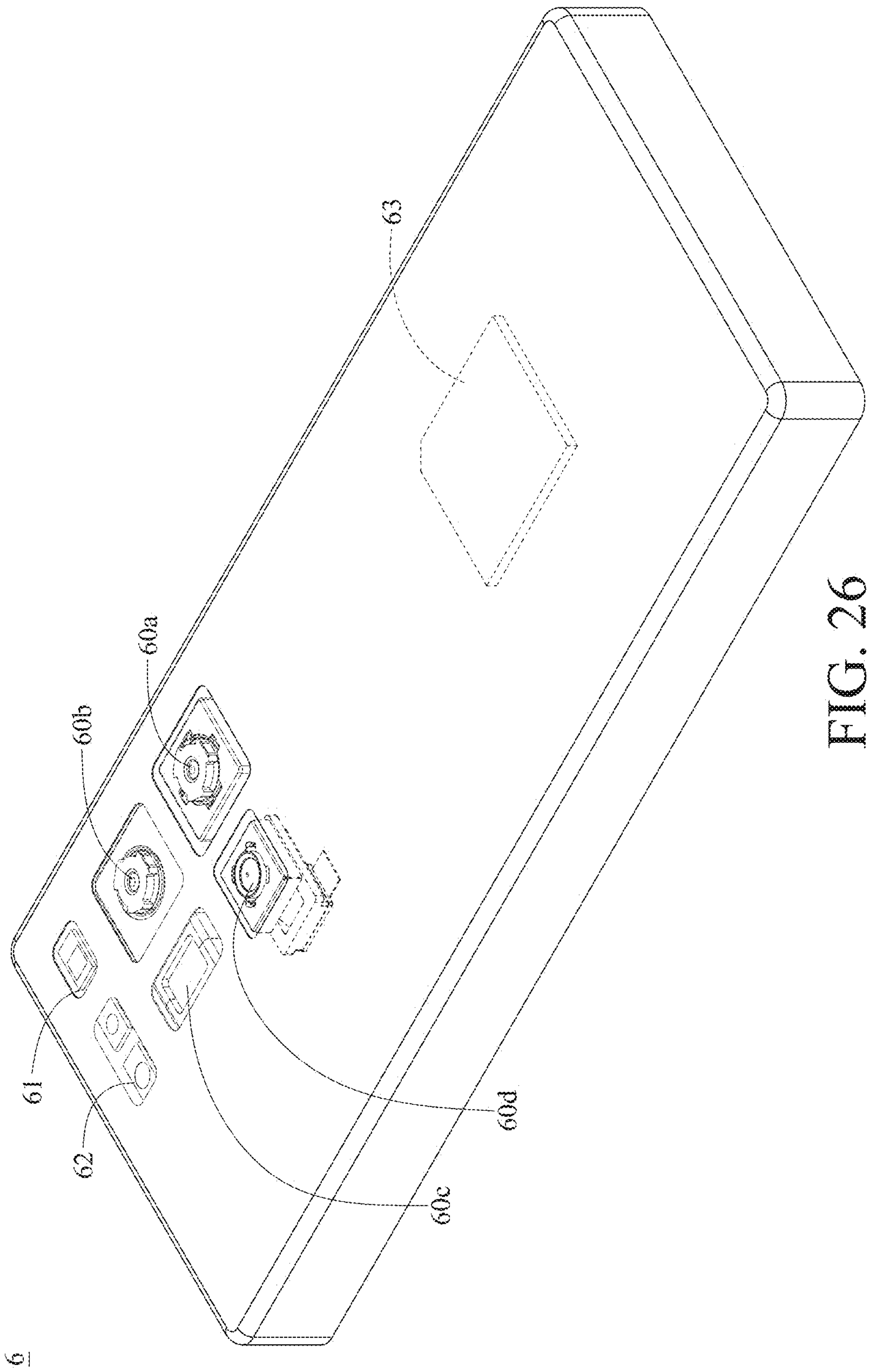


FIG. 26

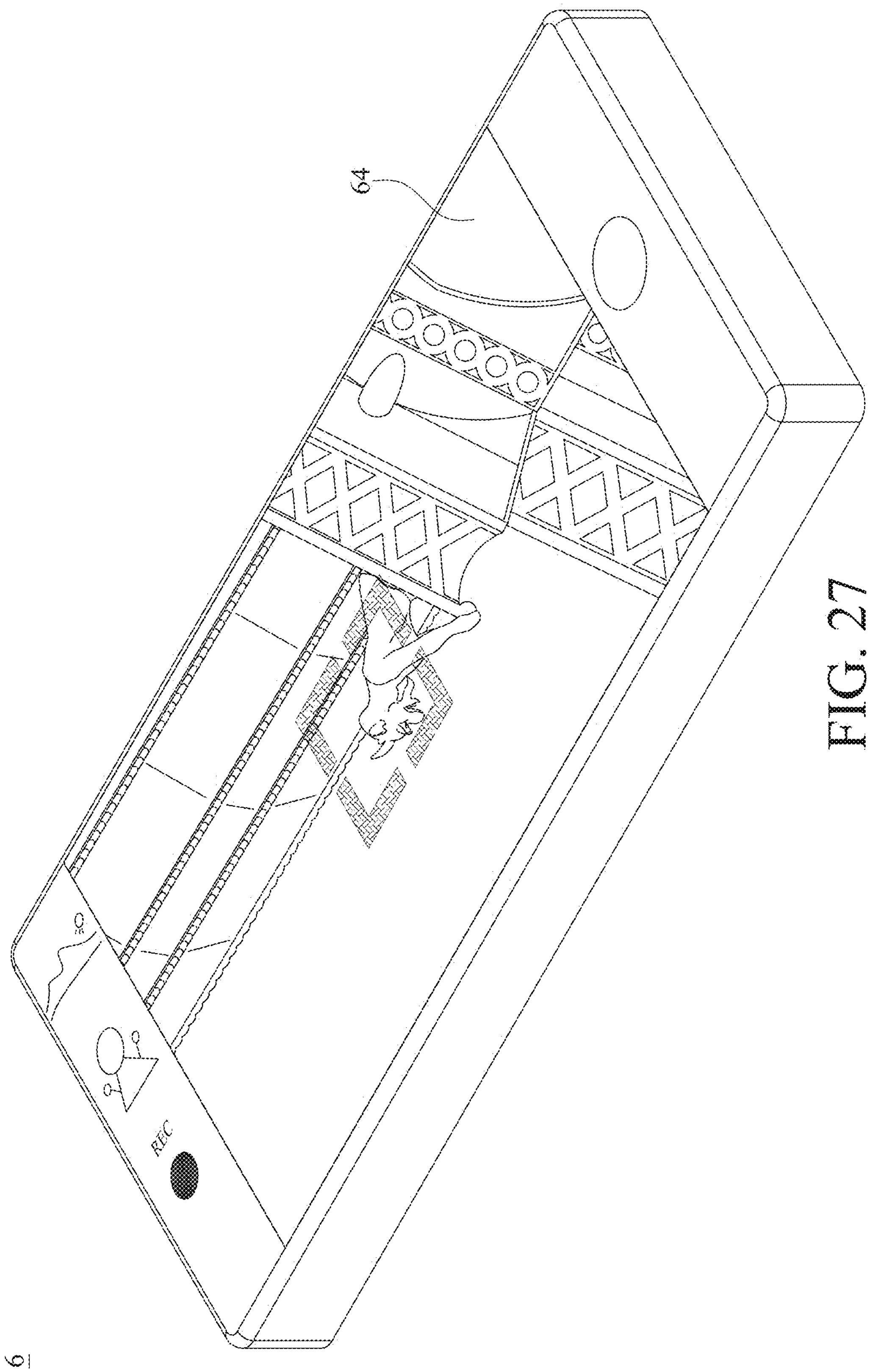


FIG. 27

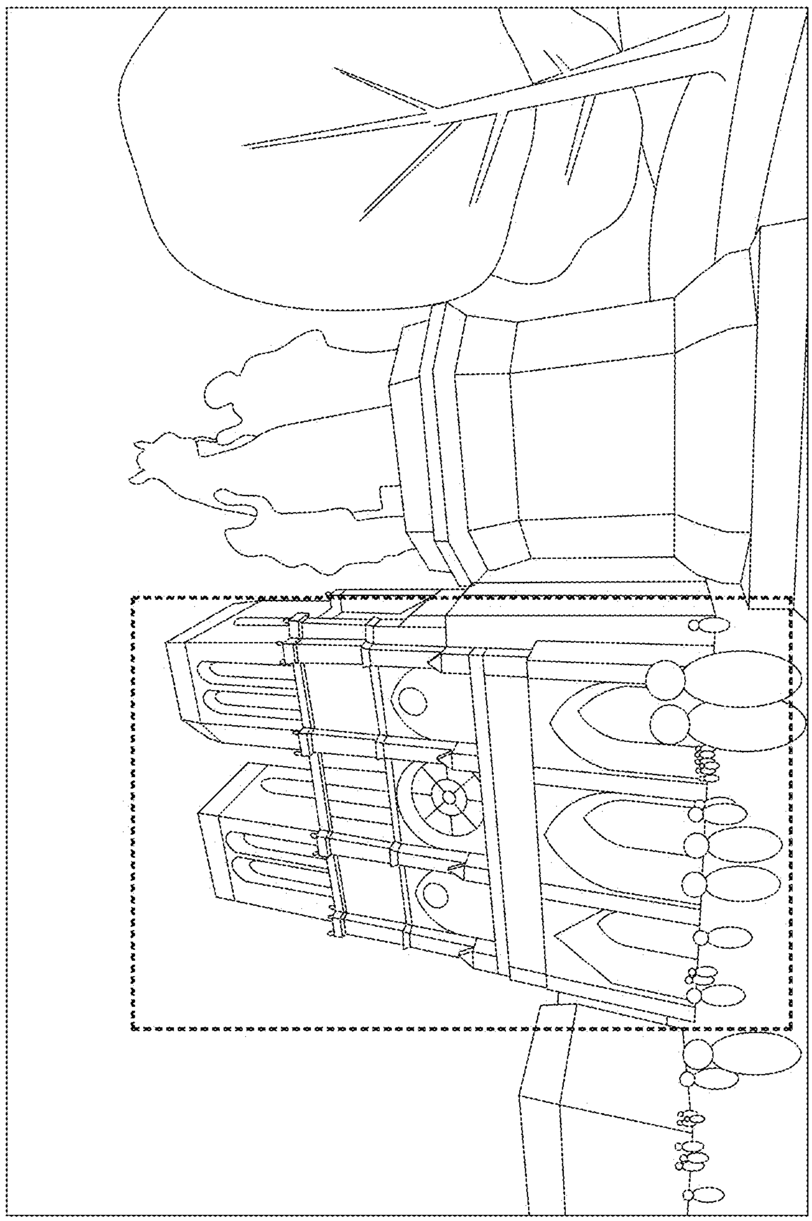


FIG. 28

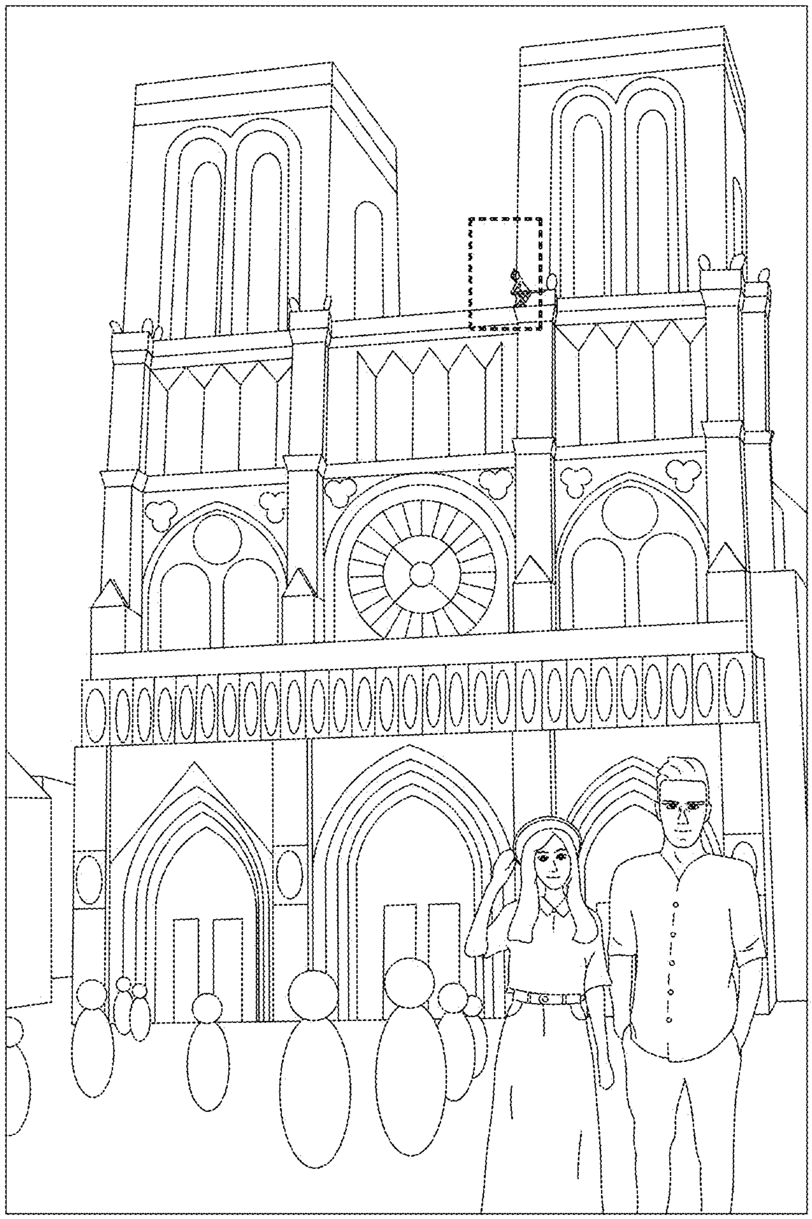


FIG. 29

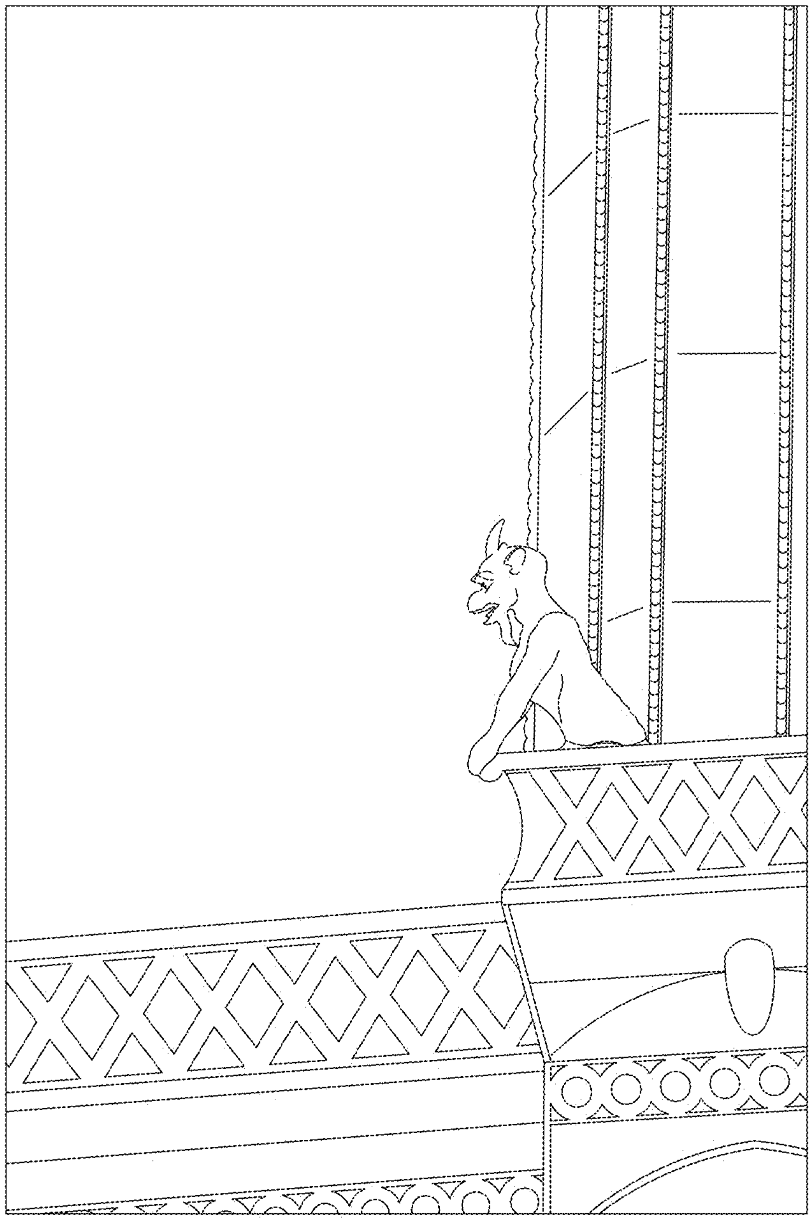


FIG. 30

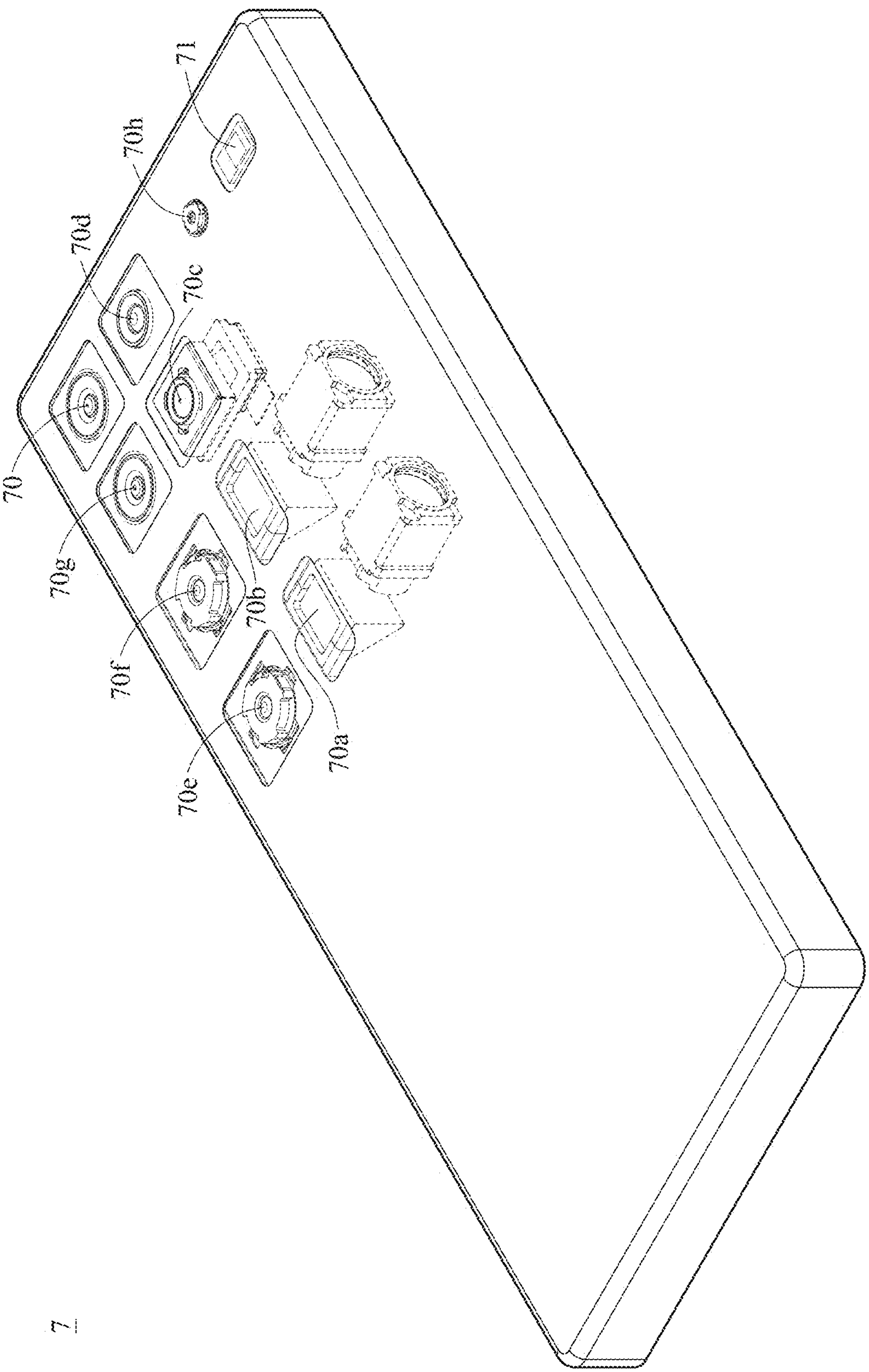


FIG. 31

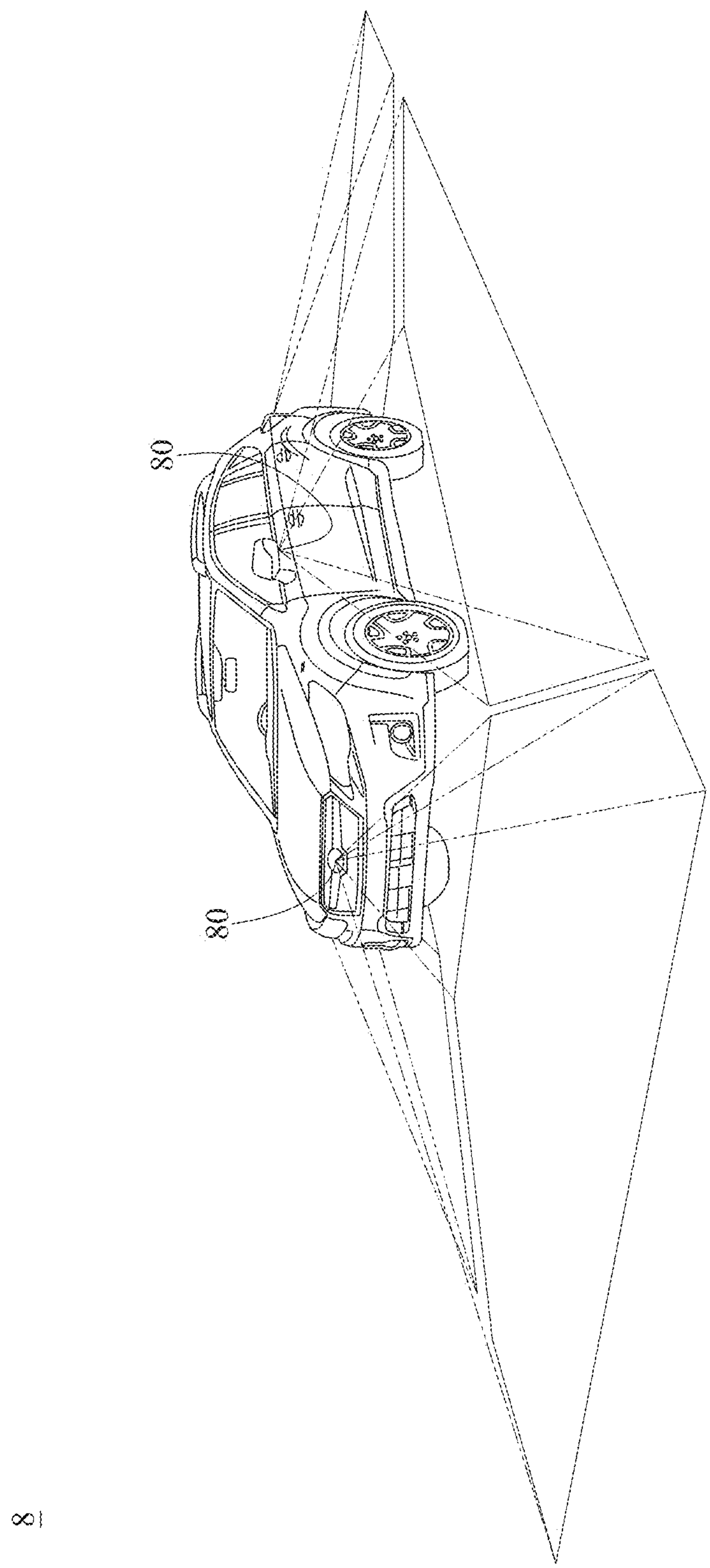


FIG. 32

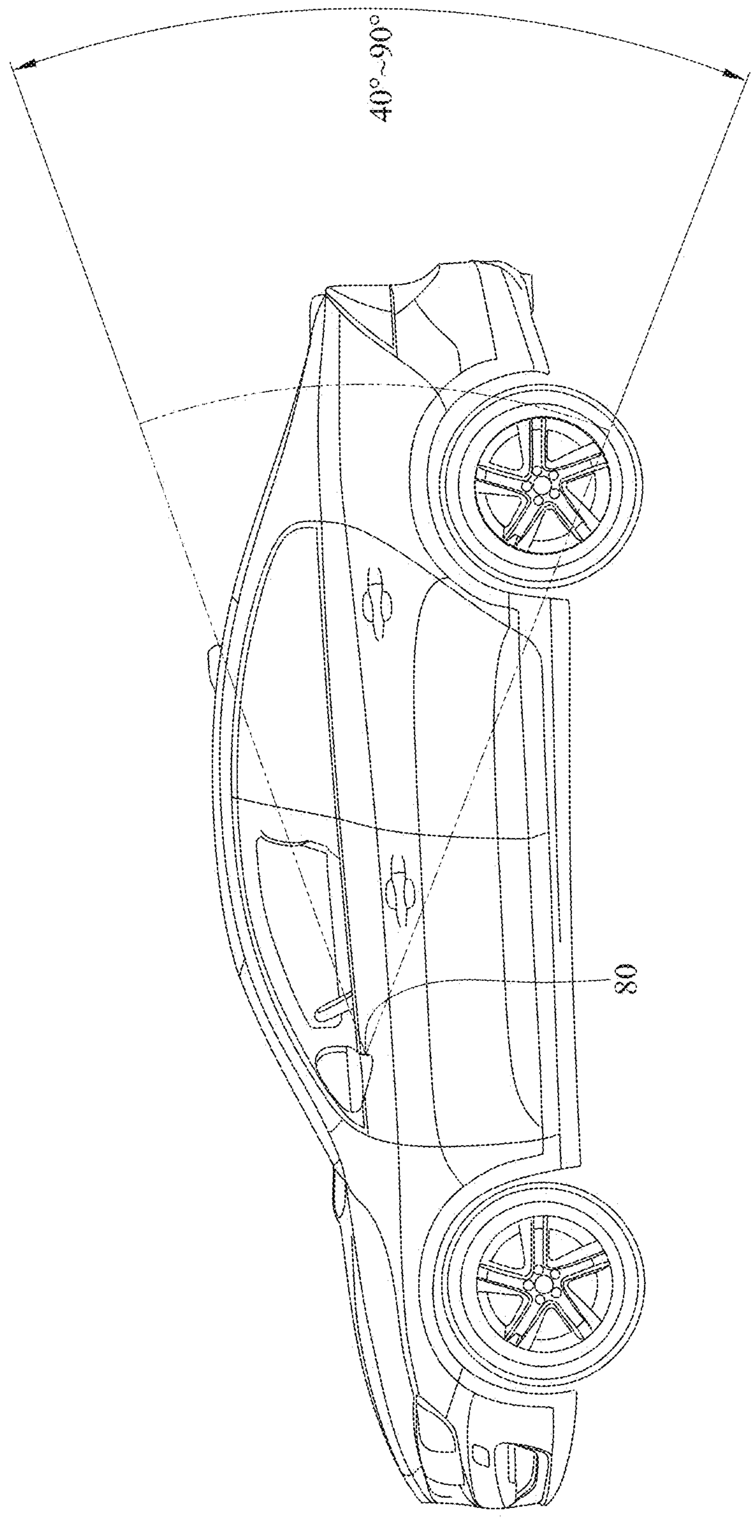


FIG. 33

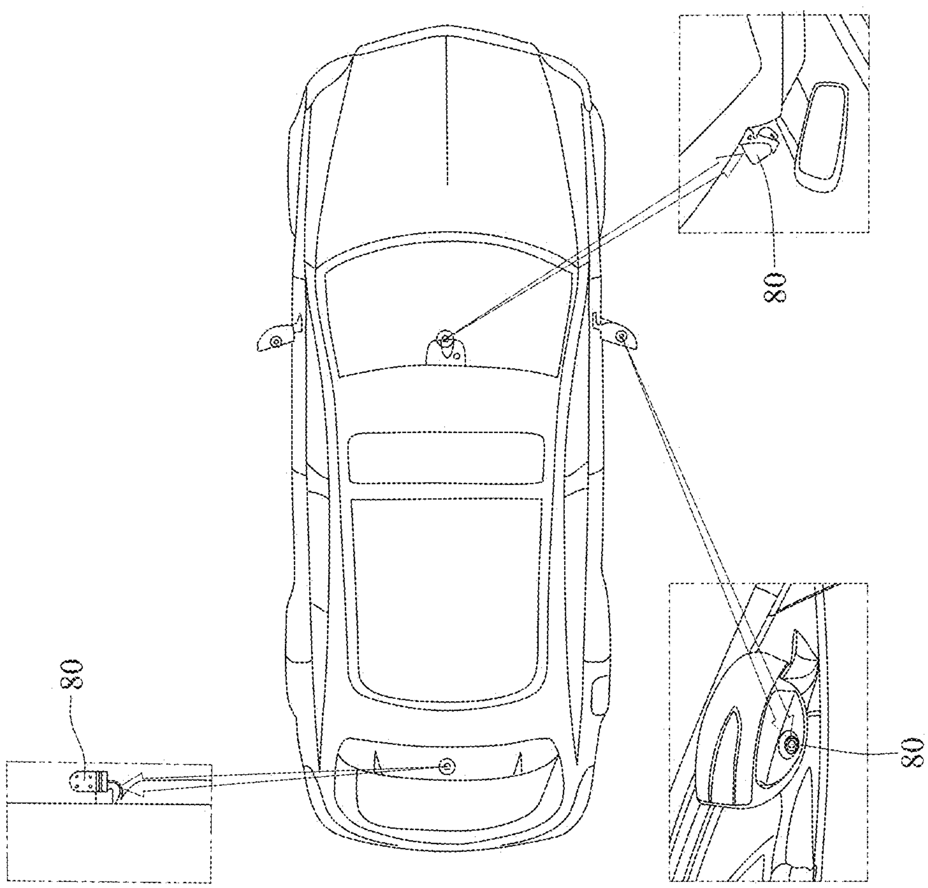


FIG. 34

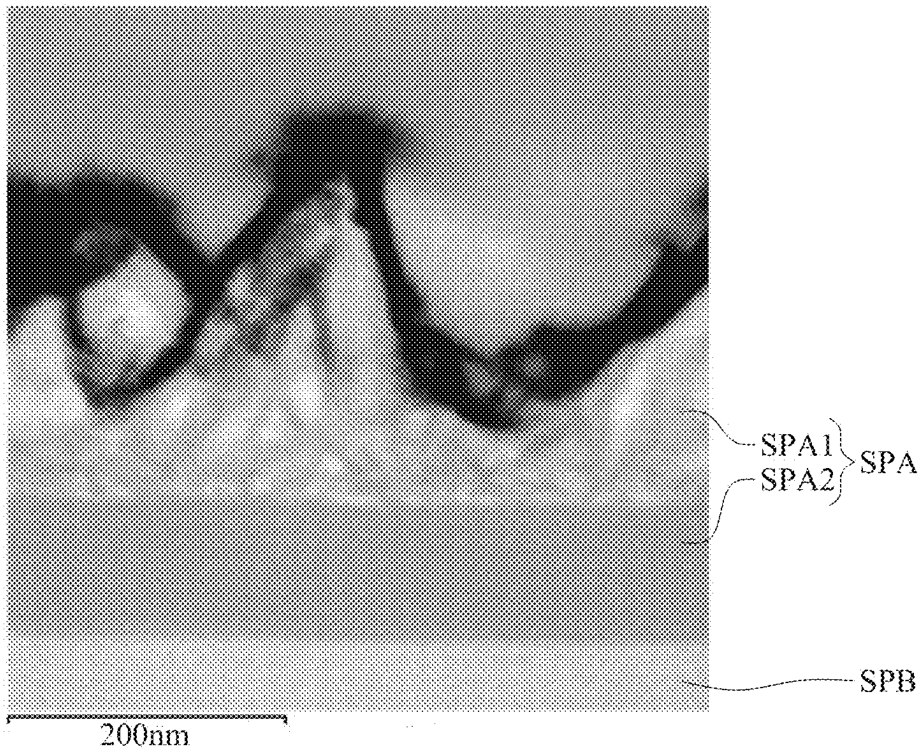


FIG. 35

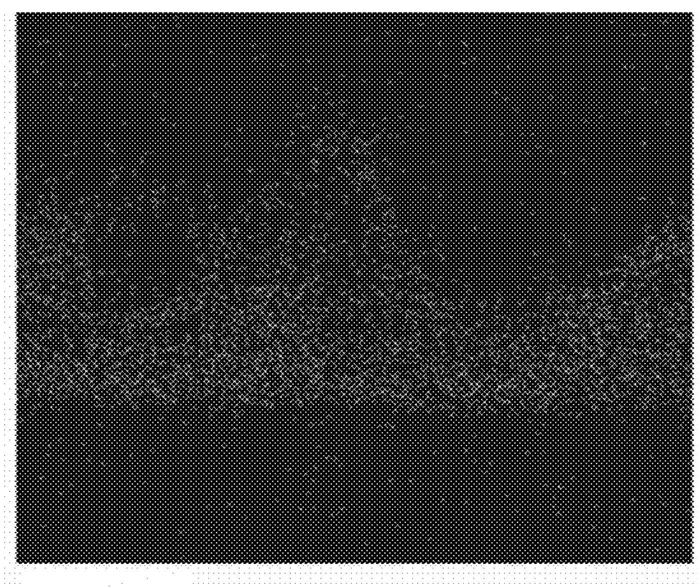


FIG. 36

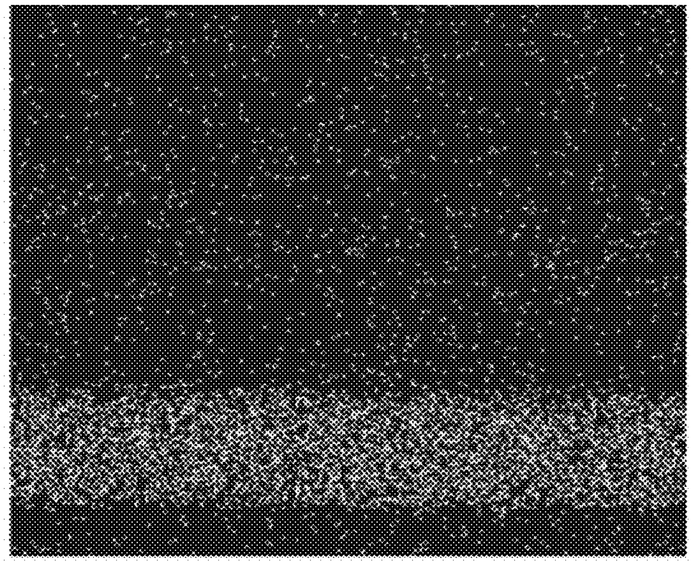


FIG. 37

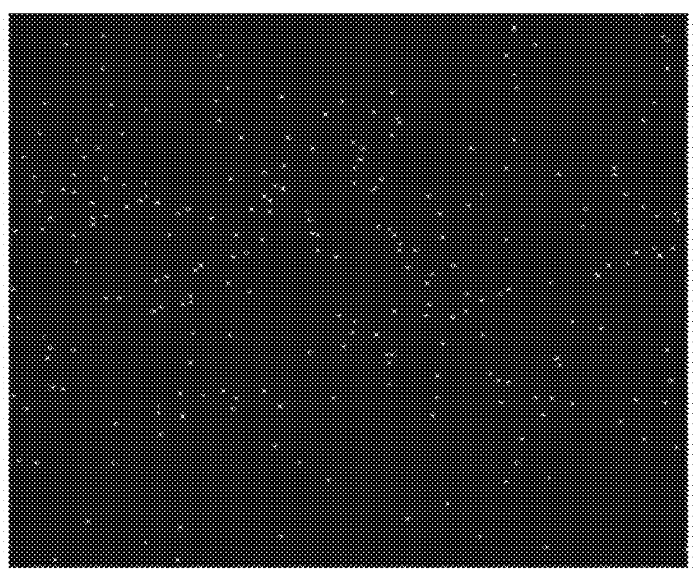


FIG. 38

OPTICAL COMPONENT, IMAGING LENS AND ELECTRONIC DEVICE

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application 63/555,650, filed on Feb. 20, 2024, which is incorporated by reference herein in its entirety.

BACKGROUND

Technical Field

[0002] The present disclosure relates to an optical component, an imaging lens and an electronic device, more particularly to an optical component and an imaging lens applicable to an electronic device.

Description of Related Art

[0003] With the development of semiconductor manufacturing technology, the performance of image sensors has been improved, and the pixel size thereof has been scaled down. Therefore, featuring high image quality becomes one of the indispensable features of an optical system nowadays. Furthermore, due to the rapid changes in technology, smartphone devices equipped with optical systems are trending towards multi-functionality for various applications, and therefore the functionality requirements for the optical systems have been increasing.

[0004] In recent years, it has become increasingly popular to use miniature optical systems in mobile devices for photography. However, mobile devices are often affected by intense sunlight during outdoor use, causing the optical systems to be significantly impacted by strong non-imaging stray light. Especially the non-imaging light easily reflects within the optical systems, greatly reducing image quality.

[0005] Conventional techniques for optical systems involve methods such as inking, sandblasting, and coating the surfaces of optical elements to reduce reflectivity and eliminate stray light. Although these methods can improve optical image quality, they are still insufficient for eliminating high-intensity stray light. Furthermore, in the field of non-mobile device optical systems, there are other techniques for reducing reflectivity, such as forming porous microstructures on the surface of coatings. However, the structures lack sufficient support and are prone to deformation due to environmental factors, which significantly reduces anti-reflective effectiveness. Therefore, improving the structure of internal components in optical systems for reducing the reflection intensity of non-imaging light has become a critical issue to meet the high-end requirements for electronic devices nowadays.

SUMMARY

[0006] According to one aspect of the present disclosure, an optical component includes a substrate and an anti-reflective film. Preferably, the substrate has an aspherical surface, and light passes through the aspherical surface. Preferably, the anti-reflective film is disposed at least on the aspherical surface. The anti-reflective film includes a nanostructure layer and at least one intermediate layer. The nanostructure layer includes a plurality of ridge-like protrusions that are non-directionally extended, a bottom of the ridge-like protrusions is located closer to the substrate than a top of the ridge-like protrusions, and the ridge-like protrusions gradually taper from the bottom toward the top. An average structural height of the ridge-like protrusions is greater than 108 nm and less than 368 nm. The intermediate layer is disposed between the nanostructure layer and the substrate. In addition, a main component of the nanostructure layer is aluminum oxide, the nanostructure layer further includes a metallic doping agent, and at least part of the metallic doping agent is distributed inside the ridge-like protrusions. Preferably, the metallic doping agent includes at least one of titanium, vanadium, chromium, titanium oxide, vanadium oxide and chromium oxide.

[0007] According to another aspect of the present disclosure, an optical component includes a substrate and an anti-reflective film. Preferably, the substrate has a reflection surface configured to reflect light. Preferably, the anti-reflective film is disposed at least on one or some surfaces of the substrate. The anti-reflective film includes a nanostructure layer and at least one intermediate layer. The nanostructure layer includes a plurality of ridge-like protrusions that are non-directionally extended, a bottom of the ridge-like protrusions is located closer to the substrate than a top of the ridge-like protrusions, and the ridge-like protrusions gradually taper from the bottom toward the top. An average structural height of the ridge-like protrusions is greater than 108 nm and less than 368 nm. The intermediate layer is disposed between the nanostructure layer and the substrate. In addition, a main component of the nanostructure layer is aluminum oxide, the nanostructure layer further includes a metallic doping agent, and at least part of the metallic doping agent is distributed inside the ridge-like protrusions. Preferably, the metallic doping agent includes at least one of titanium, vanadium, chromium, titanium oxide, vanadium oxide and chromium oxide.

[0008] According to another aspect of the present disclosure, an imaging lens includes one of the aforementioned optical components, and an optical axis of the imaging lens passes through the optical component.

[0009] According to another aspect of the present disclosure, an electronic device includes the aforementioned imaging lens and an image sensor disposed on an image surface of the imaging lens.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The disclosure can be better understood by reading the following detailed description of the embodiments, with reference made to the accompanying drawings as follows:

[0011] FIG. **1** is a cross-sectional view of an imaging lens according to the 1st embodiment of the present disclosure;

[0012] FIG. **2** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **1**;

[0013] FIG. **3** is an enlarged view of region EL**3** shown in FIG. **2**;

[0014] FIG. **4** is a perspective view of the optical component of the imaging lens shown in FIG. **1**;

[0015] FIG. **5** is an enlarged view of region EL**5** shown in FIG. **4**;

[0016] FIG. **6** is another perspective view of the optical component of the imaging lens shown in FIG. **1**;

[0017] FIG. **7** is an enlarged view of region EL**7** shown in FIG. **6**;

[0018] FIG. **8** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **1** under a transmission electron microscope;

[0019] FIG. **9** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **1**;

[0020] FIG. **10** is a schematic view of the stacking relationship among a nanostructure layer, an intermediate layer and a substrate of the optical component of the imaging lens shown in FIG. **1**;

[0021] FIG. **11** is a cross-sectional view of an imaging lens according to the 2nd embodiment of the present disclosure;

[0022] FIG. **12** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **11**;

[0023] FIG. **13** is a perspective view of the optical component of the imaging lens shown in FIG. **11**;

[0024] FIG. **14** is a schematic view of the stacking relationship among a nanostructure layer, three intermediate layers and a substrate of the optical component of the imaging lens shown in FIG. **11**;

[0025] FIG. **15** is a cross-sectional view of an imaging lens according to the 3rd embodiment of the present disclosure;

[0026] FIG. **16** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **15**;

[0027] FIG. **17** is a perspective view of the optical component of the imaging lens shown in FIG. **15**;

[0028] FIG. **18** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **15**;

[0029] FIG. **19** is a sectional view of the optical component shown in FIG. **17**;

[0030] FIG. **20** is a top view of the optical component shown in FIG. **17**;

[0031] FIG. **21** is an enlarged view of region EL**21** shown in FIG. **20**;

[0032] FIG. **22** is a cross-sectional view of an imaging lens according to the 4th embodiment of the present disclosure;

[0033] FIG. **23** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **22**;

[0034] FIG. **24** is a cross-sectional view of an imaging lens according to the 5th embodiment of the present disclosure;

[0035] FIG. **25** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **24**;

[0036] FIG. **26** is a perspective view of an electronic device according to the 6th embodiment of the present disclosure;

[0037] FIG. **27** is another perspective view of the electronic device in shown FIG. **26**;

[0038] FIG. **28** is an illustration of an image captured by an ultra-wide-angle imaging lens;

[0039] FIG. **29** is an illustration of an image captured by a high pixel imaging lens;

[0040] FIG. **30** is an illustration of an image captured by a telephoto imaging lens;

[0041] FIG. **31** is a perspective view of an electronic device according to the 7th embodiment of the present disclosure;

[0042] FIG. **32** is a perspective view of an electronic device according to the 8th embodiment of the present disclosure;

[0043] FIG. **33** is a side view of the electronic device shown in FIG. **32**;

[0044] FIG. **34** is a top view of the electronic device shown in FIG. **32**;

[0045] FIG. **35** is a partial cross-sectional view of an anti-reflective film and a substrate of an optical component according to one configuration of the present disclosure under a transmission electron microscope;

[0046] FIG. **36** is a distribution map of aluminum elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer;

[0047] FIG. **37** is a distribution map of silicon elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer; and

[0048] FIG. **38** is a distribution map of titanium elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer.

DETAILED DESCRIPTION

[0049] In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0050] The present disclosure provides an optical component, and the optical component has optical applications, such as light-folding, converging, diverging, shielding, or reducing reflection related to optical phenomena, but the present disclosure is not limited to the aforementioned literal descriptions of applications. For example, the optical component can be a lens element or a prism, but the present disclosure is not limited thereto. The optical component includes a substrate and an anti-reflective film, the substrate can be made of, for example, glass material or plastic material, and the anti-reflective film is disposed at least on one or some surfaces of the substrate. The anti-reflective film includes a nanostructure layer and at least one intermediate layer, and the intermediate layer is disposed between the nanostructure layer and substrate.

[0051] The nanostructure layer includes a plurality of ridge-like protrusions that are non-directionally extended. A bottom of the ridge-like protrusions is located closer to the substrate than a top of the ridge-like protrusions, and the ridge-like protrusions gradually taper from the bottom toward the top. Therefore, the ridge-like protrusions contribute to the formation of a gradient refractive index, thereby reducing reflectance. Moreover, an average structural height of the ridge-like protrusions is greater than 108 nm and less than 368 nm. Moreover, the height of each ridge-like protrusion may be different; therefore, the average structural height of the ridge-like protrusions can be calculated using at least three or more ridge-like protrusions, prioritizing those with identifiable contours. Additionally, the height of a ridge-like protrusion can be defined, from a cross-sectional observation (e.g., destructive measurement), as the vertical height from the absolute bottom of the ridge-like protrusion (e.g., the foot of the ridge) to the top of the ridge-like protrusion (e.g., the peak of the ridge). Please refer to FIG. **8** and FIG. **9**, which are schematic views respectively showing the bottom BPS, the top TPS and the average structural height H**1** of the ridge-like protrusions RLP and the substrate **110** in the imaging lens according to the 1st embodiment of the present disclosure.

[0052] The main component of the nanostructure layer is aluminum oxide (Al_2O_3). The nanostructure layer further includes a metallic doping agent, and at least part of the metallic doping agent is distributed inside the ridge-like protrusions. Therefore, the nanostructure layer containing the metallic doping agent is favorable for increasing the tolerance and durability of the nanostructure layer to environmental changes, reducing the impact of such changes on the film structure and maintaining the performance of the anti-reflective film. Said environmental changes may include variations in temperature, humidity, or other chemical interferences, but the present disclosure is not limited thereto.

[0053] The metallic doping agent includes at least one of titanium, vanadium, chromium, tantalum, zirconium, niobium, titanium oxide, vanadium oxide, chromium oxide, tantalum oxide, zirconium oxide, or niobium oxide. In one aspect, the metallic doping agent is selected from a group consisting of titanium, vanadium, chromium, tantalum, zirconium, niobium, titanium oxide, vanadium oxide, chromium oxide, tantalum oxide, zirconium oxide, and niobium oxide. In one aspect, the metallic doping agent is selected from a group consisting of titanium, vanadium, chromium, titanium oxide, vanadium oxide, and chromium oxide. In one aspect, the main component of the metallic doping agent is titanium oxide. Therefore, it is favorable for increasing the stability of the anti-reflective film. In one aspect, the metallic doping agent is selected from a group consisting of tantalum, zirconium, niobium, tantalum oxide, zirconium oxide, and niobium oxide. Moreover, the detection method for metallic doping agent(s) can be performed using a transmission electron microscope (TEM) equipped with an energy dispersive x-ray spectrometer (EDS) for analysis. Regardless of whether the metallic doping agent exists in the form of metal elements or metal oxides, the distribution of metal species serves as the primary basis for evaluation. For example, please refer to FIG. **35** to FIG. **38**. FIG. **35** is a partial cross-sectional view of an anti-reflective film and a substrate of an optical component according to one configuration of the present disclosure under a transmission electron microscope, FIG. **36** is a distribution map of aluminum elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer, FIG. **37** is a distribution map of silicon elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer, and FIG. **38** is a distribution map of titanium elements in the region shown in FIG. **35** analyzed using an energy dispersive x-ray spectrometer. As seen in FIG. **35** to FIG. **38**, the transmission electron microscope provides high-resolution images of the microstructure of the anti-reflective film SPA and substrate SPB of the optical component. Additionally, the energy dispersive X-ray spectrometer provides elemental composition information for the anti-reflective film SPA and substrate SPB. This elemental composition information may include, for example, the types of elements and their distribution within the substrate SPB and the nanostructure layer SPA**1** and the intermediate layer SPA**2** of the anti-reflective film SPA.

[0054] In one configuration, the substrate has an aspherical surface, light passes through the aspherical surface, and the anti-reflective film is disposed at least on the aspherical surface. In another configuration, the substrate has a reflection surface configured to reflect light. Moreover, the anti-reflective film can also be disposed on the reflection surface.

[0055] In one configuration, the main component of the intermediate layer can be silicon dioxide (SiO_2). Therefore, it is favorable for increasing the connection stability of the anti-reflective film. In another configuration, the main component of the intermediate layer can be the same as one of components that form the nanostructure layer. Therefore, it is favorable for adjusting the gradient refractive index of the anti-reflective film, and also facilitating the connection of the nanostructure layer. Moreover, the main component of the intermediate layer can be, for example, aluminum, titanium, vanadium, chromium, oxides of the aforementioned elements, or combinations thereof, but the present disclosure is not limited thereto.

[0056] The number of intermediate layers can be multiple, and the intermediate layers can form thin-film interference, which is favorable for reducing reflectance.

[0057] The at least part of the metallic doping agent distributed inside the ridge-like protrusions can gradually taper in a direction away from the substrate. Therefore, the metallic doping agent can also adjust the degree of the gradient refractive index of the nanostructure layer, thereby reducing reflectance.

[0058] There can be at least another part of the metallic doping agent distributed on a surface of the ridge-like protrusions. Therefore, it is favorable for protecting the ridge-like protrusions, preventing structural shape changes of the ridge-like protrusions due to environmental variations, thereby maintaining the anti-reflective performance.

[0059] A coverage thickness of the metallic doping agent on the surface of the ridge-like protrusions can be greater than 1 nm and less than 40 nm. Therefore, an appropriate thickness condition can preserve the structural shape of the ridge-like protrusions while enhancing the weather resistance of the ridge-like protrusions. Moreover, the coverage thickness of the metallic doping agent on the surface of the ridge-like protrusions can be greater than 1 nm and less than 30 nm. Please refer to FIG. **8**, which shows a schematic view of the coverage thickness D**1** of the metallic doping agent MDA on the surface of the ridge-like protrusions RLP in the imaging lens according to the 1st embodiment of the present disclosure.

[0060] The optical component can further include a matte structure integrally formed with the substrate, and the matte structure can be located on one or some surfaces of the substrate and have an undulating shape (e.g., having continuous convex-concave shapes). Therefore, an undulating surface is favorable for reducing stray light reflections. Moreover, the matte structure can be formed on the substrate of the optical component through mold design. Moreover, the matte structure can be disposed outside an optically active area of the optical component.

[0061] The matte structure can have a plurality of protrusion portions, and the protrusion portions can be regularly arranged. Therefore, it is favorable for facilitating the quality control of the matte structure.

[0062] The height of the protrusion portions can be greater than 40 μm and less than 1000 μm. Therefore, it is favorable for blocking stray light reflections from reaching the image surface.

[0063] The optical component can further include a light-blocking layer located on one or some surfaces of the substrate and configured to block transmission of light. Moreover, the light-blocking layer can be disposed outside the optically active area of the optical component. Therefore, it is favorable for reducing stray light. Moreover, the light-blocking layer can, for example, be composed of materials that reduce light reflection, such as dark ink, photocurable coatings, acrylic pigments, carbon black, or metal oxides, but the present disclosure is not limited thereto. Moreover, the anti-reflective film can be further disposed on the light-blocking layer.

[0064] According to the present disclosure, an imaging lens is provided. The imaging lens includes the aforementioned optical component, and an optical axis of the imaging lens passes through the optical component.

[0065] According to the present disclosure, an electronic device is provided. The electronic device includes an image sensor and the aforementioned imaging lens, and the image sensor is disposed on an image surface of the imaging lens.

[0066] According to the present disclosure, the aforementioned features and conditions can be utilized in numerous combinations so as to achieve corresponding effects.

[0067] According to the above description of the present disclosure, the following specific embodiments are provided for further explanation.

1st EMBODIMENT

[0068] FIG. **1** is a cross-sectional view of an imaging lens according to the 1st embodiment of the present disclosure, FIG. **2** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **1**, FIG. **3** is an enlarged view of region EL**3** shown in FIG. **2**, FIG. **4** is a perspective view of the optical component of the imaging lens shown in FIG. **1**, FIG. **5** is an enlarged view of region EL**5** shown in FIG. **4**, FIG. **6** is another perspective view of the optical component of the imaging lens shown in FIG. **1**, FIG. **7** is an enlarged view of region EL**7** shown in FIG. **6**, FIG. **8** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **1** under a transmission electron microscope, FIG. **9** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **1**, and FIG. **10** is a schematic view of the stacking relationship among a nanostructure layer, an intermediate layer and a substrate of the optical component of the imaging lens shown in FIG. **1**.

[0069] An imaging lens **1** is provided in this embodiment. The imaging lens **1** is a telephoto imaging lens, and the imaging lens **1** includes a plurality of optical components and an image surface IMG. The optical components include a barrel **10**, a plurality of lens elements **11** and **12**, a plurality of light-blocking elements **13**, a spacer **14**, a retainer **15** and a filter **16**. Moreover, the lens elements **11** and **12**, the light-blocking elements **13**, the spacer **14** and the retainer **15** are accommodated in the barrel **10**, the filter **16** is disposed between the lens element **12** and the image surface IMG, and an optical axis of the imaging lens **1** passes through the optical components. After entering the barrel **10**, the light passes through the lens elements **11** and **12**, the light-blocking elements **13** and the filter **16**, becoming imaging light that forms an image on the image surface IMG.

[0070] The lens element **11** includes a substrate **110**, two anti-reflective films **111** and two matte structures **112** and **113**. The substrate **110** has two aspherical surfaces AS**1** and AS**2** and a reflection surface RS**1**, light passes through the aspherical surfaces AS**1** and AS**2**, and the reflection surface RS**1** is configured to reflect light. The anti-reflective films **111** are disposed on the aspherical surfaces AS**1** and AS**2**. Note that in FIG. **2**, the anti-reflective films **111** are illustrated as separated from the substrate **110** solely for clear expression. However, the connection between the anti-reflective films **111** and the substrate **110** is not limited to the depiction shown in the figure.

[0071] As shown in FIG. **9** and FIG. **10**, each of the anti-reflective films **111** includes a nanostructure layer **1110** and an intermediate layer **1111**, and the intermediate layer **1111** is disposed between the nanostructure layer **1110** and the substrate **110**.

[0072] The main component of the nanostructure layer **1110** is aluminum oxide, and the main component of the intermediate layer **1111** is silicon dioxide. In addition, the nanostructure layer **1110** includes a plurality of ridge-like protrusions RLP that are non-directionally extended and a plurality of metallic doping agents MDA. As shown in FIG. **9**, a bottom BPS of the ridge-like protrusions RLP is located closer to the substrate **110** than a top TPS of the ridge-like protrusions RLP, and the ridge-like protrusions RLP gradually taper from the bottom BPS to the top TPS.

[0073] The main component of the metallic doping agents MDA is titanium oxide, and at least part of the metallic doping agents MDA is distributed inside the ridge-like protrusions RLP and at least another part of the metallic doping agents MDA is distributed on a surface of the ridge-like protrusions RLP. Moreover, the at least part of the metallic doping agents MDA distributed inside the ridge-like protrusions RLP gradually tapers in a direction away from the substrate **110**.

[0074] The matte structures **112** and **113** are integrally formed with the substrate **110**, and the matte structures **112** and **113** are located on surface(s) of the substrate **110** and disposed outside an optically active area of the lens element **11**. Moreover, each of the matte structures **112** and **113** has an undulating shape. Specifically, as shown in FIG. **2** to FIG. **5**, the matte structure **112** is located on an object-side surface of the substrate **110**, and the matte structure **112** has a plurality of protrusion portions **1120** that are regularly arranged. Additionally, the protrusion portions **1120** are each in a triangular shape, and the height of the protrusion portions **1120** is 75 μm. As shown in FIG. **2**, FIG. **3**, FIG. **6** and FIG. **7**, the matte structure **113** is located on an image-side surface of the substrate **110**, and the matte structure **113** has a plurality of curved protrusion portions **1130** that are regularly arranged. Additionally, the curved protrusion portions **1130** are arranged as concentric circles on the surface of the substrate **110**, and the height of the curved protrusion portions **1130** is 50 μm.

[0075] As shown in FIG. **8**, an average structural height H**1** of the ridge-like protrusions RLP is 266.2 nm.

[0076] As shown in FIG. **8**, a coverage thickness D**1** of the metallic doping agents MDA on the surface of the ridge-like protrusions RLP is 12.6 nm.

[0077] As shown in FIG. **9** and FIG. **10**, the number of the intermediate layer **1111** is one, and a thickness D**2** of the intermediate layer **1111** is 92.85 nm.

2nd EMBODIMENT

[0078] FIG. **11** is a cross-sectional view of an imaging lens according to the 2nd embodiment of the present disclosure, FIG. **12** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **11**, FIG. **13** is a perspective view of the optical component of the imaging lens shown in FIG. **11**, and FIG. **14** is a schematic view of the stacking relationship among a nanostructure layer, three intermediate layers and a substrate of the optical component of the imaging lens shown in FIG. **11**.

[0079] An imaging lens **2** is provided in this embodiment. The imaging lens **2** is a telephoto imaging lens, and the imaging lens **2** includes a plurality of optical components and an image surface IMG. The optical components include a barrel **20**, a lens assembly **21**, a retainer **25** and a prism **27**. Moreover, the lens assembly **21**, the retainer **25** and the prism **27** are accommodated in the barrel **20**, and an optical axis of the imaging lens **2** passes through the optical components. After entering the barrel **20**, the light passes through the lens assembly **21** and the prism **27**, becoming imaging light that forms an image on the image surface IMG. Note that the components inside the barrel **20** are not limited to the shapes illustrated in the figures.

[0080] The prism **27** includes a substrate **270**, an anti-reflective film **271**, a matte structure **272** and at least one light-blocking layer **274**. The substrate **270** has a light incident surface LS**1**, three reflection surfaces RS**1**, RS**2** and RS**3** and a light exit surface LS**2**, and the reflection surfaces RS**1**, RS**2** and RS**3** are configured to reflect light. The anti-reflective film **271** is disposed on the light incident surface LS**1** of the substrate **270**. Note that in FIG. **12**, the anti-reflective film **271** is illustrated as separated from the substrate **270** solely for clear expression. However, the connection between the anti-reflective film **271** and the substrate **270** is not limited to the depiction shown in the figure.

[0081] As shown in FIG. **14**, the anti-reflective film **271** includes a nanostructure layer **2710** and three intermediate layers **2711**, **2712** and **2713**, and the intermediate layers **2711**, **2712** and **2713** are disposed between the nanostructure layer **2710** and the substrate **270**.

[0082] The main component of the nanostructure layer **2710** is aluminum oxide, and the nanostructure layer **2710** includes a plurality of ridge-like protrusions non-directionally extended and a plurality of metallic doping agents. A bottom of the ridge-like protrusions is located closer to the substrate **270** than a top of the ridge-like protrusions, and the ridge-like protrusions gradually taper from the bottom to the top. The metallic doping agents includes at least one of titanium, vanadium, chromium, tantalum, zirconium, niobium, titanium oxide, vanadium oxide, chromium oxide, tantalum oxide, zirconium oxide, or niobium oxide, and at least part of the metallic doping agents is distributed inside the ridge-like protrusions.

[0083] The main component of the intermediate layer **2711** is silicon dioxide, the main component of the intermediate layer **2712** is aluminum oxide, and the main component of the intermediate layer **2713** is titanium oxide. Moreover, the main components of the intermediate layer **2712** and the intermediate layer **2713** are the same as one of components that form the nanostructure layer **2710**.

[0084] The matte structure **272** is integrally formed with the substrate **270**, and the matte structure **272** is located on the surface of the substrate **270** and disposed outside an optically active area of the prism **27**. Moreover, the matte structure **272** has an undulating shape. Specifically, as shown in FIG. **12** and FIG. **13**, the matte structure **272** is disposed on the surface of the substrate **270** adjacent to reflection surface RS**2**, and the matte structure **272** has a plurality of curved protrusion portions **2720** that are regularly arranged. The curved protrusion portions **2720** extend along an S-shaped path on the surface of the substrate **270**, and a height of the curved protrusion portions **2720** is 300 μm.

[0085] The light-blocking layer **274** is located on a connection surface CS**1** of the substrate **270** and configured to block transmission of light. Moreover, the connection surface CS**1** is connected to the light incident surface LS**1**, the reflection surfaces RS**1**, RS**2** and RS**3** and the light exit surface LS**2**.

[0086] An average structural height of the ridge-like protrusions is greater than 108 nm and less than 368 nm.

[0087] As shown in FIG. **14**, the number of the intermediate layers **2711**, **2712** and **2713** is three. A thickness D**21** of the intermediate layer **2711** is 12.6 nm, a thickness D**22** of the intermediate layer **2712** is 37.2 nm, and a thickness D**23** of the intermediate layer **2713** is 19.4 nm.

3rd EMBODIMENT

[0088] FIG. **15** is a cross-sectional view of an imaging lens according to the 3rd embodiment of the present disclosure, FIG. **16** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **15**, FIG. **17** is a perspective view of the optical component of the imaging lens shown in FIG. **15**, FIG. **18** is a partially enlarged cross-sectional view of the optical component of the imaging lens shown in FIG. **15**, FIG. **19** is a sectional view of the optical component shown in FIG. **17**, FIG. **20** is a top view of the optical component shown in FIG. **17**, and FIG. **21** is an enlarged view of region EL**21** shown in FIG. **20**.

[0089] An imaging lens **3** is provided in this embodiment. The imaging lens **3** is a telephoto imaging lens, and the imaging lens **3** includes a plurality of optical components and an image surface IMG. The optical components include a barrel **30**, a lens assembly **31**, a retainer **35** and a prism **37**. Moreover, the lens assembly **31**, the retainer **35** and the prism **37** are accommodated in the barrel **30**, and an optical axis of the imaging lens **3** passes through the optical components. After entering the barrel **30**, the light passes through the lens assembly **31** and the prism **37**, becoming imaging light that forms an image on the image surface IMG. Note that the components inside the barrel **30** are not limited to the shapes illustrated in the figures.

[0090] The prism **37** includes a substrate **370**, an anti-reflective film **371**, a plurality of matte structures **372** and **373** and a light-blocking layer **374**. The substrate **370** has a light incident surface LS**1**, three reflection surfaces RS**1**, RS**2** and RS**3** and a light exit surface LS**2**, and the reflection surfaces RS**1**, RS**2** and RS**3** are configured to reflect light. Moreover, the reflection surface RS**2** can reflect light through a high-reflective coating or total reflection principles. The anti-reflective film **371** is disposed on the light incident surface LS**1**, the reflection surface RS**2** and the light exit surface LS**2** of the substrate **370**. Note that in FIG. **16**, the anti-reflective film **371** is illustrated as separated from the substrate **370** solely for clear expression. However, the connection between the anti-reflective film **371** and the substrate **370** is not limited to the depiction shown in the figure.

[0091] As shown in FIG. **18**, the anti-reflective film **371** includes a nanostructure layer **3710** and an intermediate layer **3711**, and the intermediate layer **3711** is disposed between the nanostructure layer **3710** and the substrate **370**.

[0092] The main component of the nanostructure layer **3710** is aluminum oxide, and the nanostructure layer **3710** includes a plurality of the ridge-like protrusions RLP that are non-directionally extended and a plurality of the metallic doping agents MDA. A bottom BPS of the ridge-like protrusions RLP is located closer to the substrate **370** than a top

TPS of the ridge-like protrusions RLP, and the ridge-like protrusions RLP gradually taper from the bottom BPS to the top TPS.

[0093] The main component of the metallic doping agents MDA is titanium oxide, and at least part of the metallic doping agents MDA is distributed inside the ridge-like protrusions RLP and at least another part of the metallic doping agents MDA is distributed on a surface of the ridge-like protrusions RLP. Moreover, the at least part of the metallic doping agents MDA distributed inside the ridge-like protrusions RLP gradually tapers in a direction away from the substrate **370**.

[0094] The main component of the intermediate layer **3711** is aluminum, titanium, vanadium, chromium, oxides of the aforementioned elements, silicon dioxide or combinations thereof, and the main component of the intermediate layer **3711** is the same as one of components that form the nanostructure layer **3710**.

[0095] The matte structures **372** and **373** are integrally formed with the substrate **370**, and the matte structures **372** and **373** are located on one or some surfaces of the substrate **370** and disposed outside an optically active area of the prism **37**. Moreover, the matte structures **372** and **373** each have an undulating shape. Specifically, as shown in FIG. **17** and FIG. **19** to FIG. **21**, the matte structure **372** is disposed on the connection surface CS**1** of the substrate **370**, and the matte structure **372** has a plurality of triangular protrusion portions **3720** that are regularly arranged. A height H2 of the triangular protrusion portions **3720** is 100 μm. Moreover, the connection surface CS**1** is connected to the light incident surface LS**1**, the reflection surfaces RS**1**, RS**2** and RS**3** and the light exit surface LS**2**. Furthermore, the matte structure **373** is disposed on a recess surface PS**1** of the substrate **370**, and the matte structure **373** has a plurality of curved protrusion portions **3730** that are regularly arranged. A height of the curved protrusion portions **3730** is 150 μm.

[0096] The light-blocking layer **374** is located on some surfaces of the substrate **370** and configured to block transmission of light. Specifically, as shown in FIG. **17**, the light-blocking layer **374** is disposed on surfaces of the substrate **370** adjacent to the light incident surface LS**1**, the reflection surface RS**2** and the light exit surface LS**2**, and located outside the optically active area of the prism **37**. Furthermore, as shown in FIG. **18**, a part of the anti-reflective film **371** is further disposed on the light-blocking layer **374**, such that a part of the light-blocking layer **374** is located between the anti-reflective film **371** and the substrate **370**.

[0097] An average structural height of the ridge-like protrusions RLP is greater than 108 nm and less than 368 nm. A coverage thickness of the metallic doping agents MDA on the surface of the ridge-like protrusions RLP is greater than 1 nm and less than 40 nm.

[0098] As shown in FIG. **18**, the number of the intermediate layer **3711** is one. Furthermore, as shown in FIG. **17**, FIG. **19** and FIG. **20**, the prism **37** has a plurality of gate traces GT**1** at suitable positions to provide better molding efficiency for the prism **37**.

4th EMBODIMENT

[0099] FIG. **22** is a cross-sectional view of an imaging lens according to the 4th embodiment of the present disclosure, and FIG. **23** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **22**. In this embodiment, an imaging lens **4** is similar to the imaging lens **1** of the 1st embodiment as described above. The same or similar reference numerals indicate the same or similar components, and functions and effects provided by those components are the same as described above, so an explanation in this regard will not be provided again.

[0100] The imaging lens **4** is an ultra-wide-angle imaging lens, and the imaging lens **4** includes a plurality of optical components and an image surface IMG. The optical components include a barrel **40**, a plurality of lens elements **41** and **42**, a light-blocking element **43** and a retainer **45**. Moreover, the lens elements **41** and **42**, the light-blocking element **43** and the retainer **45** are accommodated in the barrel **40**, and an optical axis of the imaging lens **4** passes through the optical components. After entering the barrel **40**, the light passes through the lens elements **41** and **42** and the light-blocking element **43**, becoming imaging light that forms an image on the image surface IMG.

[0101] The lens element **41** includes a substrate **410** and an anti-reflective film **411**. The substrate **410** has an aspherical surface AS**1**, and light passes through the aspherical surface AS**1**. The anti-reflective film **411** is disposed on the aspherical surface AS**1**. Note that in FIG. **23**, the anti-reflective film **411** is illustrated as separated from the substrate **410** solely for clear expression. However, the connection between the anti-reflective film **411** and the substrate **410** is not limited to the depiction shown in the figure. Moreover, the components inside the barrel **40** are not limited to the shapes illustrated in the figures.

5th EMBODIMENT

[0102] FIG. **24** is a cross-sectional view of an imaging lens according to the 5th embodiment of the present disclosure, and FIG. **25** is a cross-sectional view of an optical component of the imaging lens shown in FIG. **24**.

[0103] An imaging lens **5** is provided in this embodiment. The imaging lens **5** is a wide-angle imaging lens, and the imaging lens **5** includes a plurality of optical components and an image surface IMG. The optical components include a barrel **50**, a plurality of lens elements **51** and **52**, a plurality of light-blocking elements **53** and a retainer **55**. Moreover, the lens elements **51** and **52**, the light-blocking elements **53** and the retainer **55** are accommodated in the barrel **50**, and an optical axis of the imaging lens **5** passes through the optical components. After entering the barrel **50**, the light passes through the lens elements **51** and **52** and the light-blocking elements **53**, becoming imaging light that forms an image on the image surface IMG.

[0104] The lens element **51** includes a substrate **510** and an anti-reflective film **511**. The substrate **510** has an aspherical surface AS**1**, and light passes through the aspherical surface AS**1**. The anti-reflective film **511** is disposed on the aspherical surface AS**1**. Note that in FIG. **25**, the anti-reflective film **511** is illustrated as separated from the substrate **510** solely for clear expression. However, the connection between the anti-reflective film **511** and the substrate **510** is not limited to the depiction shown in the figure. Moreover, the components inside the barrel **50** are not limited to the shapes illustrated in the figures.

6th EMBODIMENT

[0105] FIG. **26** is a perspective view of an electronic device according to the 6th embodiment of the present disclosure, and FIG. **27** is another perspective view of the electronic device in shown FIG. **26**.

[0106] In this embodiment, the electronic device **6** is a smartphone including a plurality of imaging lenses, a flash module **61**, a focus assist module **62**, an image signal processor **63**, a display module (user interface) **64**, an image software processor (not shown) and an image sensor (not shown).

[0107] These imaging lenses includes an ultra-wide-angle imaging lens **60***a*, a high pixel imaging lens **60***b*, a telephoto imaging lens **60***c* and a telephoto imaging lens **60***d*. Moreover, the imaging lens **60***a* includes, for example, the imaging lens **4** of the 4th embodiment as described above, the imaging lens **60***c* includes, for example, the imaging lens **2** of the 2nd embodiment or the imaging lens **3** of the 3rd embodiment as described above, and the imaging lens **60***d* includes, for example, the imaging lens **1** of the 1st embodiment as described above. The image sensor is disposed on the image surface of the imaging lenses **60***a*, **60***b*, **60***c* and **60***d*.

[0108] The image captured by the ultra-wide-angle imaging lens **60***a* enjoys a feature of multiple imaged objects. FIG. **28** is an image captured by the ultra-wide-angle imaging lens **60***a*.

[0109] The image captured by the high pixel imaging lens **60***b* enjoys a feature of high resolution and less distortion, and the high pixel imaging lens **60***b* can capture part of the image in FIG. **28**. FIG. **29** is an image captured by the high pixel imaging lens **60***b*.

[0110] The image captured by the telephoto imaging lens **60***c* or **60***d* enjoys a feature of high optical magnification, and the imaging lens **60***c* or **60***d* can capture part of the image in FIG. **29**. FIG. **30** is an image captured by the telephoto imaging lens **60***c* or **60***d*. Moreover, the maximum field of view of the imaging lens corresponds to the field of view in FIG. **30**.

[0111] When a user captures images of an object, the light rays converge in the ultra-wide-angle imaging lens **60***a*, the high pixel imaging lens **60***b*, the telephoto imaging lens **60***c* or the telephoto imaging lens **60***d* to generate images, and the flash module **61** is activated for light supplement. The focus assist module **62** detects the object distance of the imaged object to achieve fast auto focusing. The image signal processor **63** is configured to optimize the captured image to improve image quality and provided zooming function. The light beam emitted from the focus assist module **62** can be either conventional infrared or laser. The display module **64** can include a touch screen, and the user is able to interact with the display module **64** to adjust the angle of view and switch between different imaging lenses, and the image software processor having multiple functions to capture images and complete image processing. Alternatively, the user may capture images via a physical button. The image processed by the image software processor can be displayed on the display module **64**.

7th EMBODIMENT

[0112] FIG. **31** is a perspective view of an electronic device according to the 7th embodiment of the present disclosure.

[0113] In this embodiment, the electronic device **7** is a smartphone including an imaging lens **70**, an imaging lens **70***a*, an imaging lens **70***b*, an imaging lens **70***c*, an imaging lens **70***d*, an imaging lens **70***e*, an imaging lens **70***f*, an imaging lens **70***g*, an imaging lens **70***h*, a flash module **71**, an image signal processor, a display module, an image software processor (not shown) and an image sensor (not shown). The imaging lens **70**, the imaging lens **70***a*, the imaging lens **70***b*, the imaging lens **70***c*, the imaging lens **70***d*, the imaging lens **70***e*, the imaging lens **70***f*, the imaging lens **70***g* and the imaging lens **70***h* are disposed on the same side of the electronic device **7**, while the display module is disposed on the opposite side of the electronic device **7**. Moreover, the imaging lens **70***d* includes, for example, the imaging lens **1** of the 1st embodiment as described above, the imaging lens **70***c* includes, for example, the imaging lens **2** of the 2nd embodiment or the imaging lens **3** of the 3rd embodiment as described above, the imaging lens **70** and the imaging lens **70***g* each include the imaging lens **4** of the 4th embodiment as described above, and the imaging lens **70***e* and the imaging lens **70***f* each include the imaging lens **5** of the 5th embodiment as described above. The image sensor is disposed on the image surface of the imaging lenses **70**, **70***a*, **70***b*, **70***c*, **70***d*, **70***e*, **70***f*, **70***g* and **70***h*.

[0114] The imaging lens **70** is an ultra-wide-angle imaging lens, the imaging lens **70***a* is a telephoto imaging lens, the imaging lens **70***b* is a telephoto imaging lens, the imaging lens **70***c* is a telephoto imaging lens, the imaging lens **70***d* is a telephoto imaging lens, the imaging lens **70***e* is a wide-angle imaging lens, the imaging lens **70***f* is a wide-angle imaging lens, the imaging lens **70***g* is an ultra-wide-angle imaging lens, and the imaging lens **70***h* is a ToF (time of flight) imaging lens. In this embodiment, the imaging lens **70**, the imaging lens **70***a*, the imaging lens **70***b*, the imaging lens **70***c*, the imaging lens **70***d*, the imaging lens **70***e*, the imaging lens **70***f* and the imaging lens **70***g* have different fields of view, such that the electronic device **7** can have various magnification ratios so as to meet the requirement of optical zoom functionality. In addition, the imaging lens **70***a* and the imaging lens **70***b* are each a telephoto imaging lens with a light-folding element configuration. In addition, the imaging lens **70***h* can determine depth information of the imaged object. In this embodiment, the electronic device **7** includes multiple imaging lenses **70**, **70***a*, **70***b*, **70***c*, **70***d*, **70***e*, **70***f*, **70***g*, and **70***h*, but the present disclosure is not limited to the number and arrangement of imaging lenses. When a user captures images of an object, the light rays converge in the imaging lens **70**, the imaging lens **70***a*, the imaging lens **70***b*, the imaging lens **70***c*, the imaging lens **70***d*, the imaging lens **70***e*, the imaging lens **70***f*, the imaging lens **70***g* or the imaging lens **70***h* to generate an image(s), and the flash module **71** is activated for light supplement. Further, the subsequent processes are performed in a manner similar to the abovementioned embodiments, so the details in this regard will not be provided again.

8th EMBODIMENT

[0115] FIG. **32** is a perspective view of an electronic device according to the 8th embodiment of the present disclosure, FIG. **33** is a side view of the electronic device shown in FIG. **32**, and FIG. **34** is a top view of the electronic device shown in FIG. **32**.

[0116] In this embodiment, the electronic device **8** is an automobile. The electronic device **8** includes a plurality of automotive imaging lenses **80**, and the imaging lenses **80** each include the imaging lens of the present disclosure. The imaging lenses **80** can serve as, for example, panoramic view car cameras, dashboard cameras and vehicle backup cameras.

[0117] As shown in FIG. **32**, the imaging lenses **80** are, for example, disposed around the automobile to capture peripheral images of the automobile, which is favorable for obtaining external traffic information so as to achieve autopilot function. In addition, the image software processor may stitch the peripheral images into one panoramic view image for the driver's checking every corner surrounding the automobile, thereby favorable for parking and driving.

[0118] As shown in FIG. **33**, the imaging lenses **80** are, for example, respectively disposed on the lower portion of the side mirrors. A maximum field of view of the imaging lenses **80** can be 40 degrees to 90 degrees for capturing images in regions on left and right lanes.

[0119] As shown in FIG. **34**, the imaging lenses **80** can also be, for example, respectively disposed on the lower portion of the side mirrors and inside the front and rear windshields for providing external information to the driver, and also providing more viewing angles so as to reduce blind spots, thereby improving driving safety.

[0120] The smartphones, panoramic view car cameras, dashboard cameras and vehicle backup cameras in the embodiments are only exemplary for showing the optical component and the imaging lens of the present disclosure installed in an electronic device, and the present disclosure is not limited thereto. The optical component and the imaging lens can be optionally applied to optical systems with a movable focus. Furthermore, the imaging lens features good capability in aberration corrections and high image quality, and can be applied to 3D (three-dimensional) image capturing applications, in products such as digital cameras, mobile devices, digital tablets, smart televisions, network surveillance devices, multi-camera devices, image recognition systems, motion sensing input devices, wearable devices and other electronic imaging devices.

[0121] The foregoing description, for the purpose of explanation, has been described with reference to specific embodiments. It is to be noted that the present disclosure shows different data of the different embodiments; however, the data of the different embodiments are obtained from experiments. The embodiments were chosen and described in order to best explain the principles of the disclosure and its practical applications, to thereby enable others skilled in the art to best utilize the disclosure and various embodiments with various modifications as are suited to the particular use contemplated. The embodiments depicted above and the appended drawings are exemplary and are not intended to be exhaustive or to limit the scope of the present disclosure to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings.

What is claimed is:

1. An optical component comprising:

a substrate having an aspherical surface, wherein light passes through the aspherical surface; and

an anti-reflective film disposed at least on the aspherical surface, and the anti-reflective film comprising:

a nanostructure layer comprising a plurality of ridge-like protrusions that are non-directionally extended, wherein a bottom of the plurality of ridge-like protrusions is located closer to the substrate than a top of the plurality of ridge-like protrusions, the plurality of ridge-like protrusions gradually taper from the bottom toward the top, and an average structural height of the plurality of ridge-like protrusions is greater than 108 nm and less than 368 nm; and

at least one intermediate layer disposed between the nanostructure layer and the substrate;

wherein a main component of the nanostructure layer is aluminum oxide, the nanostructure layer further comprises a metallic doping agent, at least part of the metallic doping agent is distributed inside the plurality of ridge-like protrusions, and the metallic doping agent comprises at least one of titanium, vanadium, chromium, titanium oxide, vanadium oxide, and chromium oxide.

2. The optical component of claim **1**, wherein a main component of the at least one intermediate layer is silicon dioxide.

3. The optical component of claim **1**, wherein a main component of the at least one intermediate layer is same as one of components that form the nanostructure layer.

4. The optical component of claim **1**, wherein the at least part of the metallic doping agent distributed inside the plurality of ridge-like protrusions gradually tapers in a direction away from the substrate.

5. The optical component of claim **1**, wherein at least another part of the metallic doping agent is distributed on a surface of the plurality of ridge-like protrusions.

6. The optical component of claim **5**, wherein a coverage thickness of the metallic doping agent on the surface of the plurality of ridge-like protrusions is greater than 1 nm and less than 40 nm.

7. The optical component of claim **6**, wherein the coverage thickness of the metallic doping agent on the surface of the plurality of ridge-like protrusions is greater than 1 nm and less than 30 nm.

8. The optical component of claim **1**, wherein a main component of the metallic doping agent is titanium oxide.

9. The optical component of claim **1**, further comprising a matte structure, wherein the matte structure is integrally formed with the substrate, and the matte structure is located on one or some surfaces of the substrate and has an undulating shape.

10. The optical component of claim **9**, wherein the matte structure has a plurality of protrusion portions, and the plurality of protrusion portions are regularly arranged.

11. The optical component of claim **10**, wherein a height of the plurality of protrusion portions is greater than 40 μm and less than 1000 μm.

12. An optical component comprising:

a substrate having a reflection surface, wherein the reflection surface is configured to reflect light; and

an anti-reflective film disposed at least on one or some surfaces of the substrate, and the anti-reflective film comprising:

a nanostructure layer comprising a plurality of ridge-like protrusions that are non-directionally extended, wherein a bottom of the plurality of ridge-like protrusions is located closer to the substrate than a top of the plurality of ridge-like protrusions, the plurality of ridge-like protrusions gradually taper from the bottom toward the top, and an average structural height of the plurality of ridge-like protrusions is greater than 108 nm and less than 368 nm; and at least one intermediate layer disposed between the nanostructure layer and the substrate;

wherein a main component of the nanostructure layer is aluminum oxide, the nanostructure layer further comprises a metallic doping agent, at least part of the metallic doping agent is distributed inside the plurality of ridge-like protrusions, and the metallic doping agent comprises at least one of titanium, vanadium, chromium, titanium oxide, vanadium oxide, and chromium oxide.

13. The optical component of claim **12**, wherein a main component of the at least one intermediate layer is silicon dioxide.

14. The optical component of claim **12**, wherein a main component of the at least one intermediate layer is same as one of components that form the nanostructure layer.

15. The optical component of claim **12**, further comprising a light-blocking layer, wherein the light-blocking layer is located on one or some surfaces of the substrate and configured to block transmission of light.

16. The optical component of claim **15**, wherein the anti-reflective film is further disposed on the light-blocking layer.

17. The optical component of claim **12**, wherein the at least part of the metallic doping agent distributed inside the plurality of ridge-like protrusions gradually tapers in a direction away from the substrate.

18. The optical component of claim **12**, wherein at least another part of the metallic doping agent is distributed on a surface of the plurality of ridge-like protrusions.

19. The optical component of claim **18**, wherein a coverage thickness of the metallic doping agent on the surface of the plurality of ridge-like protrusions is greater than 1 nm and less than 40 nm.

20. The optical component of claim **19**, wherein the coverage thickness of the metallic doping agent on the surface of the plurality of ridge-like protrusions is greater than 1 nm and less than 30 nm.

21. The optical component of claim **12**, wherein a main component of the metallic doping agent is titanium oxide.

22. The optical component of claim **12**, further comprising a matte structure, wherein the matte structure is integrally formed with the substrate, and the matte structure is located on one or some surfaces of the substrate and has an undulating shape.

23. The optical component of claim **22**, wherein the matte structure has a plurality of protrusion portions, and the plurality of protrusion portions are regularly arranged.

24. The optical component of claim **23**, wherein a height of the plurality of protrusion portions is greater than 40 μm and less than 1000 μm.

25. An imaging lens comprising:

the optical component of claim **1**;

wherein an optical axis of the imaging lens passes through the optical component.

26. An electronic device comprising:

the imaging lens of claim **25**; and

an image sensor disposed on an image surface of the imaging lens.

27. An imaging lens comprising:

the optical component of claim **12**;

wherein an optical axis of the imaging lens passes through the optical component.

28. An electronic device comprising:

the imaging lens of claim **27**; and

an image sensor disposed on an image surface of the imaging lens.

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