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LIGHT-EMITTING DEVICE AND METHOD OF MANUFACTURING LIGHT-EMITTING DEVICE

Abstract

A light-emitting device includes: a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a Ti layer covering at least the upper surface of the Cu wiring line; a TiN layer disposed on the Ti layer; a TiW layer disposed on the TiN layer; a metal layer disposed on the TiW layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element including an electrode disposed on the conductive member.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2024-023654, filed Feb. 20, 2024, the content of which is hereby incorporated by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a light-emitting device and a method of manufacturing the light-emitting device.

2. Description of Related Art

[0003] Japanese Patent Publication No. 2005-150440 describes a semiconductor device including a semiconductor substrate, a metal pad formed as an electrode of the semiconductor substrate, a barrier metal layer stacked on the metal pad, and a bump formed on the barrier metal layer.

SUMMARY

[0004] When a portion of the barrier metal layer is etched using the bump as a mask subsequent to forming the bump by plating, if the amount of side etching of the barrier metal layer is too large, a space connecting the outside and wiring such as metal pads is formed, increasing the possibility of contact between the wiring and a corrosive substance.

[0005] Embodiments of the present disclosure can provide a light-emitting device that suppresses corrosion of wiring lines and a method of manufacturing the light-emitting device.

[0006] A light-emitting device according to an embodiment of the present disclosure includes: a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a Ti layer covering at least the upper surface of the Cu wiring line; a TiN layer disposed on the Ti layer; a TiW layer disposed on the TiN layer; a metal layer disposed on the TiW layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element including an electrode disposed on the conductive member.

[0007] A light-emitting device according to an embodiment of the present disclosure includes: a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a TiW layer covering the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of an upper surface of the insulating layer continuous with the inner surface; a first Ti layer covering an upper surface of the TiW layer, and covering an outer lateral surface of the TiW layer located between the upper surface of the TiW layer and the upper surface of the insulating layer; a metal layer disposed on the first Ti layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element including an electrode disposed on the conductive member.

[0008] A light-emitting device according to an embodiment of the present disclosure includes: a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a foundation layer covering the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of an upper surface of the insulating layer continuous with the inner surface; a metal layer disposed on the foundation layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element including an electrode disposed on the conductive member. In the foundation layer, a portion covering a part of the upper surface of the insulating layer includes an outer lateral surface defining an outer edge of the foundation layer, and a recessed portion recessed toward a center of the foundation layer in a top view from at least a part of a region of the outer lateral surface.

[0009] A method of manufacturing a light-emitting device according to an embodiment of the present disclosure includes: preparing a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a Ti layer so as to cover at least the upper surface of the Cu wiring line; forming a TiN layer on the Ti layer; forming a TiW layer on the TiN layer; forming a metal layer on the TiW layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer; disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching at least a part of the TiW layer that does not overlap the conductive member in a top view.

[0010] A method of manufacturing a light-emitting device according to an embodiment includes: preparing a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a first TiW layer and a second TiW layer, the first TiW layer being formed to cover each of the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of the upper surface of the insulating layer continuous with the inner surface, and the second TiW layer being formed on the upper surface of the insulating layer at a position separated from the first TiW layer; forming a first Ti layer so as to cover an upper surface of the first TiW layer and an outer lateral surface of the first TiW layer located between the upper surface of the first TiW layer and the upper surface of the insulating layer; forming a metal layer on the first Ti layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer; disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching the second TiW layer.

[0011] A method of manufacturing a light-emitting device according to an embodiment includes: preparing a substrate including a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a first foundation layer and a second foundation layer, the first foundation layer being formed to cover each of the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of an upper surface of the insulating layer continuous with the inner surface, and the second foundation layer being formed on the upper surface of the insulating layer at a position separated from the first foundation layer; forming a metal layer on at least the first foundation layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer; disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching the second foundation layer.

[0012] According to an embodiment of the present disclosure, a light-emitting device that suppresses corrosion of wiring lines and a method of manufacturing the light-emitting device can be provided.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A more complete appreciation of embodiments of the invention and many of the attendant advantages thereof will be readily obtained by reference to the following detailed description when considered in connection with the accompanying drawings.

[0014] FIG. **1** is a schematic perspective view of a light-emitting device according to a first embodiment.

[0015] FIG. **2** is an enlarged top view schematically illustrating region II illustrated in FIG. **1** in the light-emitting device according to the first embodiment.

[0016] FIG. **3** is an enlarged schematic top view for describing a configuration example of a unit region III illustrated in FIG. **2** in the light-emitting device according to the first embodiment.

[0017] FIG. **4** is a schematic cross-sectional view illustrating a cross section taken along line IV-IV illustrated in FIG. **3** in the light-emitting device according to the first embodiment.

[0018] FIG. **5**A is a schematic top view for describing an example of a method of manufacturing the light-emitting device according to the first embodiment.

[0019] FIG. **5**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0020] FIG. **6**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0021] FIG. **6**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0022] FIG. **7**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0023] FIG. **7**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0024] FIG. **8**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0025] FIG. **8**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0026] FIG. **9**A is a schematic top view for describing an example of a method of manufacturing the light-emitting device according to the first embodiment.

[0027] FIG. **9**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0028] FIG. **10**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0029] FIG. **10**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0030] FIG. **11**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0031] FIG. **11**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0032] FIG. **12**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0033] FIG. **12**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0034] FIG. **13**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the first embodiment.

[0035] FIG. **13**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the first embodiment.

[0036] FIG. **14** is an enlarged schematic top view for describing a configuration example of a unit region III in a light-emitting device according to a second embodiment.

[0037] FIG. **15** is a schematic cross-sectional view illustrating a cross section taken along line XV-XV illustrated in FIG. **14** in the light-emitting device according to the second embodiment.

[0038] FIG. **16** is a schematic cross-sectional view illustrating a cross section taken along line XVI-XVI illustrated in FIG. **14** in the light-emitting device according to the second embodiment.

[0039] FIG. **17**A is a schematic top view for describing an example of an example of a method of manufacturing the light-emitting device according to the second embodiment.

[0040] FIG. **17**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the second embodiment.

[0041] FIG. **18**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the second embodiment.

[0042] FIG. **18**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the second embodiment.

[0043] FIG. **19**A is a schematic top view for describing an example of the method of manufacturing the light-emitting device according to the second embodiment.

[0044] FIG. **19**B is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the second embodiment.

[0045] FIG. **19**C is a schematic cross-sectional view for describing the example of the method of manufacturing the light-emitting device according to the second embodiment.

DETAILED DESCRIPTION OF EMBODIMENT

[0046] A light-emitting device and a method of manufacturing the light-emitting device according to embodiments of the present disclosure will be described below with reference to the drawings. The following forms are examples of the light-emitting device and the method of manufacturing the light-emitting device for realizing the technical concept of the embodiments, and are not limited to the following. The dimensions, materials, shapes, relative arrangements, and the like of the components described in the embodiments are not intended to limit the scope of the present disclosure, but are merely illustrative examples, unless otherwise specifically stated. Note that the sizes, positional relationship, or the like of members illustrated in each of the drawings may be exaggerated for clarity of description. In the following description, members having the same terms and reference signs represent the same members or members of the same quality, and detailed description of these members is omitted as appropriate. As a cross-sectional view, an end view illustrating only a cut surface may be used.

[0047] In the following drawings, directions may be indicated by an X axis, a Y axis, and a Z axis. The X axis, the Y axis, and the Z axis are orthogonal to one another. The direction in which the arrow points in the X axis direction is denoted as +X direction or +X side, and the opposite direction of the +X direction is denoted as −X direction or −X side. The direction in which the arrow points in the Y axis direction is denoted as +Y direction or +Y side, and the opposite direction of the +Y direction is denoted as −Y direction or −Y side. The direction in which the arrow points in the Z axis direction is denoted as +Z direction or +Z side, and the opposite direction of the +Z direction is denoted as −Z direction or −Z side. Also, the expression “in top view” used in the embodiments refers to viewing an object from the +Z direction. However, this does not limit the orientation of the light-emitting device during use, and the orientation of the light-emitting device may be any chosen orientation. In the embodiments, a surface of a target object when viewed from the +Z direction is referred to as an “upper surface”, and a surface of the target object when viewed from the −Z direction is referred to as a “lower surface”. In the following embodiments, “being aligned with the X axis, the Y axis, and the Z axis” includes an object having an inclination within a range of ±10° relative to the axes. In the embodiments, the orthogonality may include an error within ±10° with respect to 90°.

[0048] In the present disclosure, a polygon such as a rectangle will be referred to as a polygon, including a shape with rounded, chamfered, angled, rounded, or otherwise processed corners of a polygon, unless otherwise specified. A shape obtained by processing not only the corners (ends of a side) but also an intermediate portion of the side is similarly referred to as a polygon. That is, a shape that is partially processed while leaving the polygon as the base is included in the interpretation of the “polygon” described in the present disclosure.

[0049] The same applies not only to polygons but also to the terms representing specific shapes such as trapezoids, circles, protrusions, and recessions. The same also applies to the terms related to each side forming the shape. That is, even when processing is performed on a corner or an intermediate portion of a certain side, the interpretation of “side” includes the processed portion.

[0050] The term “to cover” or “covering” is not limited to cases of direct contact, but also includes cases of indirect covering, e.g., through other members. The term “to dispose” is not limited to cases of direct contact, but also includes cases of indirect disposing, e.g., through other members.

First Embodiment

[0051] A configuration example of a light-emitting device **1** according to a first embodiment will be described with reference to FIGS. **1** to **4**. FIG. **1** is a perspective view schematically illustrating the light-emitting device **1** according to the first embodiment. FIG. **2** is an enlarged top view schematically illustrating region II illustrated in FIG. **1** in the light-emitting device **1** according to the first embodiment. FIG. **3** is an enlarged schematic top view illustrating a configuration example in the unit region III illustrated in FIG. **2**. FIG. **4** is a cross-sectional view schematically illustrating a cross section taken along line IV-IV illustrated in FIG. **3**.

Overall Configuration of Light-Emitting Device **1**

[0052] The light-emitting device **1** includes a substrate **10**, an insulating layer **20**, a titanium (Ti) layer **31**, a titanium nitride (TiN) layer **33**, a titanium-tungsten (TiW) layer **35**, a metal layer **37**, a conductive member **40**, and a light-emitting element **50**. The light-emitting device **1** can further include a package substrate **60**, a wire line **70**, a light shielding member **80**, a wavelength conversion member **90**, and a covering member **95**. In FIG. **1**, a part of the wavelength conversion member **90** and a part of the covering member **95** are omitted for convenience of description. In FIG. **1**, the light-emitting element **50** covered with the part of the wavelength conversion member **90** which is omitted from the drawing, and the wire line **70** covered with the part of the covering member **95** which is omitted from the drawing are visible.

[0053] As illustrated in FIG. **1**, the package substrate **60** includes a heat dissipation portion **61** and a plurality of terminals **62** individually arranged in a region on an upper surface of the package substrate **60**, the region sandwiching the heat dissipation portion **61**. The substrate **10** is, for example, supported by the package substrate **60** via the heat dissipation portion **61**. Terminals **18** disposed on the upper surface of the substrate **10** are electrically connected to the terminals **62** of the package substrate **60** via the wire lines **70**. The terminals **62** of the package substrate **60** are electrically connected to an external power supply. That is, the terminals **18** of the substrate **10** are electrically connected to an external power supply via the terminals **62** of the package substrate **60** and the wire lines **70**. The terminals **18** disposed on the upper surface of the substrate **10**, the terminals **62** disposed on the upper surface of the package substrate **60**, and the wire lines **70** are covered with the covering member **95**.

[0054] The wavelength conversion member **90** is disposed on the light-emitting element **50**. The wavelength conversion member **90** includes, for example, a base material made of a light-transmissive resin and a phosphor contained in the base material. The wavelength conversion member **90** converts a part of the wavelength of light emitted from the light-emitting element **50** to light with other wavelengths. This allows extraction of light of predetermined colors, such as blue light, green light, red light, and white light from the light-emitting device **1**.

[0055] The light-emitting device **1** includes a plurality of the light-emitting elements **50**. As illustrated in FIG. **2**, the plurality of light-emitting elements **50** are arrayed on the substrate **10** along the X axis direction and the Y axis direction. For example, the light shielding member **80** is disposed between lateral surfaces of adjacent light-emitting elements **50** facing each other, and is also disposed between the substrate **10** and the plurality of light-emitting elements **50**. As illustrated in FIG. **2**, in a top view, a virtual rectangular region surrounding a single light-emitting element **50** is referred to as a “unit region III”. Adjacent light-emitting elements **50** are surrounded by adjacent unit regions III. That is, the plurality of unit regions III are arrayed along the X axis direction and the Y axis direction, similarly to the plurality of light-emitting elements **50**.

[0056] FIG. **3** illustrates, in a perspective manner, an electrode **52**, an opening **21** of the insulating layer **20**, and the conductive member **40** of the light-emitting element **50** surrounded by the unit region III. Here, the insulating layer **20** is a layer located on the −Z side of the light-emitting element **50** and disposed on the substrate **10**.

[0057] In the example illustrated in FIG. **3**, four electrodes **52** are disposed in the unit region III. That is, in the example illustrated in FIG. **3**, a single light-emitting element **50** includes four electrodes **52**. Among the four electrodes **52**, two electrodes **52** located on the-X side correspond to one of n-side electrodes or p-side electrodes. Among the four electrodes **52**, two electrodes **52** located on the +X side correspond to the other of the n-side electrodes and the p-side electrodes. However, the number of electrodes **52** included in the single light-emitting element **50** is not limited thereto. The single light-emitting element **50** needs to include at least two electrodes **52**.

[0058] In a top view, the opening **21** is provided in a region overlapping the electrode **52**. In the example illustrated in FIG. **3**, two openings **21** each overlap a corresponding electrode **52** in a top view. That is, eight openings **21** are provided in the unit region III. However, the number of the openings **21** is not limited thereto.

[0059] In a top view, the conductive member **40** overlaps the electrode **52**. The number of conductive members **40** is preferably a number corresponding to the number of electrodes **52**. In the example illustrated in FIG. **3**, four conductive members **40** are provided in the unit region III. However, the number of the conductive members **40** is not limited thereto. As will be described later with reference to FIG. **4**, the Ti layer **31**, the TiN layer **33**, the TiW layer **35**, and the metal layer **37** are disposed on the −Z side of each conductive member **40**.

Substrate **10**

[0060] As illustrated in FIG. **1**, the substrate **10** has a substantially rectangular external shape in a top view. However, the substrate **10** can have another external shape such as a substantially circular shape, a substantially elliptical shape, or a substantially polygonal shape in a top view. The substrate **10** can include an integrated circuit for controlling a light emitting operation of the light-emitting element **50**. An example of the integrated circuit is an electronic circuit such as an application specific integrated circuit (ASIC). The integrated circuit is used to control the light emitting operation of each of the plurality of light-emitting elements **50**.

[0061] As illustrated in FIG. **4**, the substrate **10** includes a base material **11** and a copper (Cu) wiring line **12**. The Cu wiring line **12** is, for example, electrically connected to the terminal **18** via an internal wiring line provided inside the base material **11**. At least two Cu wiring lines **12** are provided in the unit region III. The two Cu wiring lines **12** are arranged at positions separated from each other. However, the number of the Cu wiring lines **12** is not limited thereto.

[0062] The base material **11** is a base material of the substrate **10**. As illustrated in FIG. **4**, the base material **11** has an upper surface **11***a*, a lower surface **11***b*, and a lateral surface between the upper surface **11***a* and the lower surface **11***b*. The base material **11** is mainly made of an insulator having insulating properties, or a semiconductor substance. Examples of the substance constituting the base material **11** include a semiconductor substrate such as silicon, a ceramic substrate such as aluminum nitride, and a resin substrate such as glass epoxy. However, the substance constituting

the base material **11** is not limited thereto.
[0063] The Cu wiring line **12** has a substantially rectangular external shape in a top view. However, the Cu wiring line **12** can have another external shape such as a substantially circular shape, a substantially elliptical shape, or a substantially polygonal shape in a top view. The Cu wiring line **12** is disposed on the upper surface **11***a* side of the base material **11**.
[0064] The Cu wiring line **12** has an upper surface **12***a*, a lower surface **12***b*, and a lateral surface **12***c* between the upper surface **12***a* and the lower surface **12***b*. The upper surface **12***a* of the Cu wiring line **12** is exposed from the upper surface **11***a* of the base material **11**. The lower surface **12***b* and the lateral surface **12***c* of the Cu wiring line **12** are located inside the base material **11**.
Insulating Layer **20**
[0065] As illustrated in FIG. **4**, the insulating layer **20** is disposed on the base material **11** and the Cu wiring line **12**. As described with reference to FIG. **3**, the insulating layer **20** includes the opening **21**. The opening **21** penetrates through the insulating layer **20** in the Z axis direction. Preferably, the opening **21** is located on the upper surface **12***a* of the Cu wiring line **12**, the upper surface **11***a* of the base material **11** is covered with the insulating layer **20**, and the base material **11** is not exposed from the opening **21** in a top view. Preferably, only the Cu wiring line **12** is exposed from the opening **21**, and the interface between the Cu wiring line **12** and the upper surface **11***a* of the base material **11** is not exposed from the opening **21**. This reduces the possibility of the Cu wiring line **12** coming into contact with corrosive substances such as sulfur and sulfur compounds.
[0066] Examples of the material constituting the insulating layer **20** include oxides such as silicon oxide (SiO.sub.2), aluminum oxide (Al.sub.2O.sub.3), niobium oxide (Nb.sub.2O.sub.5), and titanium oxide, and nitrides such as silicon nitride (Si.sub.3N.sub.4) and aluminum nitride (AlN). However, the substance constituting the insulating layer **20** is not limited thereto.
Ti Layer **31**
[0067] The Ti layer **31** is a layer made of titanium. The Ti layer **31** covers at least the upper surface **12***a* of the Cu wiring line **12**. More specifically, the Ti layer **31** covers a region overlapping the opening **21** in a top view on the upper surface **12***a* of the Cu wiring line **12**. The Ti layer **31** can also cover the inner surface **21***a* of the insulating layer **20** that defines the opening **21**. The Ti layer **31** can also cover a part of the upper surface of the insulating layer **20** continuous with the inner surface **21***a*. In a top view, the outer edge of the Ti layer **31** is located outside the outer edge of the opening **21**. This allows the Ti layer **31** to cover the region overlapping the opening **21** in a top view on the upper surface **12***a* of the Cu wiring line **12**. As a result, formation of the path connecting the outside and the Cu wiring line **12** can be suppressed. This reduces the possibility of the Cu wiring line **12** coming into contact with corrosive substances such as sulfur and sulfur compounds. That is, corrosion such as sulfurization in the Cu wiring line **12** can be suppressed.
[0068] In addition, for example, the Ti layer **31** having high adhesion to metals, oxides, and nitrides is in contact with each of the upper surface **12***a* of the Cu wiring line **12**, the inner surface **21***a* of the insulating layer **20**, and a part of the upper surface of the insulating layer **20** continuous with the inner surface **21***a*, which makes it possible to suppress peeling of the Ti layer **31**. The Ti layer **31** also has high adhesion to the TIN layer **33**. Therefore, disposing the TiN layer **33** on the Cu wiring line **12** via the Ti layer **31** can suppress separation of the TiN layer **33** from the Cu wiring line **12**. A thickness of the Ti layer **31** is preferably in a range from 30 nm to 2500 nm, for example. However, the thickness of the Ti layer **31** is not limited thereto.
[0069] In a top view, the outer edge of the Ti layer **31** is preferably located closer to the center of the metal layer **37** than the outer edge of the metal layer **37** is. This allows formation of a recessed space **31**S which is, for example, recessed in the X axis direction below the metal layer **37**. As illustrated in FIG. **4**, a part of the light shielding member **80** is located in the recessed space **31**S. That is, a part of the light shielding member **80** located in the recessed space **31**S faces the lower surface of the metal layer **37** in the Z axis direction. Therefore, even when a force acting upward on the light shielding member **80** is generated, separation of the light shielding member **80** from the

substrate **10** can be suppressed.

TiN Layer **33**

[0070] The TiN layer **33** is a layer containing titanium and nitrogen as main components thereof. The composition ratio of titanium and nitrogen in the TiN layer **33** is not limited. The TiN layer **33** can contain an element other than titanium and nitrogen. The TiN layer **33** is disposed on the Ti layer **31**. The TiN layer **33** can cover the entire upper surface of the Ti layer **31**, or can cover a part of the upper surface of the Ti layer **31**. However, the TiN layer **33** preferably covers at least a region of the Ti layer **31** overlapping the upper surface **12***a* of the Cu wiring line **12** in a top view. Thus, the region of the upper surface **12***a* of the Cu wiring line **12** overlapping the opening **21** in a top view can be covered with the Ti layer **31** and the TiN layer **33**. As a result, formation of the path connecting the outside and the Cu wiring line **12** can be further suppressed. This further suppresses corrosion of the Cu wiring line **12**.

[0071] In a top view, the outer edge of the TiN layer **33** is preferably located closer to the center of the metal layer **37** than the outer edge of the metal layer **37** is. Thus, for example, a recessed space **33**S recessed in the X axis direction can be provided below the metal layer **37**. The recessed space **33**S can be continuous with the recessed space **31**S outside the outer edge of the Ti layer **31**. As illustrated in FIG. **4**, a part of the light shielding member **80** is located in the recessed space **33**S. That is, a part of the light shielding member **80** located in the recessed space **33**S faces the lower surface of the metal layer **37** in the Z axis direction. Therefore, even when a force acting upward on the light shielding member **80** is generated, separation of the light shielding member **80** from the substrate **10** can be suppressed.

[0072] The thickness of the TiN layer **33** is preferably smaller than the thickness of the TiW layer **35** located on the TiN layer **33**. The thickness of the TiN layer **33** is smaller than the thickness of the TiW layer **35**, allowing the present invention to be made thinner. The thickness of the TiN layer **33** is preferably in a range from 50 nm to 200 nm, for example. However, the thickness of the TiN layer **33** is not limited thereto.

TiW Layer **35**

[0073] The TiW layer **35** is a layer containing titanium and tungsten as main components thereof. The composition ratio of titanium and tungsten in the TiW layer **35** is not limited. The TiW layer **35** can contain an element other than titanium and tungsten. The TiW layer **35** is disposed on the TiN layer **33**. The TiW layer **35** can cover the entire upper surface of the TiN layer **33**, or can cover a part of the upper surface of the TiN layer **33**. The TiW layer **35** can function as a seed layer for growing the conductive member **40**.

[0074] In a top view, the outer edge of the TiW layer **35** is preferably located closer to the center of the metal layer **37** than the outer edge of the metal layer **37** is. This allows formation of a recessed space **35**S which is, for example, recessed in the X axis direction below the metal layer **37**. The recessed space **35**S can be continuous with the recessed space **33**S outside the outer edge of the TiN layer **33**. As illustrated in FIG. **4**, a part of the light shielding member **80** is located in the recessed space **35**S. That is, a part of the light shielding member **80** located in the recessed space **35**S faces the lower surface of the metal layer **37** in the Z axis direction. Therefore, even when a force acting upward on the light shielding member **80** is generated, separation of the light shielding member **80** from the substrate **10** can be suppressed.

[0075] The thickness of the TiW layer **35** can be smaller than the thickness of the metal layer **37**. The thickness of the TiW layer **35** is smaller than the thickness of the metal layer **37**, allowing the present invention to be made thinner. In contrast, the thickness of the metal layer **37** can be greater than the thickness of the TiW layer **35** to increase the electrical conductivity. On the other hand, when the TiW layer **35** is thinner than the metal layer **37**, the thickness of the TiW layer **35** is preferably in a range from 100 nm to 300 nm, for example. However, the thickness of the TiW layer **35** is not limited thereto.

Metal Layer **37**

[0076] The metal layer **37** is disposed on the TiW layer **35**. The metal layer **37** contains at least one of gold (Au), platinum (Pt), ruthenium (Ru), palladium (Pd), or rhodium (Rh). The metal layer **37** can have a single-layer structure composed of one kind of metal layer among these metal layers, or can have a laminated structure in which different kinds of metal layers among these metal layers are laminated. This increases the reliability of the metal layer **37**. The reflectance of the metal layer **37** can be increased. The thickness of the metal layer **37** is preferably in a range from 150 nm to 800 nm, for example. However, the thickness of the metal layer **37** is not limited thereto.
[0077] The metal layer **37** can function as a seed layer for growing the conductive member **40**. Since the conductive member **40** contains Au, a layer containing Au is preferable as the metal layer **37**. The metal layer **37** is more preferably a layer composed of Au alone from the viewpoint of corrosion resistance and the like. However, the configuration of the metal layer **37** is not limited thereto.
Conductive Member **40**
[0078] The conductive member **40** is disposed on the metal layer **37**. The conductive member **40** is bonded to the electrode **52** of the light-emitting element **50**. The conductive member **40** can function as a bonding member between the substrate **10** and the light-emitting element **50**. Preferably, the thickness of the conductive member **40** is, for example, in a range from 2500 nm to 5000 nm. However, the thickness of the conductive member **40** is not limited thereto.
[0079] The conductive member **40** contains Au. Alternatively, the conductive member **40** can be made of Au alone. The conductive member **40** containing Au can reduce the electrical resistance in the current path between the Cu wiring line **12** and the electrode **52**, while suppressing corrosion of the conductive member **40**. In particular, the corrosion resistance can be improved when compared with a conductive member containing Cu having high reactivity with corrosive substances such as sulfur and a sulfur compound.
Light-Emitting Element **50**
[0080] The light-emitting element **50** is a semiconductor light-emitting element such as a light emitting diode (LED) or a laser diode (LD). The light-emitting element **50** includes a semiconductor structure **51** and a plurality of electrodes **52**. The semiconductor structure **51** includes an n-type semiconductor layer, an active layer, and a p-type semiconductor layer which are stacked in this order in the Z direction. The plurality of electrodes **52** includes an n-side electrode and a p-side electrode. The n-side electrode of the plurality of electrodes **52** is electrically connected to the n-type semiconductor layer of the semiconductor structure **51**. On the other hand, the p-side electrode of the plurality of electrodes **52** is electrically connected to the p-type semiconductor layer of the semiconductor structure **51**.
[0081] For example, the semiconductor structure **51** emits blue light. The n-type semiconductor layer, the active layer, and the p-type semiconductor layer in the semiconductor structure **51** are made of, for example, a nitride-based semiconductor (In.sub.xAl.sub.yGa.sub.1-X-YN, 0≤X, 0≤Y, X+Y≤1). The upper surface of the semiconductor structure **51** corresponds to a light extraction surface.
[0082] The semiconductor structure **51** has a substantially rectangular external shape in a top view. However, the semiconductor structure **51** can have another external shape such as a substantially circular shape, a substantially elliptical shape, or a substantially polygonal shape in a top view. The semiconductor structure **51** has an upper surface, a lower surface, and a lateral surface between the upper surface and the lower surface. For example, a protective film made of an insulator material can be disposed on the upper surface and the lateral surface of the semiconductor structure **51**. The lateral surface of the semiconductor structure **51** is covered with the light shielding member **80**. The plurality of electrodes **52** are disposed on the lower surface of the semiconductor structure **51**. The plurality of electrodes **52** are disposed at positions separated from each other on the lower surface of the semiconductor structure **51**. The electrode **52** contains, for example, a metal such as Au.

[0083] The electrode **52** has a substantially rectangular external shape in a top view. However, the electrode **52** can have another external shape such as a substantially circular shape, a substantially elliptical shape, or a substantially polygonal shape in a top view. The electrode **52** is disposed on the conductive member **40**.

Light Shielding Member **80**

[0084] The light shielding member **80** preferably has light reflectivity. The light shielding member **80** having the light reflectivity allows the light emitted from the light-emitting element **50** and reaching the light shielding member **80** to be reflected to, for example, the +Z side. Thus, the light-extracting efficiency of the light-emitting device **1** can be improved.

[0085] For example, the light shielding member **80** is made of a resin material containing a light reflective material. Examples of the light reflective material include titanium oxide, zinc oxide, magnesium oxide, magnesium carbonate, magnesium hydroxide, calcium carbonate, calcium hydroxide, calcium silicate, magnesium silicate, barium titanate, barium sulfate, aluminum hydroxide, aluminum oxide, zirconium oxide, and silicon oxide. One of these is preferably used alone, or a combination of two or more types thereof are preferably used. Examples of the resin material include a resin material whose main component is a thermosetting resin such as an epoxy resin, an epoxy-modified resin, a silicone resin, a silicone-modified resin, and a phenol resin.

Method of Manufacturing Light-Emitting Device **1**

[0086] A method of manufacturing the light-emitting device **1** according to the first embodiment is described below. The method of manufacturing the light-emitting device **1** according to the first embodiment includes preparing the substrate **10**, forming the insulating layer **20**, forming the Ti layer **31**, forming the TiN layer **33**, forming the TiW layer **35**, forming the metal layer **37**, forming the resist layer **55**, disposing the light-emitting element **50**, bonding the conductive member **40** and the electrode **52** of the light-emitting element **50**, removing the resist layer **55**, and etching at least a part of the TiW layer **35**. For convenience of explanation, the method of manufacturing the light-emitting device **1** according to the first embodiment is described using an example form in the region corresponding to a particular unit region III described with reference to FIG. **3**, but the same applies to other unit regions III.

Preparing Substrate **10**

[0087] Preparing the substrate **10** is described with reference to FIGS. **5**A and **5**B. FIG. **5**A schematically illustrates a top view of the region of the upper surface corresponding to the unit region III of the substrate **10**. FIG. **5**B schematically illustrates a cross section taken along line VB-VB illustrated in FIG. **5**A. As illustrated in FIGS. **5**A and **5**B, the prepared substrate **10** includes the base material **11** and the Cu wiring line **12** disposed on the upper surface **11***a* side of the base material **11**. A plurality of recessed portions is formed on the upper surface **11***a* of the base material **11**, and the Cu wiring line **12** is disposed in each recessed portion. Subsequent to disposing Cu in the recessed portion of the upper surface **11***a* of the base material **11**, the surface can be planarized by polishing, grinding, or the like and used as the Cu wiring line **12**.

Forming Insulating Layer **20**

[0088] Subsequently, the insulating layer **20** is formed. Forming the insulating layer **20** is described with reference to FIGS. **6**A and **6**B. FIG. **6**A schematically illustrates the upper surface of the region corresponding to the unit region III in an intermediate including the substrate **10** and the insulating layer **20**. FIG. **6**B schematically illustrates a cross section taken along line VIB-VIB illustrated in FIG. **6**A.

[0089] As illustrated in FIGS. **6**A and **6**B, the insulating layer **20** is formed on the substrate **10**. Examples of the method of forming the insulating layer **20** include chemical vapor deposition (CVD), sputtering, and the like. At this time, the insulating layer **20** is formed so that the opening **21** is disposed on at least a part of the upper surface **12***a* of the Cu wiring line **12**. For example, by disposing a mask in a region corresponding to the opening **21** and forming the insulating layer **20** in a region other than the mask is disposed on the substrate **10**, the opening **21** can be formed on at least a part of the upper surface **12***a* of the Cu wiring line **12**. The opening **21** can also be formed on at least a part of the upper surface **12***a* of the Cu wiring line **12** by, for example, removing the region corresponding to the opening **21** subsequent to forming the insulating layer **20** uniformly on the substrate **10**. Preferably, only the Cu wiring line **12** is exposed from the opening **21** and the interface between the Cu wiring line **12** and the base material **11** is not exposed from the opening **21**. This is because the interface between the Cu wiring line **12** and the base material **11** is covered with the insulating layer **20**, which suppresses penetration of corrosive substances such as moisture, sulfur and sulfur compounds, and oxygen into the lateral and bottom surfaces of the Cu wiring line **12**.

Forming Ti Layer **31**

[0090] Subsequently, the Ti layer **31** is formed. Forming the Ti layer **31** is described with reference to FIGS. **7**A and **7**B. FIG. **7**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, and the Ti layer **31**. FIG. **7**B schematically illustrates a cross section taken along line VIIB-VIIB illustrated in FIG. **7**A.

[0091] As illustrated in FIGS. **7**A and **7**B, the Ti layer **31** is formed so as to cover the upper surface **12***a* of the Cu wiring line **12**. That is, the region of the upper surface **12***a* of the Cu wiring line **12** overlapping the opening **21** in a top view is covered with the Ti layer **31**. This allows the upper surface **12***a* of the Cu wiring line **12** to be covered with the insulating layer **20** or the Ti layer **31**. The Ti layer **31** can be formed so as to cover the inner surface **21***a* of the insulating layer **20** defining the opening **21**. Furthermore, the Ti layer **31** can be formed so as to cover a part of the upper surface of the insulating layer **20** continuous with the inner surface **21***a*. Examples of the method of forming the Ti layer **31** include sputtering, vacuum deposition, the CVD, atomic layer deposition (ALD), and the like. At this time, the Ti layer **31** preferably covers not only the exposed Cu wiring line **12** but also a part of the insulating layer **20** on the outer periphery of the exposed Cu wiring line **12**. This allows the Ti layer **31** to completely cover the Cu wiring line **12** exposed from the insulating layer **20**. In particular, the corrosion of the Cu wiring line **12** can be suppressed by reducing corrosive substances such as sulfur which enter through the outer periphery of the Ti layer **31** along the interface between the Ti layer **31** and the insulating layer **20**. This is because the entry path for corrosive substances or the like can be made longer.

Forming TiN Layer **33**

[0092] Subsequently, the TiN layer **33** is formed. With reference to FIGS. **8**A and **8**B, forming the TiN layer **33** is described. FIG. **8**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the Ti layer **31**, and the TiN layer **33**. FIG. **8**B schematically illustrates a cross section taken along line VIIIB-VIIIB illustrated in FIG. **8**A

[0093] As illustrated in FIGS. **8**A and **8**B, the TiN layer **33** is formed on the Ti layer **31**. The TiN layer **33** can be formed so as to cover the upper surface of the Ti layer **31** entirely or partially. However, in the case of partially covering the upper surface of the Ti layer **31**, the TiN layer **33** is preferably formed so as to cover at least a region of the upper surface of the Ti layer **31** overlapping the opening **21** in a top view. Examples of the method of forming the TiN layer **33** include sputtering, vacuum deposition, the CVD, the ALD, and the like.

Forming TiW Layer **35**

[0094] Subsequently, the TiW layer **35** is formed. Forming the TiW layer **35** is described with reference to FIGS. **9**A and **9**B. FIG. **9**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the Ti layer **31**, the TiN layer **33**, and the TiW layer **35**. FIG. **9**B schematically illustrates a cross section taken along line IXB-IXB illustrated in FIG. **9**A.

[0095] As illustrated in FIGS. **9**A and **9**B, the TiW layer **35** is formed over the TIN layer **33**. Here, the TiW layer **35** can also function as a seed layer for plate growing the conductive member **40**.

Therefore, the TiW layer **35** is formed so as to correspond to a current path for plate growing the conductive member **40**. For example, as illustrated in FIG. **9**A, the TiW layer **35** is formed so as to include two regions **35**Y**1** and **35**Y**2** extending in the Y axis direction and two regions **35**X**1** and **35**X**2** extending in the X axis direction and intersecting with the regions **35**Y**1** and **35**Y**2**, respectively. In a top view, the regions **35**Y**1** and **35**Y**2** overlap the TiN layer **33**. The regions **35**X**1** and **35**X**2** are respectively connected to the regions **35**X**1** and **35**X**2** of the TiW layer **35** in the adjacent unit region III. Examples of the method of forming the TiW layer **35** include sputtering, vacuum deposition, the CVD, the ALD, and the like.

[0096] The thickness of the TiN layer **33** is smaller than that of the TiW layer **35**. Since the entire surfaces of the Ti layer **31** and the TiN layer **33** are covered with the TiW layer **35**, an etchant comes into contact with the TiN layer **33** subsequent to etching the TiW layer **35**. This is because a process margin can be provided for the etching of the TiN layer **33**.

Forming Metal Layer **37**

[0097] Subsequently, the metal layer **37** is formed. Forming the metal layer **37** is described with reference to FIGS. **10**A and **10**B. FIG. **10**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the Ti layer **31**, the TiN layer **33**, the TiW layer **35**, and the metal layer **37**. FIG. **10**B schematically illustrates a cross section taken along line XB-XB illustrated in FIG. **10**A.

[0098] As illustrated in FIGS. **10**A and **10**B, the metal layer **37** is formed over the TiW layer **35**. The metal layer **37** contains at least one of Au, Pt, Ru, Pd, or Rh. Similarly to the TiW layer **35**, the metal layer **37** can also function as a seed layer for plate growing the conductive member **40** which will be described separately. Therefore, the metal layer **37** is preferably formed so as to overlap the TiW layer **35** in a top view. For example, as illustrated in FIG. **10**A, the metal layer **37** is formed so as to include two regions **37**Y**1** and **37**Y**2** extending in the Y axis direction and two regions **37**X**1** and **37**X**2** extending in the X axis direction and intersecting with the regions **37**Y**1** and **37**Y**2**, respectively. The regions **37**X**1** and **37**X**2** are connected to the regions **37**X**1** and **37**X**2** of the metal layer **37** in the adjacent unit region III, respectively. Examples of the method of forming the metal layer **37** include sputtering, vacuum deposition, the CVD, the ALD, and the like.

Forming Resist Layer **55**, Disposing Light-Emitting Element **50**

[0099] Subsequently, the resist layer **55** is formed and the light-emitting element **50** is disposed. With reference to FIGS. **11**A and **11**B, forming the resist layer **55** and disposing the light-emitting element **50** are described. FIG. **11**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the Ti layer **31**, the TiN layer **33**, the TiW layer **35**, the metal layer **37**, and the light-emitting element **50**. FIG. **11**B schematically illustrates a cross section taken along line XIB-XIB illustrated in FIG. **11**A.

[0100] Prior to disposing the light-emitting element **50**, the resist layer **55** extending from the upper surface of the insulating layer **20** to the +Z side is formed as illustrated in FIG. **11**B. Examples of the method of forming the resist layer **55** includes photolithography. However, the method of forming the resist layer **55** is not limited thereto.

[0101] Subsequent to forming the resist layer **55**, the light-emitting element **50** is disposed on the metal layer **37** using a conveying means of choice. At this time, the lower surface of the semiconductor structure **51** in the light-emitting element **50** is supported on the upper surface of the resist layer **55**. Accordingly, the light-emitting element **50** is disposed at a position separated from the metal layer **37**. The electrode **52** disposed on the lower surface side of the light-emitting element **50** is located at a position separated from the metal layer **37** and faces the metal layer **37**.

Bonding Conductive Member **40** and Electrode **52** of Light-Emitting Element **50**, Removing Resist Layer **55**

[0102] Subsequently, the conductive member **40** and the electrode **52** of the light-emitting element **50** are bonded. With reference to FIGS. **12**A and **12**B, bonding the conductive member **40** and the electrode **52** of the light-emitting elements **50** and removing the resist layer **55** are described. FIG. **12**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the Ti layer **31**, the TiN layer **33**, the TiW layer **35**, the metal layer **37**, the light-emitting element **50**, and the conductive member **40**. FIG. **12**B schematically illustrates a cross section taken along line XIIB-XIIB illustrated in **12**A.

[0103] As illustrated in FIGS. **12**A and **12**B, the conductive member **40** is formed on the metal layer **37**. The conductive member **40** contains Au. Examples of the method of forming the conductive member **40** include plating. For example, the conductive member **40** is formed using electrolytic plating. The conductive member **40** is plate grown using the TiW layer **35** and the metal layer **37** as seed layers.

[0104] When the conductive member **40** is formed by electrolytic plating, each of the intermediate and the metal electrode before the conductive member **40** is formed is immersed in an electrolytic plating solution. Subsequently, the outside voltage is applied to the intermediate and the metal electrode so that the TiW layer **35** and the metal layer **37** of the intermediate serve as a cathode and the metal electrode serves as an anode. Thus, the conductive member **40** extending to the +Z side is formed on the metal layer **37**. That is, the upper surface of the conductive member **40** is in contact with the lower surface of the electrode **52**. Thus, the conductive member **40** and the electrode **52** can be bonded. Subsequent to bonding the conductive member **40** and the electrode **52**, the resist layer **55** is removed. For example, the resist layer **55** is removed using a stripper solution or the like.

Etching at Least Part of TiW Layer **35**

[0105] Subsequently, at least a part of the TiW layer **35** is etched. With reference to FIGS. **13**A and **13**B, at least a part of the TiW layer **35** is etched. FIG. **13**A schematically illustrates the upper surface of the region corresponding to the unit region III in the light-emitting device **1**. FIG. **13**B schematically illustrates a cross section taken along line XIIIB-XIIIB illustrated in FIG. **13**A.

[0106] Prior to etching at least a part of the TiW layer **35**, a part of the metal layer **37** can be etched. Examples of the method of etching a part of the metal layer **37** include wet etching using an etchant that removes a material constituting the metal layer **37**. Since the etching of the metal layer **37** is performed using the conductive member **40** as a mask, a part of the metal layer **37** not overlapping the conductive member **40** in a top view is removed as illustrated in FIG. **13**B. In addition, a part of the region of the metal layer **37** overlapping the conductive member **40** in a top view can be removed by side etching.

[0107] Subsequent to etching a part of the metal layer **37**, at least a part of the TiW layer **35** is etched. Examples of the method of etching at least a part of the TiW layer **35** include wet etching using an etchant that removes TiW layer **35**. Examples of the etchant for removing the TiW layer **35** is a hydrogen peroxide-based etchant. However, the etchant for removing the TiW layer **35** is not limited thereto. Since the etching of the TiW layer **35** is performed using the conductive member **40** as a mask, a part of the TiW layer **35** not overlapping the conductive member **40** in a top view is removed as illustrated in FIG. **13**B. In addition, a part of the region of the TiW layer **35** overlapping the conductive member **40** in a top view can be removed by side etching. By etching the metal layer **37** and the TiW layer **35**, the plurality of the light-emitting elements **50** become electrically independent from each other.

[0108] As illustrated in FIG. **13**B, the region overlapping the opening **21** in a top view on the upper surface **12**_a_ of the Cu wiring line **12** is covered with the Ti layer **31**. In addition, in the example illustrated in FIG. **13**B, the region of the upper surface **12**_a_ of the Cu wiring line **12** overlapping the opening **21** in a top view is further covered with the TiN layer **33**. As a result, even when a part of the region of the TiW layer **35** overlapping the conductive member **40** in a top view is removed by side etching, the path connecting the outside and the Cu wiring line **12** is not formed. As a result, the possibility of the Cu wiring line **12** coming into contact with corrosive substances can be reduced. That is, the corrosion of the Cu wiring line **12** can be suppressed.

[0109] Through these steps, the light-emitting device **1** is obtained. However, the method of manufacturing the light-emitting device **1** can include other steps as appropriate. The method of manufacturing the light-emitting device **1** can include, for example, forming the light shielding member **80** between the opposing lateral surfaces of adjacent light-emitting elements **50** and between the substrate **10** and the light-emitting element **50**, forming the wavelength conversion member **90** on the light-emitting element **50**, disposing the wire line **70** electrically connecting the substrate **10** and the package substrate **60**, forming the covering member **95** covering the wire line **70**, and the like.

Second Embodiment

[0110] A configuration example of a light-emitting device **1**A according to a second embodiment will be described with reference to FIGS. **14** to **16**. FIG. **1** is a perspective view schematically illustrating the light-emitting device **1** according to the first embodiment. FIG. **14** is an enlarged schematic cross-sectional view for describing the configuration example in the unit region III of the light-emitting device **1**A according to the second embodiment. FIG. **14** also illustrates, in a perspective manner, the electrode **52** of the light-emitting element **50**, the opening **21** of the insulating layer **20**, and the conductive member **40** surrounded by the unit region III. FIG. **15** is a cross-sectional view schematically illustrating a cross section taken along line XV-XV illustrated in FIG. **14**. FIG. **16** is a cross-sectional view schematically illustrating a cross section taken along line XVI-XVI illustrated in FIG. **14**. In the second embodiment, the components that are the same as those described above in the first embodiment will be denoted by the same reference numerals, and redundant descriptions thereof will be omitted as appropriate.

Overall Configuration of Light-Emitting Device **1**A

[0111] The light-emitting device **1**A includes the substrate **10**, the insulating layer **20**, a foundation layer **30**A, the metal layer **37**, the conductive member **40**, and the light-emitting element **50**. The second embodiment differs from the first embodiment in that the foundation layer **30**A is provided. The foundation layer **30**A is disposed on the −Z side of the conductive member **40**. The foundation layer **30**A also reduces the Cu wiring line **12** of the substrate **10** coming into contact with corrosive substances. The metal layer **37** is disposed between the foundation layer **30**A and the conductive member **40**.

[0112] The foundation layer **30**A can have a single-layer structure composed of one kind of metal or alloy, or can have a multilayer structure in which two or more kinds of layers composed of different kinds of metals or alloys are stacked. For example, the foundation layer **30**A includes a TiW layer **35**A and a first Ti layer **31**A. In the example illustrated in FIG. **15**, the foundation layer **30**A further includes a Pt layer **39**. However, the configuration of the foundation layer **30**A is not limited thereto.

TiW Layer **35**A

[0113] The TiW layer **35**A is a layer containing titanium and tungsten as main components thereof. In the TiW layer **35**A, the composition ratio of titanium and tungsten is not limited. The TiW layer **35**A can contain an element other than titanium and tungsten. The TiW layer **35**A can function as a seed layer for growing the conductive member **40**.

[0114] In the example illustrated in FIG. **15**, the TiW layer **35**A has an upper surface **35**A**1**, a lower surface **35**A**2**, an outer lateral surface **35**A**3**, an inner lateral surface **35**A**4**, and an inner bottom surface **35**A**5**. The outer lateral surface **35**A**3** defines an outer edge of the TiW layer **35**A. The outer lateral surface **35**A**3** is located between the upper surface **35**A**1** of the TiW layer **35**A and the upper surface of the insulating layer **20**. The inner lateral surface **35**A**4** of the TiW layer **35**A is located between the upper surface **35**A**1** and the inner bottom surface **35**A**5**.

[0115] The TiW layer **35**A covers the upper surface **12***a* of the Cu wiring line **12**. More specifically, the TiW layer **35**A covers a region of the upper surface **12***a* of the Cu wiring line **12** overlapping the opening **21** in a top view. The TiW layer **35**A also covers the inner surface **21***a* of the insulating layer **20** defining the opening **21**. The TiW layer **35**A also covers a part of the upper surface of the insulating layer **20** continuous with the inner surface **21***a*. This allows the TiW layer **35**A to cover the region of the upper surface **12***a* of the Cu wiring line **12** overlapping the opening **21** in a top view. As a result, formation of the path connecting the outside and the Cu wiring line **12** can be suppressed. This reduces the possibility of the Cu wiring line **12** coming into contact with corrosive substances such as sulfur and sulfur compounds. That is, corrosion such as sulfurization of the Cu wiring line **12** can be suppressed.

First Ti Layer **31**A

[0116] The first Ti layer **31**A is a layer made of titanium. The first Ti layer **31**A covers each of the upper surface **35**A**1** and the outer lateral surface **35**A**3** of the TiW layer **35**A. The first Ti layer **31**A can cover each of the inner lateral surface **35**A**4** and the inner bottom surface **35**A**5** of the TiW layer **35**A. The first Ti layer **31**A at least covers each of the upper surface **35**A**1** and the outer lateral surface **35**A**3** of the TiW layer **35**A, which further suppresses the formation of the path connecting the outside and the Cu wiring line **12**.

[0117] As illustrated in FIG. **15**, the first Ti layer **31**A covers the region of the upper layer of the insulating layer **20** adjacent to the outer lateral surface **35**A**3** of the TiW layer **35**A. The outer lateral surface **31**A**3** defining the outer edge of the first Ti layer **31**A is located on the insulating layer **20**. For example, in a top view, the outer lateral surface **31**A**3** of the first Ti layer **31**A is located closer to the center of the first Ti layer **31**A than the outer lateral surface **39**A**3** of the Pt layer **39** is. The outer lateral surface **31**A**3** of the first Ti layer **31**A corresponds to the outer lateral surface of the foundation layer **30**A. In other words, the foundation layer **30**A includes a recessed portion **30**A**1** that is recessed toward the center of the foundation layer **30**A in a top view from at least a part of the region of the outer lateral surface of the foundation layer **30**A.

[0118] As illustrated in FIG. **16**, a recessed portion **30**A**2** recessed toward the center of the first Ti layer **31**A is also provided in the outer lateral surface **31**A**4** located at a position different from the position of the outer lateral surface **31**A**3** in the first Ti layer **31**A. The outer lateral surface **31**A**4** of the first Ti layer **31**A corresponds to another outer lateral surface of the foundation layer **30**A. That is, the foundation layer **30**A further includes another recessed portion **30**A**2** located at a position different from the position of the recessed portion **30**A**1**.

[0119] A part of the light shielding member **80** is also located in the recessed portions **30**A**1** and **30**A**2**. That is, the light shielding member **80** located in the recessed portions **30**A**1** and **30**A**2** and the +Z side region of the foundation layer **30**A face each other in the Z axis direction. Therefore, even when a force acting upward on the light shielding member **80** is generated, the separation of the light shielding member **80** from the substrate **10** can be further suppressed.

Pt Layer **39**

[0120] As illustrated in FIGS. **15** and **16**, the Pt layer **39** is disposed between the first Ti layer **31**A and the metal layer **37**. Since the foundation layer **30**A includes the Pt layer **39**, the corrosion of the Cu wiring line **12** can be further suppressed.

Other

[0121] The foundation layer **30**A can further include a TiN layer and a second Ti layer between the first Ti layer **31**A and the Pt layer **39**. The TiN layer is preferably disposed on the first Ti layer **31**A. The TiN layer can further suppress the corrosion of the Cu wiring line **12**. The second Ti layer is preferably disposed on the TIN layer. The second Ti layer can function as an adhesion layer between the TiN layer and the metal layer **37**.

Method of Manufacturing Light-Emitting Device **1**A

[0122] Subsequently, a method of manufacturing the light-emitting device **1**A according to the second embodiment is described below. The method of manufacturing the light-emitting device **1**A according to the second embodiment includes preparing the substrate **10**, forming the insulating layer **20**, forming the first TiW layer and the second TiW layer, forming the first Ti layer **31**A, forming the metal layer **37**, forming the resist layer **55**, disposing the light-emitting element **50**, bonding the conductive member **40** and the electrode **52** of the light-emitting element **50**, removing the resist layer **55**, and etching the second TiW layer. For convenience of description, the method of manufacturing the light-emitting device **1**A according to the second embodiment is described using an example form in the region corresponding to a particular unit region III, but the same applies to other unit regions III.

[0123] The preparing of the substrate **10**, the forming of the insulating layer **20**, the forming of the metal layer **37**, the forming of the resist layer **55**, the disposing of the light-emitting element **50**, the bonding of the conductive member **40** and the electrode **52** of the light-emitting element **50**, and the removing of the resist layer **55** are the same as or similar to those in the first embodiment, and thus description thereof will be omitted.

Forming First TiW Layer and Second TiW Layer

[0124] Subsequent to forming the insulating layer **20**, the first TiW layer and the second TiW layer are formed. With reference to FIGS. **17**A and **17**B, forming the first TiW layer and the second TiW layer is described. The fist TiW layer corresponds to the TiW layer **35**A described with reference to FIGS. **15** and **16**. Hereinafter, the first TiW layer will be referred to as the “first TiW layer **35**A”. The second TiW layer will be referred to as the “second TiW layer **35**B”. FIG. **17**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the first TiW layer **35**A, and the second TiW layer **35**B. FIG. **17**B schematically illustrates a cross section taken along line XVIIB-XVIIB illustrated in FIG. **17**A.

[0125] As illustrated in FIGS. **17**A and **17**B, the second TiW layer **35**A is formed so as to cover the upper surface **12***a* of the Cu wiring line **12**. That is, a region of the upper surface **12***a* of the Cu wiring line **12** overlapping the opening **21** in a top view is covered with the first TiW layer **35**A. Thus, the upper surface **12***a* of the Cu wiring line **12** is covered with the insulating layer **20** or the first TiW layer **35**A. The first TiW layer **35**A is formed so as to cover the inner surface **21***a* of the insulating layer **20** defining the opening **21**. In addition, the first TiW layer **35** is formed to cover a part of the upper surface of the insulating layer **20** continuous with the inner surface **21***a*. The method of forming the first TiW layer **35**A can be the same as the method for forming the TiW layer **35** of the first embodiment.

[0126] The second TiW layer **35**B is formed at a timing the same as or different from the timing of forming the first TiW layer **35**A. As illustrated in FIG. **17**A, the second TiW layer **35**B is formed on the upper surface of the insulating layer **20** at a position separated from the first TiW layer **35**A. In the example illustrated in FIG. **17**A, seven second TiW layers **35**B are formed, but the number of the second TiW layers **35**B is not limited thereto. The second TiW layers **35**B are respectively formed at positions separated from each other on the upper surface of the insulating layer **20**. The method of forming the second TiW layer **35**B can be the same as the method for forming the TiW layer **35** of the first embodiment.

Forming First Ti Layer **31**A

[0127] Subsequently, the first Ti layer **31**A is formed. With reference to FIGS. **18**A and **18**B, forming the first Ti layer **31**A is described. FIG. **18**A schematically illustrates the upper surface of the region corresponding to the unit region III in the intermediate including the substrate **10**, the insulating layer **20**, the first TiW layer **35**A, the second TiW layer **35**B, and the first Ti layer **31**A. FIG. **18**B schematically illustrates a cross section taken along line XVIIIB-XVIIIB illustrated in FIG. **18**A.

[0128] As illustrated in FIGS. **18**A and **18**B, the first TiW layer **31**A is formed so as to cover the upper surface **35**A**1** of the first TiW layer **35**A and the outer lateral surface **35**A**3** of the first TiW layer **35**A located between the upper surface **35**A**1** of the first TiW layer **35**A and the upper surface of the insulating layer **20** (see FIG. **18**B). The first Ti layer **31**A is formed so as to cover a part of the second TiW layer **35**B (see FIG. **18**A). The second TiW layer **35**B has a region overlapping the first Ti layer **31**A and a region not overlapping the first Ti layer **31**A in a top view.

[0129] In forming the metal layer **37** subsequent to forming the first Ti layer **31**A, the metal layer **37** is formed on the first Ti layer **31**A. The second TiW layer **35**B has a region overlapping the metal layer **37** and a region not overlapping the metal layer **37** in a top view. As a result, a current path is formed for plate growing the conductive member **40**, including the first Ti layer **31**A, the first TiW layer **35**A, the second TiW layer **35**B, and the metal layer **37**. The method of forming the first Ti layer **31**A can be the same as the method for forming the Ti layer **31** of the first embodiment. The Pt layer **39** can be formed between forming the first Ti layer **31**A and forming the metal layer **37**. Thus, the Pt layer **39** is disposed between the first Ti layer **31**A and the metal layer **37**.

Etching Second TiW Layer **35**B

[0130] Subsequently, the second TiW layer **35**B is etched. With reference to FIGS. **19**A to **19**C, etching the second TiW layer **35**B is described. FIG. **19**A schematically illustrates the upper surface of the region corresponding to the unit region III in the light-emitting device **1**A. FIG. **19**B schematically illustrates a cross section taken along line XIXB-XIXB illustrated in FIG. **19**A. FIG. **19**C schematically illustrates a cross section taken along line XIXC-XIXC illustrated in FIG. **19**A.

[0131] The second TiW layer **35**B is etched by wet etching using a predetermined etchant. At this time, as illustrated in FIGS. **19**A and **19**B, the first TiW layer **35**A is located at a position separated from the second TiW layer **35**B and is covered with the first Ti layer **31**A. Therefore, when the second TiW layer **35**B is etched, the etchant does not reach the first TiW layer **35**A. Thus, the second TiW layer **35**B can be removed, while leaving the first TiW layer **35**A covering the Cu wiring line **12**. In other words, this suppresses the formation of the path continuous with the outside and the Cu wiring line **12**, while making each of the plurality of light-emitting elements **50** be electrically independent. The etchant for etching the second TiW layer **35**B can be the same as or similar to the etchant used for etching a part of the TiW layer **35** in the first embodiment.

[0132] The etchant for etching the second TiW layer **35**B can slightly remove the first Ti layer **31**A. Therefore, when the second TiW layer **35**B is etched, the outer lateral surface **31**A**3** of the first Ti layer **31**A is slightly removed. As a result, as illustrated in FIG. **19**B, the outer lateral surface **31**A**3** of the first Ti layer **31**A is located closer to the center of the first Ti layer **31**A than the outer lateral surface **39**A**3** of the Pt layer **39** is, for example. The region of the first Ti layer **31**A removed with the etchant for etching the second TiW layer **35**B corresponds to the recessed portion **30**A**1** of the foundation layer **30**A described with reference to FIG. **15**.

[0133] As the second TiW layer **35**B is etched, the area of the second TiW layer **35**B overlapping the first Ti layer **31**A in a top view is also removed. That is, before etching, a region in which the second TiW layer **35**B and the first Ti layer **31**A overlap each other in a top view becomes a cavity by etching the second TiW layer **35**B. For example, in the example illustrated in FIG. **19**C, a cavity recessed toward the center of the first Ti layer **31**A is formed in the outer lateral surface **31**A**4** of the first Ti layer **31**A. This cavity corresponds to the recessed portion **30**A**2** of the foundation layer **30**A described with reference to FIG. **16**.

[0134] In disposing the light shielding member **80** subsequent to forming the second TiW layer **35**B, a part of the light shielding member **80** is also located in the recessed portions **30**A**1** and **30**A**2**. Accordingly, the light shielding member **80** located in the recessed portions **30**A**1** and **30**A**2** and the +Z side region of the foundation layer **30**A face each other in the Z axis direction. As a result, even when a force acting upward on the light shielding member **80** is generated, the separation of the light shielding member **80** from the substrate **10** can be suppressed.

[0135] Through these steps, the light-emitting device **1**A is obtained. The method of manufacturing the light-emitting device **1**A can further include other steps. In the method of manufacturing the light-emitting device **1**A, the “forming of the first TiW layer **35**A and the second TiW layer **35**B” is replaced with the “forming of the first foundation layer and the second foundation layer”. The “etching of the second TiW layer **35**B” can be replaced with the “etching the second foundation layer”.

[0136] The first foundation layer corresponds to a layer including the first TiW layer **35**A. The second foundation layer corresponds to a layer including the second TiW layer **35**B. However, the first foundation layer is not limited to the configuration including the first TiW layer **35**A. The second foundation layer is not limited to the configuration including the second TiW layer **35**B.
[0137] Although the preferred embodiments and the like have been described in detail above, the disclosure is not limited to the above-described embodiments and the like, various modifications and substitutions can be made to the above-described embodiments and the like without departing from the scope described in the claims.

Claims

1. A light-emitting device, comprising: a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a Ti layer covering at least the upper surface of the Cu wiring line; a TiN layer disposed on the Ti layer; a TiW layer disposed on the TiN layer; a metal layer disposed on the TiW layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element comprising an electrode disposed on the conductive member.
2. The light-emitting device according to claim 1, wherein a thickness of the TiW layer is smaller than a thickness of the metal layer.
3. The light-emitting device according to claim 1, wherein a thickness of the TiN layer is smaller than the thickness of the TiW layer.
4. The light-emitting device according to claim 1, wherein, in a top view, an outer edge of the TiW layer is located closer to a center of the metal layer than an outer edge of the metal layer is to the center of the metal layer.
5. A light-emitting device, comprising: a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a TiW layer covering the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of an upper surface of the insulating layer continuous with the inner surface; a first Ti layer covering an upper surface of the TiW layer, and covering an outer lateral surface of the TiW layer located between the upper surface of the TiW layer and the upper surface of the insulating layer; a metal layer disposed on the first Ti layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element comprising an electrode disposed on the conductive member.
6. The light-emitting device according to claim 5, further comprising: a Pt layer disposed between the first Ti layer and the metal layer, wherein the metal layer is made of Au.
7. The light-emitting device according to claim 5, further comprising: a TiN layer disposed on the first Ti layer; and a second Ti layer disposed on the TiN layer.
8. A light-emitting device, comprising: a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; an insulating layer disposed on the substrate and having an opening on at least a part of an upper surface of the Cu wiring line; a foundation layer covering the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of an upper surface of the insulating layer continuous with the inner surface; a metal layer disposed on the foundation layer and containing at least one of Au, Pt, Ru, Pd, or Rh; a conductive member disposed on the metal layer and containing Au; and a light-emitting element comprising an electrode disposed on the conductive member, wherein, in the foundation layer, a portion covering a part of the upper surface of the insulating layer comprises an outer lateral surface defining an outer edge of the foundation layer, and a recessed portion recessed toward a center of the foundation layer in a top view from at least a part of a region of the outer

lateral surface.

9. A method of manufacturing a light-emitting device, comprising: preparing a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a Ti layer so as to cover at least the upper surface of the Cu wiring line; forming a TiN layer on the Ti layer; forming a TiW layer on the TiN layer; forming a metal layer on the TiW layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer; disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching at least a part of the TiW layer that does not overlap the conductive member in a top view.

10. A method of manufacturing a light-emitting device, the method comprising: preparing a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a first TiW layer and a second TiW layer, the first TiW layer being formed to cover each of the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of the upper surface of the insulating layer continuous with the inner surface, and the second TiW layer being formed on the upper surface of the insulating layer at a position separated from the first TiW layer; forming a first Ti layer so as to cover an upper surface of the first TiW layer and an outer lateral surface of the first TiW layer located between the upper surface of the first TiW layer and the upper surface of the insulating layer; forming a metal layer on the first Ti layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer; disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching the second TiW layer.

11. A method of manufacturing a light-emitting device, the method comprising: preparing a substrate comprising a base material and a Cu wiring line disposed on an upper surface side of the base material; forming an insulating layer on the substrate so that an opening is formed on at least a part of an upper surface of the Cu wiring line; forming a first foundation layer and a second foundation layer, the first foundation layer being formed to cover each of the upper surface of the Cu wiring line, an inner surface of the insulating layer defining the opening, and a part of the upper surface of the insulating layer continuous with the inner surface, and the second foundation layer being formed on the upper surface of the insulating layer at a position separated from the first foundation layer; forming a metal layer on at least the first foundation layer, the metal layer containing at least one of Au, Pt, Ru, Pd, or Rh; forming a resist layer on at least a part of the insulating layer, disposing a light-emitting element on the resist layer at a position separated from the metal layer; forming a conductive member containing Au on the metal layer by plating and bonding the conductive member and an electrode of the light-emitting element; removing the resist layer; and etching the second foundation layer.