

TITLE OF THE INVENTION

CONDUCTIVE FILM, METHOD FOR PRODUCING SAME, AND SPUTTERING
TARGET USED FOR SAME

BACKGROUND OF THE INVENTION

[Field of the Invention]

[0001] The present invention relates to a conductive film suitably used for a reflective electrode film for an organic light-emitting diode (OLED) element or a light-emitting diode (LED), a wiring film for a touch panel, or the like, a method for producing the conductive film, and a sputtering target used for the conductive film.

[Description of the Related Art]

[0002] In general, an organic EL display device is constructed such that an OLED element including an anode (positive electrode) and a cathode (negative electrode), which are arranged on both sides of an electroluminescent layer including an organic EL layer, on a TFT active matrix substrate on which a thin film transistor (hereinafter referred to as "TFT") serving as a switching element is disposed is formed in each pixel region.

[0003] The light extraction method used for an OLED element includes the bottom emission type that extracts light emitted from a transparent substrate and the top emission type that extracts light to the opposite side of the substrate. Since a high aperture ratio can be obtained

in the top emission type, the top emission type is advantageous for obtaining higher luminance. Conventionally, in the top emission type OLED element, a reflective electrode film made of Al, Al alloy, Ag, or Ag alloy is used as the metal film of an anode, and a transparent conductive film made of Indium Tin Oxide (hereinafter referred to as "ITO"), Aluminum doped Zinc Oxide (hereinafter referred to as "AZO"), or the like is disposed between the reflective electrode film and an electroluminescent layer (see Patent Document 1). The transparent conductive film having high work function characteristics is provided to inject positive holes to an organic EL layer.

[0004] Here, in order to efficiently reflect light emitted from an organic EL layer, it is preferable that a reflection electrode film exhibits high reflectivity. It is also preferable that the reflection electrode film has a low resistance as an electrode. Such materials known include Ag alloy and Al alloy. In order to obtain an OLED element having higher luminance, Ag alloy is excellent in high visible light reflection.

Here, a sputtering method is employed for forming a reflection electrode film for an OLED element, and a silver alloy sputtering target is employed (see Patent Document 2).

[0005] In addition to a reflection electrode film for an OLED element, it has also been conventionally investigated to employ an Ag alloy film as a conductive film for a lead-out wiring or the like for a touch panel. When pure Ag is used as such a wiring film, a short-circuit

malfunction readily occurs due to the occurrence of migration. Thus, it has been conventionally investigated to employ an Ag alloy film.

[Prior Art Documents]

[Patent Documents]

[0006] [Patent Document 1] Japanese Patent Laid-Open No. 2006-236839

[Patent Document 2] WO 2002/077317

SUMMARY OF THE INVENTION

[Problems to be solved by the Invention]

[0007] However, the following problems still remain in the conventional techniques described above.

It is required that an Ag alloy film serving as an anode of an OLED element has low resistance and high reflectivity characteristics for a reflection electrode and also has a small surface roughness in order to ensure soundness of a transparent conductive film formed on the upper layer of the Ag alloy film. In other words, when the surface roughness of an Ag alloy film is large, the roughness of the Ag alloy film induces defects in a transparent conductive film formed on the upper layer of the Ag alloy film and an electroluminescent layer including an organic EL layer to be formed in the subsequent step, resulting in a reduction in the production yield of organic EL panels. Also, a sulfur content included in a process atmosphere sulfurizes an Ag alloy film, which induces

defects in the sulfurized region, resulting in a reduction in yield.

As described above, the conventional technique has not achieved to obtain an Ag alloy film having sufficient low resistance, high reflectivity, small surface roughness, and high sulfuration resistance.

Furthermore, when a conductive film is used for a reflection film, a reflective electrode film, or the like composed of an LED, it is required that an Ag alloy film has heat resistance to heat generation by the LED so as to be able to favorably maintain the reflectance thereof, however, the conventional Ag alloy film could not attain sufficient heat resistance.

[0008] The present invention has been made in view of the aforementioned circumstances, and an object of the present invention is to provide a conductive film exhibiting low resistance, high reflectivity characteristics, and small surface roughness and having both high sulfuration resistance and heat resistance; a method for producing the conductive film; and a sputtering target used for the conductive film.

[Means for Solving the Problems]

[0009] The present invention has adopted the following structure in order to solve the aforementioned problems. In other words, a conductive film according to a first aspect of the present invention is characterized in that the conductive film consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least

one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

Since the conductive film consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities, it becomes possible that the conductive film has low resistance and high reflectivity characteristics as well as small surface roughness, high sulfuration resistance and heat resistance due to the presence of In and Sb contained therein.

[0010] Here, the reason why the content of metal component elements in the conductive film of the present invention is limited to the above range is as follows:

At least one of In and Sn:

At least one of In and Sn is added to the conductive film of the present invention because both In and Sn have the effect of reducing surface roughness as well as increasing sulfuration resistance and heat resistance. However, it is not preferable that the effect is not sufficiently exhibited if the content percentage of In or Sn is less than 0.1 at%, whereas the specific resistance of the conductive film increases and the reflectance thereof decreases if the content percentage of In or Sn exceeds 1.5 at%. Thus, the content percentage of at least one of In and Sn of the total metal component elements contained in the conductive film of the present invention is defined in the range of from 0.1 to 1.5 at%.

Sb:

Sb has an extremely large effect of reducing surface roughness and has small effect of reducing reflectance and specific resistance as compared with In and Sn. It is not preferable that the effect of reducing surface roughness becomes weakened if the content percentage of Sb is less than 0.1 at%, whereas the specific resistance of the conductive film increases and the reflectance thereof decreases if the content percentage of Sb exceeds 3.5 at%. Thus, the content percentage of Sb of the total metal component elements contained in the conductive film of the present invention is defined in the range of from 0.1 to 3.5 at%.

[0011] A conductive film according to a second aspect of the present invention is characterized in that the conductive film is a reflective electrode film for an OLED element in which a transparent conductive film for an OLED element is laminated on the surface of the conductive film, and an electroluminescent layer including an organic EL layer is further laminated on the transparent conductive film according to the first aspect of the present invention.

In other words, since a transparent conductive film for an OLED element is laminated on the surface of the conductive film, soundness of the transparent conductive film formed on the upper layer of the conductive film is ensured by the small surface roughness thereof, which prevents the occurrence of defects in the organic EL layer laminated on the transparent conductive film. In addition, the occurrence of defects caused by sulfuration of the

reflective electrode film is suppressed, so that the yield can be prevented from being reduced.

[0012] A conductive film according to a third aspect of the present invention is characterized in that the conductive film is a reflective electrode film for a light-emitting diode according to the first aspect of the present invention.

In other words, since the conductive film is provided with high heat resistance, the conductive film may exhibit heat resistance to heat generation by the LED so as to favorably maintain the reflectance thereof.

[0013] A conductive film according to a fourth aspect of the present invention is characterized in that the conductive film is a wiring film for a touch panel according to the first aspect of the present invention.

In other words, the conductive film has low specific resistance and small surface roughness. Furthermore, the conductive film made of alloy is less susceptible to migration, so that a short-circuit malfunction which is problematic in a wiring film for a touch panel can be avoided.

[0014] A method for producing a conductive film according to a fifth aspect of the present invention is a method for producing the conductive film according to any one of the first to fourth aspects of the present invention and is characterized in that the conductive film is formed by sputtering using a sputtering target consisting of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further

containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

In other words, since the method for producing a conductive film includes a step of sputtering using a silver alloy sputtering target consisting of the same component composition as that of the conductive film of the present invention, the conductive film having small surface roughness, high sulfuration resistance, and heat resistance can be stably obtained.

[0015] A sputtering target according to a sixth aspect of the present invention is a sputtering target used for the method according to the fifth aspect of the present invention and is characterized in that the sputtering target consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

In other words, since the sputtering target has the same component composition as that of the conductive film of the present invention, the conductive film having small surface roughness, high sulfuration resistance, and heat resistance can be stably obtained.

[0016] A sputtering target according to a seventh aspect of the present invention is the sputtering target according to the sixth aspect of the present invention and is characterized in that the sputtering target is produced by a plastic forming process on an ingot formed by melting and casting a silver alloy.

In other words, since the sputtering target has an appropriate structure controlled by the plastic forming process, an excellent conductive film can be obtained by stable sputtering.

[0017] A sputtering target according to an eighth aspect of the present invention is the sputtering target according to the seventh aspect of the present invention and is characterized in that the sputtering target is produced by subjecting an ingot to heat treatment after the ingot is subject to the plastic forming process.

In other words, since the sputtering target has an appropriate structure controlled by heat treatment, an excellent conductive film can be obtained by stable sputtering.

[Effects of the Invention]

[0018] According to the present invention, the following effect may be provided.

According to the conductive film of the present invention and the method for producing the same, since the conductive film consists of a silver alloy having a component composition containing the content of at least one of In and Sn and Sb within the above range with the balance composed of Ag and unavoidable impurities, the conductive film is provided with low resistance and high reflectivity characteristics as well as small surface roughness, high sulfuration resistance, and heat resistance. Thus, the conductive film of the present invention is employed as a reflective electrode film for an OLED element,

so that the occurrence of defects in the transparent conductive film and the organic EL layer due to the roughness or sulfuration of the conductive film can be suppressed, resulting in an improvement in the production yield of organic EL panels.

[Brief Description of the Drawings]

[0019] FIG. 1 is a schematic cross-sectional view illustrating the layer structure of an OLED element according to one embodiment of the conductive film of the present invention, a method for producing the same, and a sputtering target used for the same.

[Best Modes for Carrying Out the Invention]

[0020] Hereinafter, a description will be given of a conductive film according to one embodiment of the present invention, a method for producing the conductive film, and a sputtering target used for the conductive film with reference to FIG. 1.

[0021] The conductive film of the present embodiment consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

As shown in FIG. 1, a conductive film 1 is a reflective electrode film for an OLED element in which a transparent conductive film 2 of an OLED element 10 is laminated on the surface of the conductive film 1 and an

electroluminescent layer 3 including an organic EL layer 3b is further laminated on the transparent conductive film 2.

[0022] In other words, the OLED element 10 including the conductive film 1 is an OLED element that includes an anode 5 formed on a film formation substrate 4, an electroluminescent layer 3 including an organic EL layer 3b formed on the anode 5, and a cathode 6 formed on the electroluminescent layer 3, where the anode 5 has a conductive film 1 and a transparent conductive film 2 formed between the conductive film 1 and the electroluminescent layer 3.

[0023] For example, when an OLED element is formed on a TFT substrate, the film formation substrate 4 to be used is an insulating substrate such as a glass substrate, a heat resistance resin substrate, or the like on which a plurality of insulation films including an SiN film, a SiO₂ film serving as a gate insulation film, and the like is laminated.

The thickness of each layer and film is as follows. For example, the thickness of the electroluminescent layer 3 is from 100 to 200 nm, the thickness of the transparent conductive film 2 is from 10 to 20 nm, and the thickness of the conductive film 1 is 100 nm.

The electroluminescent layer 3 is a three-layered structure in which a hole (positive hole) transporting layer 3a, an organic EL layer 3b, and an electron-transporting layer 3c are sequentially laminated on the anode 5.

[0024] As an organic polymeric material (positive hole injection/transport material) constituting the hole-transporting layer 3a, it is preferable that a compound has a positive hole transport capability, has a positive hole injection effect from the anode 5 and an excellent positive hole injection effect for the organic EL layer 3b or a luminescence material, prevents movement of excitons generated by the organic EL layer 3b to the electron-transporting layer 3c, and has excellent thin-film formation capability.

More specifically, examples of such a compound include phthalocyanine derivatives; naphthalocyanine derivatives; porphyrin derivatives; oxazole, oxadiazole, triazole, imidazole, imidazolon, imidazolethion, pyrazoline, pyrazolone, tetrahydroimidazole, oxazole, oxadiazole, hydrazone, acylhydrazone, polyaryllalkane, stilbene, butadiene, benzidine-type triphenylamine, styrylamine-type triphenylamine, diamine-type triphenylamine, and the like and these derivatives; polymer materials such as polyvinyl carbazole and polysilane; and polymeric materials of a conductive polymer represented by polyethylene dioxy thiophene/polystyrene sulfonate (PEDOT/PSS), polyaniline/camphorsulfonic acid (PANI/CSA), and the like.

[0025] Examples of a luminescence material used for the organic EL layer 3b include low-molecular luminescence materials represented by olefin-type luminescence materials such as 4,4'-(2,2-diphenylvinyl)biphenyl or the like; anthracene-type luminescence materials such as 9,10-di(2-naphthyl)anthracene, 9,10-bis(3,5-diphenylphenyl)anthracene,

9,10-bis(9,9-dimethylfluorenyl)anthracene, 9,10-(4-(2,2-diphenylvinyl)phenyl)anthracene, 9,10'-bis(2-biphenyl)-9,9'-bisanthracene, 9,10,9',10'-tetraphenyl-2,2'-bianthryl, 1,4-bis(9-phenyl-10-anthracenyl)benzene, and the like; spiro-type luminescence materials such as 2,7,2',7'-tetrakis(2,2-diphenylvinyl)spirobifluorene, and the like; carbazole-type luminescence materials such as 4,4'-dicarbazolylbiphenyl, 1,3-dicarbazolylbenzene, and the like; and low-molecular-weight luminescence materials represented by pyrene-type luminescence materials such as 1,3,5-tripyranylbiphenyl and the like; and polymeric luminescence materials represented by polyphenylene vinylenes, polyfluorenes, polyvinyl carbazoles, and the like.

A fluorescent dye or a phosphorescence dye may be doped into the organic EL layer 3b.

[0026] As an electron injection/transport material used for the electron-transporting layer 3c, it is preferable that a compound has an electron transport capability, has an electron injection effect from the cathode 6 and an excellent electron injection effect for the organic EL layer 3b or a luminescence material, prevents movement of excitons generated by the organic EL layer 3b to a positive hole injection layer, and has excellent thin-film formation capability. More specifically, examples of such a compound include fluorenone, anthraquinodimethane, diphenylquinone, thiopyrandioxide, oxazole, oxadiazole, triazole, imidazole, perylene tetracarboxylic acid, fluorenylidene methane,

anthraquinodimethane, anthrone, and the like and these derivatives.

For the transparent conductive film 2, ITO, AZO, and the like may be employed.

[0027] The conductive film 1 of the present embodiment is formed by sputtering using a sputtering target consisting of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities. For example, the conductive film 1 is produced by the following steps.

[0028] Firstly, as starting material powder, Ag with the purity of 99.9 % by mass or greater, at least one of In and Sn with the purity of 99.9 % by mass or greater, and Sb are weighted so as to obtain a predetermined composition. Next, Ag is melted in a high vacuum atmosphere or an inert gas atmosphere, and a predetermined amount of at least one of In and Sn and a predetermined amount of Sb are added to the obtained molten metal. Then, the resulting mixture is melted in a high vacuum atmosphere or an inert gas atmosphere to thereby produce an Ag alloy ingot formed by melting and casting having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

[0029] Here, it is preferable from the viewpoints of stably obtaining the composition ratio of Ag to In, Sn, and Sb that Ag is melted in an atmosphere which is once set in vacuum and then is substituted with Ar, and, after Ag is

melted, at least one of In and Sn and Sb are added to the resulting Ag molten metal in an Ar atmosphere. Furthermore, In, Sn, and Sb may be added in the form of the previously produced master alloy such as AgIn, AgSn, AgSb, AgInSb, AgSnSb, or AgInSnSb.

[0030] The obtained ingot is subject to heat treatment in air at 600 °C for two hours after cold-rolling. Then, the resulting ingot is subject to machining to thereby produce a sputtering target having a predetermined dimension. In other words, the sputtering target is produced by subjecting an ingot formed by melting and casting a silver alloy to heat treatment after the ingot is subject to the plastic forming process.

The sputtering target is soldered to an oxygen-free copper backing plate, and the soldered sputtering target is then attached to a direct-current magnetron sputtering device.

[0031] Next, after the internal pressure of the direct-current magnetron sputtering device is evacuated by a vacuum pumping device to a pressure of 5×10^{-5} Pa or less, Ar gas is introduced into the sputtering device so as to keep a predetermined sputtering gas pressure. Then, the direct-current sputtering power of, for example, 250 W is applied to the target using a direct-current power supply. Furthermore, plasma is generated between the film formation substrate 4, which faces the target and is arranged parallel to the target with a predetermined interval therebetween, and the target, so that the conductive film 1 is deposited on the film formation substrate 4.

[0032] Since the thus-formed conductive film 1 of the present embodiment consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities, it becomes possible that the conductive film has low resistance and high reflectivity characteristics as well as small surface roughness, high sulfuration resistance and heat resistance due to the presence of at least one of In and Sn and Sb contained therein.

[0033] In particular, since the transparent conductive film 2 of the OLED element 10 is laminated on the surface of the conductive film 1, soundness of the transparent conductive film 2 formed on the upper layer of the conductive film 1 is ensured by the small surface roughness thereof, which prevents the occurrence of defects in the organic EL layer 3b laminated on the transparent conductive film 2. In addition, the occurrence of defects caused by sulfuration of the reflective electrode film (the conductive film 1) is suppressed, so that the yield can be prevented from being reduced.

[0034] Since the sputtering target of the present embodiment has the same component composition as that of the conductive film, the conductive film having small surface roughness, high sulfuration resistance, and heat resistance can be stably obtained.

Since the sputtering target has an appropriate structure controlled by the plastic forming process, an

excellent conductive film can be obtained by stable sputtering.

Furthermore, since the sputtering target has an appropriate structure controlled by heat treatment, an excellent conductive film can be obtained by stable sputtering.

[0035] While, in the above embodiment, the conductive film of the present invention is applied to an electrode film for an OLED element, the conductive film of the present invention may also be applied to, for example, a reflective electrode film for a light-emitting diode or a wiring film for a touch panel.

In other words, when the conductive film of the present invention is applied to a reflective electrode film for an LED, the conductive film of the present invention is provided with high heat resistance, and thus, the conductive film may exhibit heat resistance to heat generation by the LED so as to favorably maintain the reflectance thereof.

Also, when the conductive film of the present invention is applied to a wiring film for a touch panel, the conductive film of the present invention has low specific resistance and small surface roughness. Furthermore, the conductive film made of alloy is less susceptible to migration, so that a short-circuit malfunction which is problematic in a wiring film for a touch panel can be avoided.

[Examples]

[0036] A description will be given below of the evaluation results of the conductive film deposited on the basis of the above embodiment in Examples.

Firstly, in order to produce a sputtering target used for a conductive film, as starting material, Ag with the purity of 99.9 % by mass or greater, at least one of In and Sn with the purity of 99.9 % by mass or greater, and Sb were weighted so as to obtain a predetermined composition. Next, Ag was melted in a high vacuum atmosphere or an inert gas atmosphere, and a predetermined amount of at least one of In and Sn and a predetermined amount of Sb were added to the obtained molten metal. Then, the resulting mixture was melted in a high vacuum atmosphere or an inert gas atmosphere to thereby produce an Ag alloy ingot formed by melting and casting having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

[0037] Here, Ag was melted in an atmosphere which was once set in vacuum and then was substituted with Ar, and, after Ag was melted, at least one of In and Sn and Sb were added to the resulting Ag molten metal in an Ar atmosphere.

The obtained ingot was subject to heat treatment in air at 600 °C for two hours after cold-rolling. Then, the resulting ingot was subject to machining to thereby produce a sputtering target having a dimension with a diameter of 152.4 mm and a thickness of 6 mm.

The sputtering target was soldered to an oxygen-free copper backing plate, and the soldered sputtering target

was then attached to a direct-current magnetron sputtering device.

[0038] Next, after the internal pressure of the direct-current magnetron sputtering device was evacuated by a vacuum pumping device to a pressure of 5×10^{-5} Pa or less, Ar gas was introduced into the sputtering device so as to keep a sputtering gas pressure of 0.5 Pa. Then, the direct-current sputtering power of 250 W was applied to the target using a direct-current power supply. Furthermore, plasma is generated between an oxidation film-coated Si wafer substrate having a diameter of 4 inches (10.16 cm), which faces the target and is arranged parallel to the target with an interval of 70 mm, and the target, so that a conductive film was deposited on the oxidation film-coated Si wafer substrate.

[0039] As Examples of the present invention, the conductive films in Examples 1 to 24 each having the component composition shown in Table 1 were formed by the above production method. In each Example, two types of samples having a thickness of 100 nm and a thickness of 1000 nm were produced.

As Comparative Examples, the conductive films having the component compositions (Comparative Examples 1 to 3) without containing In, Sn, or Sb and the conductive films having the component compositions (Comparative Examples 4 to 6) containing In, Sn, or Sb exceeding the content range of the present invention were formed with the component compositions shown in FIG. 1, wherein other conditions were the same as those in Examples of the present invention.

The component compositions of samples in Examples and Comparative Examples having a film thickness of 1000 nm were measured by an electron probe microanalyzer (EPMA).

<Evaluation of Conductive Film>

[0040] For samples having a film thickness of 100 nm, the specific resistances of the conductive films in Examples and Comparative Examples were measured by the four-probe method. Next, the surface roughnesses (Ra) of the conductive films in Examples and Comparative Examples were measured by an atomic force microscope (AFM). Note that the measurement of Ra was also performed after the conductive films were subject to heat treatment in a nitrogen atmosphere at a temperature of 250 °C for 10 minutes and after the conductive films were subject to heat treatment in a nitrogen atmosphere at a temperature of 500 °C for 1 hour.

[0041] The reflectances of the conductive films in Examples and Comparative Examples at a wavelength of 550 nm were measured by a spectrophotometer. Next, the samples were immersed into 0.01 wt% Na₂S solution for 1 hour, and then, the reflectances of the conductive films at a wavelength of 550 nm were measured again by the spectrophotometer to thereby obtain sulfuration resistance indexes. Note that the measurement of reflectance at a wavelength of 550 nm was also performed after the conductive films were subject to heat treatment in a nitrogen atmosphere at a temperature of 500 °C for 1 hour. These results are shown in Table 1.

[0042] The evaluation criteria for determining the excellency of samples are as follows: whether the specific resistance is less than $6 \mu\Omega \cdot \text{cm}$, the surface roughness Ra immediately after film formation is less than 1.0 nm, the surface roughness Ra after heat treatment is less than 0.8 nm, the reflectance at a wavelength of 550 nm immediately after film formation and after heat treatment exceeds 95%, and the reflectance at a wavelength of 550 nm after immersion in Na_2S solution exceeds 60%.

[0043] [Table 1]

	COMPOSITION (at %)				SPECIFIC RESISTANCE ($\mu\Omega \cdot \text{cm}$)	SURFACE ROUGHNESS Ra (nm)			REFLECTANCE (%) AT WAVELENGTH OF 550 nm		
	In	Sn	Sb	Ag		IMMEDIATELY AFTER FILM FORMATION	AFTER HEAT TREATMENT AT 250 °C FOR 10 MIN	AFTER HEAT TREATMENT AT 500 °C FOR 1 HOUR	IMMEDIATELY AFTER FILM FORMATION	AFTER IMMERSION IN Na_2S SOLUTION	AFTER HEAT TREATMENT AT 500 °C
EXAMPLE 1	0.11	-	0.95	BALANCE	3.81	0.75	0.79	0.87	97.4	60.1	96.6
EXAMPLE 2	0.33	-	0.98	BALANCE	3.99	0.72	0.76	0.85	97.1	63.2	96.9
EXAMPLE 3	0.53	-	1.02	BALANCE	4.43	0.67	0.72	0.83	97	65.9	96.9
EXAMPLE 4	0.98	-	0.99	BALANCE	5.04	0.64	0.65	0.8	96.5	70.5	96.3
EXAMPLE 5	1.47	-	0.98	BALANCE	5.68	0.63	0.64	0.79	95.8	74.4	95.6
EXAMPLE 6	0.53	-	0.13	BALANCE	4.29	0.78	0.79	0.96	96.9	64.9	96.4
EXAMPLE 7	0.48	-	0.52	BALANCE	4.35	0.64	0.62	0.93	97.1	65.7	97.2
EXAMPLE 8	0.5	-	1.24	BALANCE	4.48	0.63	0.59	0.88	96.8	65.8	96.7
EXAMPLE 9	0.51	-	2.02	BALANCE	5.05	0.59	0.58	0.87	96	66.8	96.1
EXAMPLE 10	0.49	-	2.46	BALANCE	5.42	0.55	0.55	0.83	95.6	67.5	95.9
EXAMPLE 11	0.51	-	3.46	BALANCE	5.95	0.55	0.56	0.79	95.2	68.1	95.4
EXAMPLE 12	-	0.49	0.13	BALANCE	4.24	0.76	0.79	0.95	97.1	65	96.7
EXAMPLE 13	-	0.49	0.54	BALANCE	4.31	0.65	0.68	0.89	97.2	65.8	97
EXAMPLE 14	-	0.51	1.18	BALANCE	4.47	0.65	0.66	0.86	97	66	97.1
EXAMPLE 15	-	0.48	1.99	BALANCE	4.98	0.58	0.6	0.85	96.3	67.2	96.4
EXAMPLE 16	-	0.49	2.5	BALANCE	5.36	0.55	0.58	0.81	95.7	67.6	95.8
EXAMPLE 17	-	0.52	3.44	BALANCE	5.89	0.56	0.57	0.78	95.5	68.3	95.7
EXAMPLE 18	-	0.13	0.94	BALANCE	3.78	0.72	0.78	0.9	97.2	60.5	97.1
EXAMPLE 19	-	0.3	0.96	BALANCE	3.99	0.69	0.74	0.86	96.8	63.5	97
EXAMPLE 20	-	0.49	0.99	BALANCE	4.43	0.67	0.72	0.84	96.6	66	96.8
EXAMPLE 21	-	0.96	0.96	BALANCE	5.04	0.65	0.66	0.8	96.2	70.6	96.3
EXAMPLE 22	-	1.45	1.01	BALANCE	5.68	0.64	0.66	0.79	95.9	74.8	95.8
EXAMPLE 23	0.25	0.26	0.48	BALANCE	4.29	0.66	0.67	0.89	97.2	65.5	97.3
EXAMPLE 24	0.45	0.43	0.97	BALANCE	5.01	0.63	0.65	0.82	96.3	71	96.1
COMPARATIVE EXAMPLE 1	0.47	-	-	BALANCE	4.31	0.83	0.81	1.02	97	65.4	94.8
COMPARATIVE EXAMPLE 2	-	0.51	-	BALANCE	4.28	0.84	0.83	1.04	97.3	63.8	94.5
COMPARATIVE EXAMPLE 3	-	-	0.99	BALANCE	3.79	0.78	1.05	1.04	97.2	54.3	94.6
COMPARATIVE EXAMPLE 4	1.83	-	0.98	BALANCE	6.25	0.64	0.63	0.77	94.2	79.3	94.1
COMPARATIVE EXAMPLE 5	0.45	1.27	0.51	BALANCE	6.05	0.66	0.69	0.78	94.6	78.5	94.8
COMPARATIVE EXAMPLE 6	0.48	-	3.65	BALANCE	6.33	0.56	0.53	0.74	94.7	69.4	94.7

[0044] As can be seen from Table 1, in Comparative Examples 1 and 2 in which Sb is not contained, the surface roughnesses of the conductive films immediately after film formation and after heat treatment are large, and thus, the flatnesses of the conductive films are low. In Comparative

Example 3 in which In and Sn are not contained, the surface roughness of the conductive film after heat treatment is large and the reflectance of the conductive film after immersion in Na_2S solution is significantly reduced, resulting in a reduction in sulfuration resistance. Furthermore, in Comparative Examples 4 to 6 in which the content of In, Sn, or Sb exceeds the content range of the present invention, the specific resistances of the conductive films are high and the reflectances of the conductive films immediately after film formation are low. Thus, the conductive films are insufficient to be used as reflective electrode films. In Comparative Examples 1 to 6, the reflectances of the conductive films after heat treatment are low, resulting in a reduction in heat resistance.

[0045] In contrast, in Examples 1 to 24 of the present invention, the specific resistances of the conductive films are low, and thus, the conductive films are suitably used for electrode films. In addition, the surface roughnesses of the conductive films immediately after film formation and after heat treatment are low, and thus, the flatnesses of the conductive films are high. In other words, in Comparative Examples 1 to 3 in which only either one of at least one of In and Sn and Sb is contained, the surface roughnesses of the conductive films at least after heat treatment are large, whereas in Examples in which both at least one of In and Sn and Sb are contained, the surface roughnesses of the conductive films immediately after film formation and after heat treatment are low. In addition,

in Examples, the reflectances of the conductive films immediately after film formation, after immersion in Na₂S solution, and after heat treatment are high.

Thus, the conductive films in Examples of the present invention have specific resistance, surface roughness, reflectance, sulfuration resistance, and heat resistance which are suitable to be used as a reflective electrode film for an OLED element and an LED.

[0046] In order to use the present invention as a sputtering target, it is preferable that the sputtering target has the following concentration of metallic impurities, i.e., 100 ppm or less of Bi, 100 ppm or less of Pb, 100 ppm or less of Cu, and 100 ppm or less of Fe, and a total purity of 3N or greater. Also, it is preferable that the sputtering target has a surface roughness of 3 μ m or less, a grain diameter of 500 μ m or less, and an oxygen concentration of 300 ppm or less. In all of the above Examples, these conditions are satisfied.

The technical scope of the present invention is not limited to the aforementioned embodiments and Examples, but the present invention may be modified in various ways without departing from the scope or teaching of the present invention.

For example, while, in the above embodiment, the conductive film of the present invention is employed as a reflective electrode film for an OLED element, the conductive film of the present invention is also suitably used for a wiring film for a touch panel because of its low specific resistance and low surface roughness.

[Reference Numerals]

[0047] 1: conductive film, 2: transparent conductive
film, 3: electroluminescent layer, 4: film formation
substrate, 5: anode, 6: cathode, 10: OLED element

WHAT IS CLAIMED IS:

1. A conductive film consisting of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

2. The conductive film according to claim 1, wherein the conductive film is a reflective electrode film for an OLED element in which a transparent conductive film for an OLED element is laminated on the surface of the conductive film and an electroluminescent layer including an organic EL layer is further laminated on the transparent conductive film.

3. The conductive film according to claim 1, wherein the conductive film is a reflective electrode film for a light-emitting diode.

4. The conductive film according to claim 1, wherein the conductive film is a wiring film for a touch panel.

5. A method for producing the conductive film according to claim 1, wherein the conductive film is formed by sputtering using a sputtering target consisting of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further

containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

6. A sputtering target used for the method according to claim 5, wherein the sputtering target consists of a silver alloy having a component composition containing 0.1 to 1.5 at% of at least one of In and Sn and further containing 0.1 to 3.5 at% of Sb with the balance composed of Ag and unavoidable impurities.

7. The sputtering target according to claim 6, wherein the sputtering target is produced by a plastic forming process on an ingot formed by melting and casting a silver alloy.

8. The sputtering target according to claim 7, wherein the sputtering target is produced by subjecting an ingot to heat treatment after the ingot is subject to the plastic forming process.