



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.09.2018 Bulletin 2018/38

(51) Int Cl.:
H05B 3/44 (2006.01) H01K 1/32 (2006.01)

(21) Application number: **17190983.1**

(22) Date of filing: **14.09.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(30) Priority: **17.03.2017 JP 2017053076**

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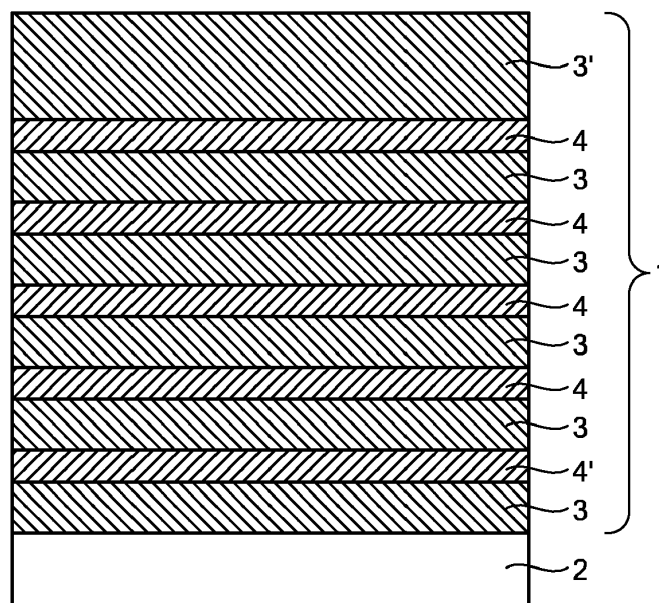
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(54) **HEATER**

(57) A heater (10) of an embodiment includes a light-emitting tube (2) and a multilayer film (1) formed on an outer surface of the light-emitting tube (2). The multilayer film (1) is formed by alternately stacking a low-refractive index film (3) and a high-refractive index film (4), and the film thickness of the low-refractive index film (3')

farthest from the light-emitting tube (2) is 2.0 times or more the film thicknesses of the other low-refractive index films (3), and the film thickness of the high-refractive index film (4') closest to the light-emitting tube (2) is equal to or larger than the film thicknesses of the other high-refractive index films (4).

FIG.2



Description

FIELD

[0001] Embodiments described herein relate to a heater.

BACKGROUND

[0002] A heater which is used for the purpose of heating an irradiation target object by radiant heat is known. The heater is required to have an anti-glare property for use in space heating, cooking, etc., and therefore, a multilayer film having a high visible light blocking effect is formed on an outer surface of a light-emitting tube. The multilayer film is composed of a material formed by alternately stacking a high-refractive index film and a low-refractive index film in order to transmit infrared light and block visible light.

[0003] The multilayer film is known to be formed such that the film thickness of the low-refractive index film farthest from the light-emitting tube is made thicker than the film thicknesses of the other low-refractive index films and the film thickness of the high-refractive index film closest to the light-emitting tube is made thinner than the film thicknesses of the other high-refractive index films in order to increase the infrared emission efficiency. However, when the film thickness of the high-refractive index film closest to the light-emitting tube is made thin, the anti-glare property is decreased.

[0004] An object of the exemplary embodiments is to provide a heater capable of improving the infrared emission efficiency while improving the anti-glare property.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

FIG. 1 is a schematic view of a heater according to an embodiment.

FIG. 2 is a schematic view of a multilayer film according to an embodiment.

FIG. 3 is a graph showing an illuminance when using a multilayer film according to an embodiment.

FIG. 4 is a graph showing a transmittance when using a multilayer film according to an embodiment.

DETAILED DESCRIPTION

[0006] A heater according to an embodiment described below includes a light-emitting tube and a multilayer film. The multilayer film is formed on an outer surface of the light-emitting tube. Further, the multilayer film is formed by alternately stacking a low-refractive index film and a high-refractive index film, and the film thickness of the low-refractive index film farthest from the light-emitting tube is 2.0 times or more the film thicknesses of the other low-refractive index films, and the film thickness of

the high-refractive index film closest to the light-emitting tube is equal to or larger than the film thicknesses of the other high-refractive index films.

[0007] Further, in the heater according to an embodiment described below, the film thickness of the low-refractive index film farthest from the light-emitting tube is 4.0 times or less the film thicknesses of the other low-refractive index films.

[0008] Further, in the heater according to an embodiment described below, the film thickness of the low-refractive index film farthest from the light-emitting tube is 2.2 times or more and 3.0 times or less the film thicknesses of the other low-refractive index films.

[0009] Further, in the heater according to an embodiment described below, the low-refractive index film contains silicon oxide as a main component, and the high-refractive index film contains iron oxide as a main component.

[0010] Further, in the heater according to an embodiment described below, the film thicknesses of the low-refractive index films and the high-refractive index films formed between the high-refractive index film closest to the light-emitting tube and the low-refractive index film farthest from the light-emitting tube are substantially the same among the low-refractive index films and are substantially the same among the high-refractive index films.

[0011] Further, in the heater according to an embodiment described below, the film thickness of each of the high-refractive index films is thinner than the film thickness of each of the low-refractive index films.

Embodiments

[0012] Hereinafter, the heater according to embodiments will be described with reference to the drawings. In the embodiments, the same reference numerals are assigned to the same components, and the repeated description thereof will be omitted.

[0013] First, an outline of the heater according to the embodiment will be described with reference to FIG. 1. FIG. 1 is a view showing an outline of the heater according to the embodiment. As shown in FIG. 1, a heater 10 includes a light-emitting tube 2, a first clasp 11, a second clasp 12, a first wiring 14, and a second wiring 15.

[0014] The light-emitting tube 2 is formed of a transparent and colorless material, and is formed in a cylindrical shape. As the material of the light-emitting tube 2, for example, quartz glass having a high softening point is exemplified. Further, on an outer surface of the light-emitting tube 2, a multilayer film 1 which will be described later with reference to FIG. 2 is formed.

[0015] The heater 10 includes a filament (not shown). The filament is disposed inside the light-emitting tube 2. One end of the filament is formed extending to a sealing portion (not shown) provided inside the first clasp 11, and is electrically connected to the first wiring 14. On the other hand, the other end of the filament is formed extending to a sealing portion (not shown) provided inside the sec-

ond clasp 12, and is electrically connected to the second wiring 15. The filament emits heat and light by applying a voltage thereto from a power supply (not shown) through the first wiring 14, and the second wiring 15.

[0016] The sealing portion provided inside the first clasp 11 and the sealing portion provided inside the second clasp 12 seal both ends of the light-emitting tube 2, respectively, and hermetically seal the inside of the light-emitting tube 2. In the inside of the sealing portion provided inside the first clasp 11, a part of one end of the filament (not shown), a metal foil (not shown) connected to one end of the filament, and a part of an outer lead (not shown) connected to an opposite side to the side where one end of the filament is connected of the metal foil are buried. One end of the first wiring 14 is connected to the outer lead buried in the sealing portion provided inside the first clasp 11, and the other end thereof is exposed outside the first clasp 11.

[0017] In the inside of the sealing portion provided inside the second clasp 12, in the same manner as the sealing portion provided inside the first clasp 11, a part of the other end of the filament (not shown), a metal foil (not shown) connected to the other end of the filament, and a part of an outer lead (not shown) connected to an opposite side to the side where the other end of the filament is connected of the metal foil are buried. One end of the second wiring 15 is connected to the outer lead, a part of which is buried in the sealing portion provided inside the second clasp 12, and the other end thereof is exposed outside the second clasp 12.

[0018] Next, the multilayer film 1 according to the embodiment will be described with reference to FIG. 2. FIG. 2 is a schematic view of the multilayer film 1 according to the embodiment. Incidentally, in FIG. 2, the light-emitting tube 2 is also shown. As shown in FIG. 2, the multilayer film 1 according to the embodiment is formed on the outer surface of the light-emitting tube 2, and includes a plurality of low-refractive index films 3 and a plurality of high-refractive index films 4. The low-refractive index film 3 contains silicon oxide as a main component, and the high-refractive index film 4 contains iron oxide as a main component.

[0019] The multilayer film 1 is formed by a dipping method, a vacuum deposition method, a sputtering method, or the like, and about 10 layers of the low-refractive index film 3 and the high-refractive index film 4 are alternately stacked. In this embodiment, odd numbered layers starting from the first layer which is directly formed on the surface of the light-emitting tube 2 are formed by the low-refractive index film 3, and even numbered layers starting from the second layer are formed by the high-refractive index film 4. Silicon oxide which is the main component of the low-refractive index film 3, specifically, silicon dioxide (SiO_2) is close to the component of the light-emitting tube 2, and therefore, by forming the low-refractive index film 3 as the first layer, the adhesive strength to the surface of the light-emitting tube 2 can be improved. Further, silicon dioxide has excellent chemical

and thermal resistance and also has a mechanical strength, and therefore, even if the low-refractive index film 3 is directly formed on the surface of the light-emitting tube 2 whose temperature becomes high, the possibility of the occurrence of peeling or damage is low. Incidentally, the low-refractive index film 3 as the first layer can also be omitted.

[0020] Iron oxide which is the main component of the high-refractive index film 4 has a higher anti-glare property than silicon oxide. Therefore, by using iron oxide in the high-refractive index film 4, the anti-glare property of the heater 10 can be improved. However, iron oxide is different from the component of the light-emitting tube 2 as compared with silicon oxide, and therefore, the high-refractive index film 4 is desirably provided on the outer side of the light-emitting tube 2 through the low-refractive index film 3.

[0021] Incidentally, the low-refractive index film 3 is not limited to silicon dioxide, and may have any form as long as the low-refractive index film 3 is silicon oxide such as silicon monoxide (SiO). Further, the low-refractive index film 3 is not limited to silicon oxide, and another metal oxide other than silicon oxide such as magnesium fluoride (MgF_2) may be used. Further, the high-refractive index film 4 is not limited to iron oxide, and a metal oxide other than iron oxide such as titanium oxide (TiO_2), niobium oxide (Nb_2O_5), or tantalum oxide (Ta_2O_5) may be used.

[0022] Further, as shown in FIG. 2, the film thicknesses of the low-refractive index films 3 excluding the low-refractive index film 3' farthest from the light-emitting tube 2 (hereinafter referred to as "uppermost low-refractive index film 3") in the multilayer film 1 are substantially the same as one another, and the film thicknesses of the high-refractive index films 4 excluding the high-refractive index film 4' closest to the light-emitting tube 2 (hereinafter referred to as "lowermost high-refractive index film 4") in the multilayer film 1 are substantially the same as one another. The film thickness of the low-refractive index film 3 is, for example, 1.4 times the film thickness of the high-refractive index film 4. That is, the film thickness of the low-refractive index film 3 is formed thicker than the film thickness of the high-refractive index film 4. For example, the film thickness of the low-refractive index film 3 is 80 nm, and the film thickness of the high-refractive index film 4 is 57 nm. However, the film thicknesses are not limited thereto.

[0023] Further, as shown in FIG. 2, in the heater 10 according to this embodiment, in the multilayer film 1, the film thickness of the low-refractive index film 3' farthest from the light-emitting tube 2 is formed thicker than the film thicknesses of the other low-refractive index films 3. Further, the high-refractive index film 4' closest to the light-emitting tube 2 is formed to a thickness which is equal to or larger than the film thicknesses of the other high-refractive index films 4.

[0024] According to this, in the heater 10 according to this embodiment, the transmittance of infrared light can

be improved without decreasing the anti-glare property. This point will be described in detail later with reference to FIG. 3 and FIG. 4. Incidentally, the film thickness of each layer of the multilayer film 1 can be measured by an SEM (Scanning Electron Microscope) analysis after polishing a cross section of the multilayer film 1. In the SEM, JSM-7500F manufactured by JEOL Ltd. is used.

[0025] Next, a correlation between the film thicknesses of the high-refractive index film 4' closest to the light-emitting tube 2 and the uppermost low-refractive index film 3' and an illuminance will be described with reference to FIG. 3. FIG. 3 is a graph showing an illuminance when using the multilayer film 1 according to the embodiment. In FIG. 3, the horizontal axis represents the ratio of the film thickness of the lowermost high-refractive index film 4' with respect to the high-refractive index film 4 (hereinafter referred to as "the film thickness ratio of the high-refractive index film 4"), and the vertical axis represents the illuminance. Incidentally, as the illuminance is lower, visible light is blocked more by the multilayer film 1, and therefore, a lower illuminance shows that the anti-glare property is favorable. The illuminance is measured at a position 50 cm away from the heater 10 using a color illuminometer CL-200A manufactured by KONICA MINOLTA, INC.

[0026] Further, in FIG. 3, an illuminance curve a1 when setting the ratio of the film thickness of the uppermost low-refractive index film 3' with respect to the low-refractive index film 3 (hereinafter referred to as "the film thickness ratio of the low-refractive index film 3") to 2.4 times, an illuminance curve a2 when setting such a film thickness ratio to 3.0 times, an illuminance curve a3 when setting such a film thickness ratio to 1.0 times, and an illuminance curve a4 when setting such a film thickness ratio to 1.5 times are shown.

[0027] As shown in FIG. 3, in the illuminance curves a1 to a4, when setting the film thickness ratio of the high-refractive index film 4 to substantially 1.0 times, the illuminance is most decreased. That is, by setting the film thickness ratio of the high-refractive index film 4 to substantially 1.0 times, the anti-glare property can be most improved.

[0028] Further, as shown in FIG. 3, when setting the film thickness ratio of the high-refractive index film 4 larger than 1.0 times, the illuminance is gradually increased. However, the illuminance is smaller than when setting such a film thickness ratio smaller than 1.0 times as in the case of 0.5 times, and therefore, a sufficient anti-glare property can be obtained.

[0029] That is, in the heater 10 according to the embodiment, by setting the film thickness of the high-refractive index film 4' closest to the light-emitting tube 2 to be equal to or larger than the film thicknesses of the other high-refractive index films 4, a sufficient anti-glare property can be obtained.

[0030] Further, it is found that when focusing on the film thickness ratio of the low-refractive index film 3, in the illuminance curve a1 when setting such a film thick-

ness ratio to 2.4 times, the illuminance curve a2 when setting such a film thickness ratio to 3.0 times, and the illuminance curve a3 when setting such a film thickness ratio to 1.0 times, a sufficient anti-glare property is obtained, however, in the illuminance curve a4 when setting such a film thickness ratio to 1.5 times, a sufficient anti-glare property is not obtained.

[0031] Next, a transmittance when using the multilayer film 1 according to the embodiment will be described with reference to FIG. 4. FIG. 4 is a graph showing a transmittance when using the multilayer film 1 according to the embodiment. Incidentally, in FIG. 4, a transmittance curve b1 when setting the film thickness ratio of the low-refractive index film 3 to 2.4 times and setting the film thickness ratio of the high-refractive index film 4 to 1.0 times is shown. Further, for comparison, a transmittance curve b2 when setting the film thickness ratio of the low-refractive index film 3 to 2.4 times and setting the film thickness ratio of the high-refractive index film 4 to 0.5 times, and a transmittance curve b3 when setting each of the film thickness ratio of the low-refractive index film 3 and the film thickness ratio of the high-refractive index film 4 to 1.0 times are also shown in FIG. 4.

[0032] First, when focusing on the transmittance curve b1 and the transmittance curve b2 shown in FIG. 4, the transmittance curve b1 and the transmittance curve b2 have a similar optical characteristic with respect to the incident light in an infrared region (a wavelength of 780 nm or more). In other words, when the film thickness ratio of the low-refractive index film 3 is fixed to 2.4 times, the infrared emission efficiency is equal in the case where the film thickness ratio of the high-refractive index film 4 is set to 1.0 times and in the case where such a film thickness ratio is set to 0.5 times.

[0033] Next, when focusing on the transmittance curve b1 and the transmittance curve b3, the transmittance curve b1 has a higher transmittance with respect to the incident light in an infrared region than the transmittance curve b3. That is, it is found that when the film thickness ratio of the high-refractive index film 4 is fixed to 1.0 times, the infrared emission efficiency is higher in the case where the film thickness ratio of the low-refractive index film 3 is set to 2.4 times than in the case where such a film thickness ratio is set to 1.0 times.

[0034] From these results, in the heater 10 according to the embodiment, by setting the film thickness ratio of the low-refractive index film 3 to 2.4 times and setting the film thickness ratio of the high-refractive index film 4 to 1.0 times or more, the infrared irradiation intensity can be improved while improving the anti-glare property.

[0035] Incidentally, in FIG. 4, the case where the film thickness ratio of the low-refractive index film 3 is set to 2.4 times is shown, however, even if such a film thickness ratio is set to 2.0 times or more and 4.0 times or less, the same effect can be expected. However, as the film thickness of the uppermost low-refractive index film 3' is thicker, it takes longer time to form the multilayer film 1, and therefore, there is a concern that the production efficiency

is decreased.

[0036] Further, as the film thickness of the uppermost low-refractive index film 3' is thinner, the transmittance of infrared light can be expected to be improved, however, there is a concern that the anti-glare property is decreased. Due to this, in order to improve both anti-glare property and transmittance of infrared light, the film thickness ratio of the low-refractive index film 3 is preferably 2.2 times or more and 3.0 times or less.

[0037] As described above, the heater 10 according to the embodiment includes the light-emitting tube 2 and the multilayer film 1. The multilayer film 1 is formed on the outer surface of the light-emitting tube 2. Further, the multilayer film 1 is formed by alternately stacking the low-refractive index film 3 and the high-refractive index film 4, and the film thickness of the low-refractive index film 3' farthest from the light-emitting tube 2 is 2.0 times or more the film thicknesses of the other low-refractive index films 3, and the film thickness of the high-refractive index film 4' closest to the light-emitting tube 2 is equal to or larger than the film thicknesses of the other high-refractive index films 4. Therefore, in the heater 10 according to the embodiment, the infrared emission efficiency can be improved while improving the anti-glare property.

[0038] Incidentally, in the above-mentioned embodiment, as the uppermost layer of the multilayer film 1, the low-refractive index film 3' which is silicon dioxide is formed, however, the configuration is not limited thereto. That is, as such an uppermost layer, zirconium oxide (ZrO_2) may be formed. By forming zirconium oxide as such an uppermost layer, ions such as sodium ions (Na^+) can be hardly transmitted therethrough to the light-emitting tube 2 side. That is, by using zirconium oxide as the uppermost layer of the multilayer film 1, the resistance of the heater 10 to an alkaline component such as a salt can be improved. Incidentally, zirconium oxide is not limited to the uppermost layer of the multilayer film 1, and may be used in a layer other than the uppermost layer.

[0039] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Claims

1. A heater, comprising:

a light-emitting tube; and
a multilayer film formed on an outer surface of the light-emitting tube, wherein

the multilayer film is formed by alternately stacking a low-refractive index film and a high-refractive index film, and the film thickness of the low-refractive index film farthest from the light-emitting tube is 2.0 times or more the film thicknesses of the other low-refractive index films, and the film thickness of the high-refractive index film closest to the light-emitting tube is equal to or larger than the film thicknesses of the other high-refractive index films.

2. The heater according to claim 1, wherein the film thickness of the low-refractive index film farthest from the light-emitting tube is 4.0 times or less the film thicknesses of the other low-refractive index films.
3. The heater according to claim 1 or 2, wherein the film thickness of the low-refractive index film farthest from the light-emitting tube is 2.2 times or more and 3.0 times or less the film thicknesses of the other low-refractive index films.
4. The heater according to any one of claims 1 to 3, wherein the high-refractive index film contains iron oxide as a main component, and the low-refractive index film contains silicon oxide as a main component.
5. The heater according to any one of claims 1 to 4, wherein the film thicknesses of the high-refractive index films and the low-refractive index films formed between the high-refractive index film closest to the light-emitting tube and the low-refractive index film farthest from the light-emitting tube are substantially the same among the high-refractive index films and are substantially the same among the low-refractive index films.
6. The heater according to claim 5, wherein the film thickness of each of the high-refractive index films is thinner than the film thickness of each of the low-refractive index films.

FIG.1

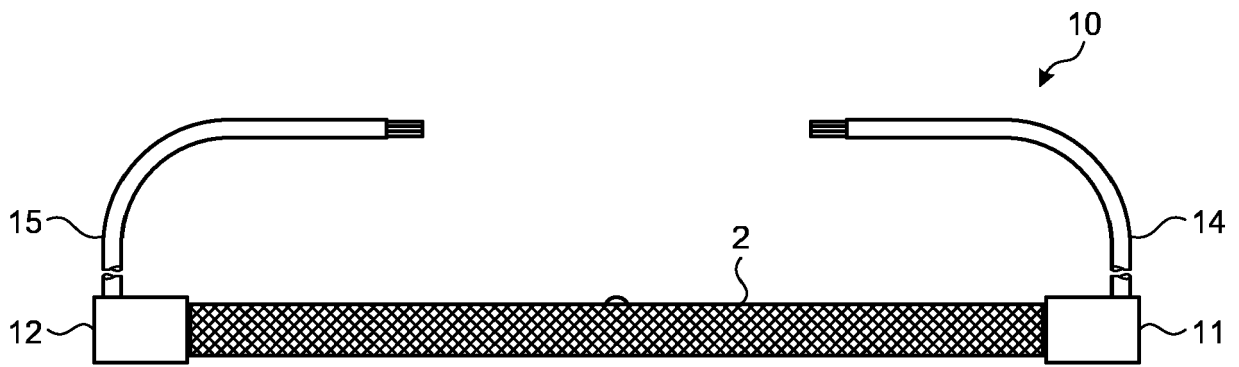


FIG.2

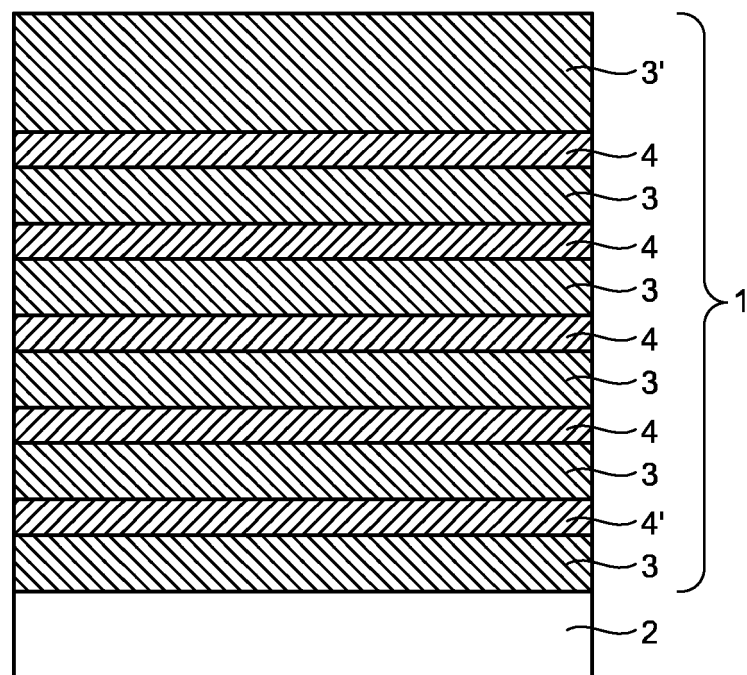


FIG.3

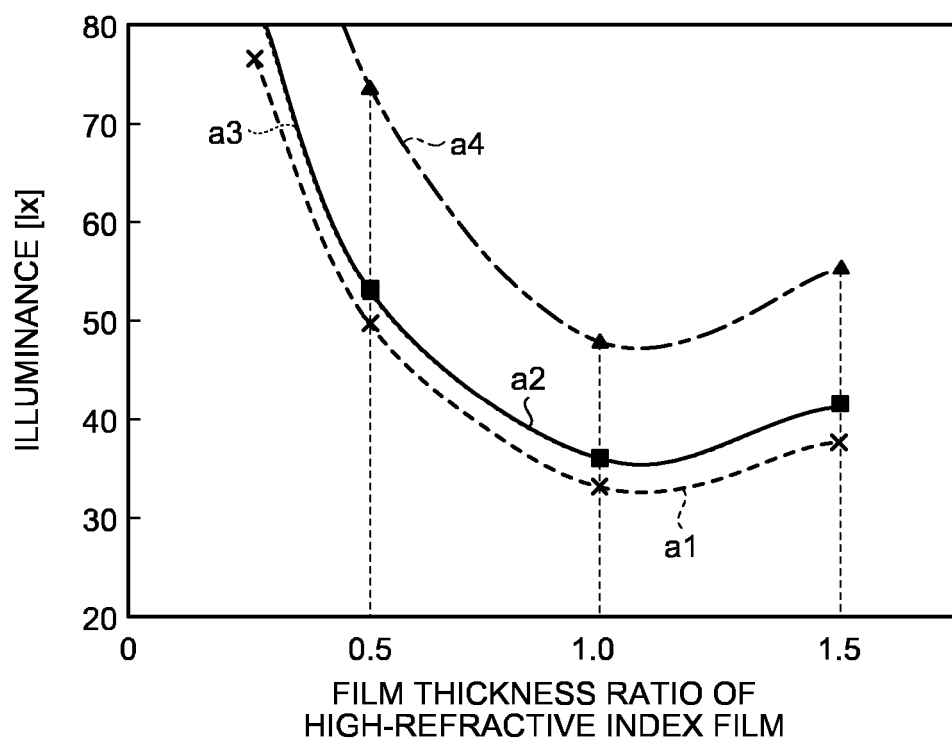
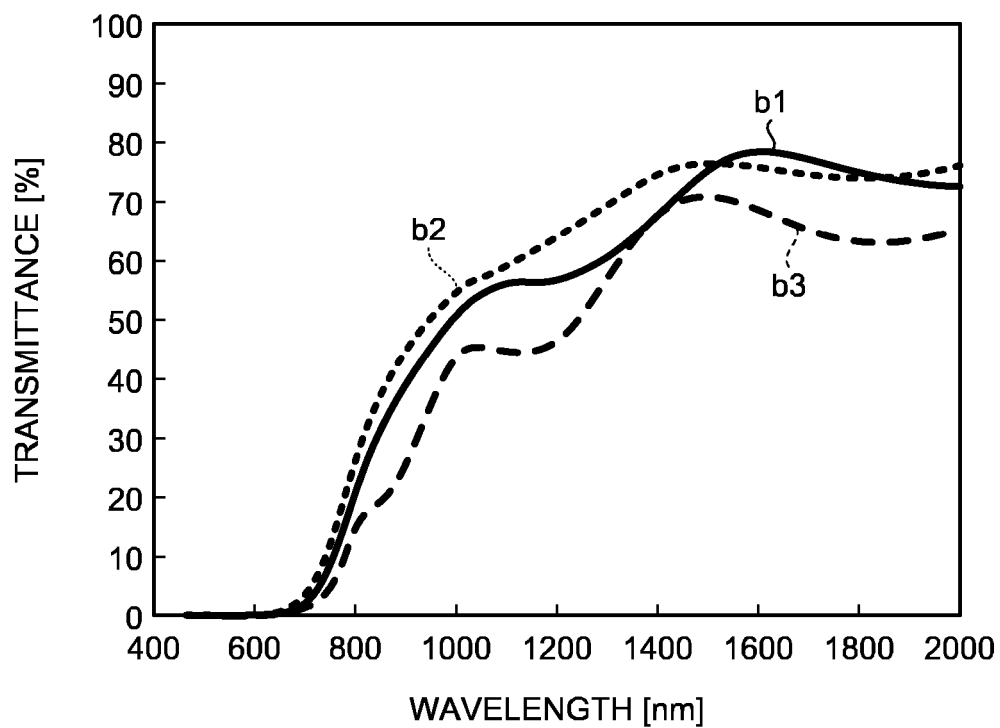


FIG.4





EUROPEAN SEARCH REPORT

Application Number
EP 17 19 0983

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2004/086105 A2 (PHILIPS INTELLECTUAL PROPERTY [DE]; KONINKL PHILIPS ELECTRONICS NV [NL] 7 October 2004 (2004-10-07)	1	INV. H05B3/44 H01K1/32
Y	* page 1, line 1 - line 5 *	4-6	
A	* page 2, line 5 - line 11 *	2,3	
	* page 2, line 17 - line 24 *		
	* page 2, line 31 - page 3, line 6 *		
	* page 6, line 13 - page 7, line 8; figures 1.1,1.2 *		

Y	EP 2 879 160 A1 (TOSHIBA LIGHTING & TECHNOLOGY [JP]) 3 June 2015 (2015-06-03)	4-6	
	* paragraph [0004] *		
	* paragraph [0011] *		
	* paragraph [0037] *		

Y	EP 2 961 243 A1 (TOSHIBA LIGHTING & TECHNOLOGY [JP]) 30 December 2015 (2015-12-30)	4-6	
	* paragraph [0041] - paragraph [0044] *		
	* paragraph [0001] *		
	* paragraph [0004] *		

A	WO 98/23897 A1 (DEPOSITION SCIENCES INC [US]) 4 June 1998 (1998-06-04)	1	H05B H01K
	* abstract; figure 1 *		

The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 February 2018	Examiner Barzic, Florent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 19 0983

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-02-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004086105 A2	07-10-2004	CN 1764852 A	26-04-2006
		EP 1616206 A2	18-01-2006
		JP 2006523366 A	12-10-2006
		US 2006178077 A1	10-08-2006
		WO 2004086105 A2	07-10-2004

EP 2879160 A1	03-06-2015	EP 2879160 A1	03-06-2015
		JP 2015076334 A	20-04-2015

EP 2961243 A1	30-12-2015	EP 2961243 A1	30-12-2015
		JP 2016009628 A	18-01-2016

WO 9823897 A1	04-06-1998	AT 325307 T	15-06-2006
		DE 69735822 T2	10-05-2007
		EP 1009949 A1	21-06-2000
		JP 2001508190 A	19-06-2001
		US 5923471 A	13-07-1999
		US 6331914 B1	18-12-2001
		WO 9823897 A1	04-06-1998
