

a strong induced electric field. More specifically, when the polarity of the voltage applied to the external electrode is (+), electrons accumulate in the glass tube coated with the conductive layer. On the other hand, when the polarity thereof is (-), cations accumulate. The wall charges accumulated through continuous polarity conversion using the alternating current electric field reciprocate between the opposite ends of the glass tube. As such, while the wall charges collide with the mercury gas that is supplied together with the inert gas, the excited light emission of the mercury gas is induced. Then, UV light, produced during this emission, excites the phosphor applied on the inner wall of the glass tube, thereby causing it to emit visible light.

[10] Further, the UV light thus radiated excites the phosphor applied on the inner wall of the glass tube 210. Accordingly, when light is emitted from the inner space of the glass tube 210, light is radiated externally.

[11] In the conventional external electrode fluorescent lamp 210, as the areas of both ends of the glass tube 210, functioning as the dielectric material, to be coated with the conductive layer 221, are enlarged, the magnitude of wall charges is increased, whereby the brightness of the lamp may be increased to some degrees. However, there is a limitation in the ability to extend the conductive layer 221 in a longitudinal direction. In the case where the conductive layer 221 extends in a longitudinal direction, the area in which light is externally radiated is decreased, undesirably reducing the emission efficiency.

Disclosure of Invention

Technical Problem

[12] Accordingly, embodiments of the present invention seek~~has been made~~ to solve the above problems occurring in the related art, and embodiments~~an object of the present invention seek~~is to provide a fluorescent lamp having ceramic-glass composite electrodes, which may have~~has~~ a high dielectric constant, high secondary electron emission, and high polarization under the same electric field, and thus may enables the movement of many more electrons and cations, resulting in high brightness.

[13] Embodiments~~Another object of the present invention also seek~~is to provide a fluorescent lamp having ceramic-glass composite electrodes, a dielectric constant that may have~~of which has~~ superior temperature stability, and thus there may be~~is~~ no brightness variation even in response to changes in the external environment.

[14] Embodiments~~A further object of the present invention also seek~~is to provide a fluorescent lamp having ceramic-glass composite electrodes, having the composition of a glass additive in the ceramic-glass composite that may~~to~~ easily adjust the thermal expansion coefficient, thereby preventing failure due to a difference in thermal expansion coefficient.

[15] Embodiments~~Still a further object of the present invention also seek~~is to provide a ceramic-glass

composite electrode having constant capacitance, in which the electrode is formed in a hollow cylindrical shape having a stepped portion to limit the length of the electrode inserted into the fluorescent lamp.

Technical Solution

- [16] According to an aspect of the present invention, there is provided a fluorescent lamp having ceramic-glass composite electrodes, comprising a glass tube, which has a phosphor applied on an inner surface thereof and is filled with a mixture of inert gas and metal vapor, both ends of which are sealed; and hollow cylindrical electrodes provided at both ends of the glass tube.

~~In order to achieve the above objects, the present invention provides a fluorescent lamp having ceramic-glass composite electrodes, which has the following configuration.~~

- [17] Each of the hollow cylindrical electrodes has a stepped portion between a central portion thereof and an end portion thereof, and is formed of a composite of CaO- MgO-SrO-ZrO₂- TiO₂ ceramics and glass frit in an amount of 0.3~10 wt% based on a total amount of the ceramics, and

the CaO- MgO-SrO-ZrO₂- TiO₂ ceramics comprise CaO in a range of 0<CaO<1 mol, MgO in a range of 0<MgO<1 mol, SrO in a range of 0<SrO<1 mol, ZrO₂ in a range of 0<ZrO₂<1 mol, and TiO₂ in a range of 0<TiO₂<1 mol, in which CaO+MgO+SrO:ZrO₂+TiO₂ has a molar ratio of 1:1, and further comprise one or more selected from a group consisting of MnO, Al₂O₃, Cr₂O₃, and Fe₂O₃, by 3 wt% or less based on a total amount thereof.

~~The fluorescent lamp having ceramic-glass composite electrodes includes a glass tube, which has a phosphor applied on the inner surface thereof and is filled with a mixture of inert gas and metal vapor, and both ends of which are sealed; and hollow cylindrical electrodes provided at both ends of the glass tube, in which each of the hollow cylindrical electrodes has a stepped portion between a central portion thereof and an end portion thereof, and is formed of a ceramic-glass composite.~~

- [18] In embodiments of the present invention, the stepped portion of the electrode may be formed in a manner such that the inner diameter of the central portion thereof is smaller than that of the end portion thereof, thus making the central portion thicker. The ceramic-glass composite electrode may have a conductive layer formed on the outer surface thereof, and the end portion thereof may be connected to the glass tube using a sealing glass paste.

- [19] The electrode in embodiments of the present invention may be typically formed by subjecting ceramic-glass composite powder to injection molding or pressing. The requirements for the electrode material are as follows.

- [20] The ceramic composition composed of MgO-CaO-TiO_2 or $\text{CaO-MgO-SrO-TiO}_2 - \text{ZrO}_2$ should have a phase transfer temperature of -30°C or lower, and thus should not break upon connection to the glass tube, due to a drastic change in thermal expansion coefficient resulting from the change in crystalline structure at a temperature of $400\sim 600^\circ\text{C}$, at which the sealing glass paste is burned. Further, when the fluorescent lamp is used in low-temperature areas, the ceramic-glass composite electrode and the glass tube of the lamp should not break due to the phase transfer phenomenon. In addition, the composition should be present in a monocrystalline structure at -30°C , which is a minimum temperature for use, and above. In addition, to increase the charge-discharge amounts of ions and electrons, the composition should have a dielectric constant greater than that of glass (having a dielectric constant of $10\sim 15$). In addition, the ceramic composition should have greater polarization in an electric field, even at the same dielectric constant.
- [21] The ceramic material thus selected may be added with glass frit, in order to decrease the difference in thermal expansion coefficient from that of the glass tube and

to minimize the generation of sputtering at the grain boundary of the ceramic material.

[22] As the electrode material satisfying the above requirements, ~~as disclosed herein in the present invention~~, a composite comprising a $\text{CaO-MgO-SrO-ZrO}_2\text{-TiO}_2$ ceramic composition and glass frit may be used. This glass frit is preferably added in an amount of 0.3~10 wt% based on the total amount of the ceramic composition.

[23] The $\text{CaO-MgO-SrO-ZrO}_2\text{-TiO}_2$ ceramic composition may include a basic composition comprising CaO in a range of $0 < \text{CaO} < 1$ mol, MgO in a range of $0 < \text{MgO} < 1$ mol, SrO in a range of $0 < \text{SrO} < 1$ mol, ZrO_2 in a range of $0 < \text{ZrO}_2 < 1$ mol, and TiO_2 in a range of $0 < \text{TiO}_2 < 1$ mol, in which $\text{CaO}+\text{MgO}+\text{SrO}:\text{ZrO}_2+\text{TiO}_2$ has a molar ratio of 1:1, and may further include 3 wt% or less of one or more selected from the group consisting of MnO , Al_2O_3 , Cr_2O_3 , and Fe_2O_3 , based on the total amount thereof.

[24] The MgO-SrO component of the composition may be replaced with oxide having a difference in ion radius of 15% or less.

Advantageous Effects

[25] According to embodiments of the present invention, the fluorescent lamp having ceramic-glass composite electrodes ~~may have~~ has the following advantages compared to conventional external electrode lamps.

[26] First, the fluorescent lamp in embodiments of the present invention ~~may have~~ has a dielectric constant much higher than glass having a dielectric constant of about 10, and ~~may have~~ has high secondary electron emission. Furthermore, polarization thereof under the same electric field may be is at least 2 times that of glass. Thus, under conditions of the same electrode area and the same dielectric area, many more electrons and ions may be moved in the glass tube, thereby greatly increasing the brightness of the lamp.

[27] Second, the temperature stability of dielectric constant may be is superior at temperatures of -30°C and above. Thus, when the lamp is driven, brightness may be is maintained uniform even though the temperature is increased by the impulse of ions and electrons colliding with the electrodes. That is, there may be is no brightness variation even in response to changes in the external environment.

[28] Third, the thermal expansion coefficient may be easily adjusted by changing the composition of the glass additive in the ceramic-glass composite. Therefore, when the lamp glass tube and the ceramic-glass composite electrode material are sealed through thermal treatment using a glass sealing material, failure due to the difference in thermal expansion coefficient therebetween may be prevented, which enables the stable fabrication of the lamp depending on the type of lamp tube.

[29] Fourth, upon the fabrication of the lamp, the ceramic-glass composite electrode is formed to have a hollow cylindrical shape having a stepped portion to limit the length

Claims

- [1] A fluorescent lamp having ceramic-glass composite electrodes, comprising a glass tube, which has a phosphor applied on an inner surface thereof and is filled with a mixture of inert gas and metal vapor, both ends of which are sealed; and hollow cylindrical electrodes provided at both ends of the glass tube, wherein each of the hollow cylindrical electrodes has a stepped portion between a central portion thereof and an end portion thereof, and is formed of a ceramic-glass composite.
- [2] The fluorescent lamp according to claim 1, wherein the ceramic-glass composite comprises $\text{CaO-MgO-SrO-ZrO}_2\text{-TiO}_2$ ceramics and glass frit.
- [3] The fluorescent lamp according to claim 1 or 2, wherein the glass frit is used in an amount of 0.3~10 wt% based on a total amount of the ceramics.
- [4] The fluorescent lamp according to claim 3, wherein the $\text{CaO-MgO-SrO-ZrO}_2\text{-TiO}_2$ ceramics comprise CaO in a range of $0 < \text{CaO} < 1$ mol, MgO in a range of $0 < \text{MgO} < 1$ mol, SrO in a range of $0 < \text{SrO} < 1$ mol, ZrO_2 in a range of $0 < \text{ZrO}_2 < 1$ mol, and TiO_2 in a range of $0 < \text{TiO}_2 < 1$ mol, in which $\text{CaO+MgO+SrO:ZrO}_2\text{+TiO}_2$ has a molar ratio of 1:1.
- [5] The fluorescent lamp according to claim 4, wherein the $\text{CaO-MgO-SrO-ZrO}_2\text{-TiO}_2$ ceramics further comprise one or more selected from a group consisting of MnO , Al_2O_3 , Cr_2O_3 , and Fe_2O_3 , by 3 wt% or less based on a total amount thereof.
- [6] The fluorescent lamp according to claim 4, wherein the glass frit includes SiO_2 : BaO : CaO at a molar ratio of 1:0.6:0.4.
- [7] The fluorescent lamp according to claim 4, wherein the glass frit comprises 75 wt% of SiO_2 , 18 wt% of B_2O_3 , 4 wt% of Na_2O , 2 wt% of K_2O , and 1 wt% of Al_2O_3 .
- [8] The fluorescent lamp according to claim 1 or 2, wherein the ceramic-glass composite electrode has a conductive layer formed on an outer surface thereof, and the end portion thereof is connected to the glass tube using a sealing glass paste.
- [9] The fluorescent lamp according to claim 1 or 2, wherein the stepped portion of the electrode is formed in a manner such that an inner diameter of the central portion thereof is smaller than that of the end portion thereof, to thus make the central portion thicker.
- [10] The fluorescent lamp according to claim 4, wherein the MgO-SrO is replaced with oxide having ion radius 15% or less than that of MgO-SrO .
- [11] The fluorescent lamp according to claim 1 or 2, wherein the temperature dependecny of dielectric constant of the ceramic-glass composite electrode is

40% or less in a temperature range from -30°C to 250°C.

- [12] The fluorescent lamp according to claim 1 or 2, wherein the ceramic-glass composite electrode has polarization per unit area corresponding to at least 2 times that of glass under a same electric field, and has hysteresis loss of 20% or less when an electric field of 10 kV is applied to 1 mm.
- [13] The fluorescent lamp according to claim 1 or 2, wherein the ceramic-glass composite electrode has a dielectric loss of 0.3% or less.

~~17~~

CLAIMS

[Claim 1]

A fluorescent lamp having ceramic-glass composite electrodes, comprising a glass tube, which has a phosphor applied on an inner surface thereof and is filled with a mixture of inert gas and metal vapor, both ends of which are sealed; and hollow cylindrical electrodes provided at both ends of the glass tube,

wherein each of the hollow cylindrical electrodes has a stepped portion between a central portion thereof and an end portion thereof, and is formed of a composite of CaO-MgO-SrO-ZrO₂-TiO₂ ceramics and glass frit in an amount of 0.3~10 wt% based on a total amount of the ceramics, and

the CaO- MgO-SrO-ZrO₂- TiO₂ ceramics comprise CaO in a range of 0<CaO<1 mol, MgO in a range of 0<MgO<1 mol, SrO in a range of 0<SrO<1 mol, ZrO₂ in a range of 0<ZrO₂<1 mol, and TiO₂ in a range of 0<TiO₂<1 mol, in which CaO+MgO+SrO:ZrO₂+TiO₂ has a molar ratio of 1:1, and further comprise one or more selected from a group consisting of MnO, Al₂O₃, Cr₂O₃, and Fe₂O₃, by 3 wt% or less based on a total amount thereof.

[Claim 2]

The fluorescent lamp according to claim 1, wherein the glass frit includes SiO₂:BaO:CaO at a molar ratio of 1:0.6:0.4.

[Claim 3]

The fluorescent lamp according to claim 1, wherein the glass frit comprises 75 wt% of SiO₂, 18 wt% of B₂O₃, 4 wt% of Na₂O, 2 wt% of K₂O, and 1 wt% of Al₂O₃.

[claim 4]

The fluorescent lamp according to claim 1, wherein

the ceramic-glass composite electrode has a conductive layer formed on an outer surface thereof, and the end portion thereof is connected to the glass tube using a sealing glass paste.

[Claim 5]

The fluorescent lamp according to claim 1, wherein the stepped portion of the electrode is formed in a manner such that an inner diameter of the central portion thereof is smaller than that of the end portion thereof, to thus make the central portion thicker.

[Claim 6]

The fluorescent lamp according to claim 1, wherein the MgO-SrO is replaced with oxide having a difference in ionic radius 15% or less compared with that of MgO-SrO.

[Claim 7]

The fluorescent lamp according to claim 1, wherein the ceramic-glass composite electrode has no phase transition point at a temperature of not less than -30 °C.

[Claim 8]

The fluorescent lamp according to claim 1, wherein the ceramic-glass composite electrode has polarization value higher than that of glass which has maximum polarization value of $0.031 \mu\text{C}/\text{cm}^2$ in an electric field of 10 kV/mm, and polarization curve thereof keeps linear dependency on electric field variation.

[Claim 9]

The fluorescent lamp according to claim 1, wherein the dielectric constant of the ceramic-glass composite electrode is higher than that of glass and stays at a constant level or decreases as the temperature rises in a range from -30 °C to 250°C.

[Claim 10]

The fluorescent lamp according to claim 5, wherein the inner diameter of the central portion of the electrode is the same as that of the glass tube.