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(54) **High-pressure discharge lamp**

(57) A high-pressure discharge lamp comprises a translucent ceramics airtight vessel (1) including an envelopment portion (1a) and a small-diameter cylindrical portion (1b) connected to the envelopment portion (1a) and having a sealing portion (SP). A current introducing conductor (2) is inserted in the inside of the small-diameter cylindrical portion (1b) including a sealing metal portion (2a) and a halogen-resistant portion (2b) connected each other. An electrode (3) is arranged at one end of the halogen-resistant portion (2b). The sealing portion (SP) is sealed by a fusion of melted poly-crystalline alumina ceramics of the small-diameter cylindrical portion (1b) at the sealing metal portion (2a) of the current introducing conductor (2), and the melted alumina ceramics includes aluminum grain growth control additives.

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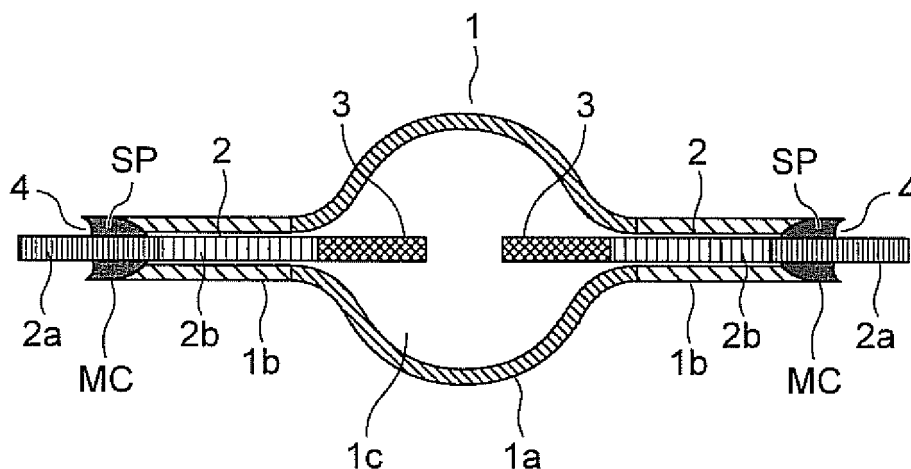


FIG. 1

Description**BACKGROUND OF INVENTION**

1. Field of Invention

[0001] The present invention relates to a high-pressure discharge lamp equipped with a translucent ceramics discharge vessel.

2. Description of the Related Art

[0002] In a high-pressure discharge lamp equipped with a translucent ceramics discharge vessel, a frit-less sealing method to seal an opening of the electric discharge vessel by fusion has been already known well, for example, as shown in Japanese Patent Application Laid Open No. P 2007-115651.

[0003] Moreover, in the frit-less sealing method, it is also well known to reduce of generation of cracks in the translucent ceramics of a sealing portion as shown in Japanese Patent Application Laid Open No. P 2009-009921. According to the above conventional sealing method, an inner surface of a small-diameter cylindrical portion at the sealing portion is formed of poly-crystalline aluminum ceramics having an average crystal grain size of 50 micrometers or less.

[0004] Since the frit-less sealing method can solve many problems caused by using the frit glass, it is very effective technology. However, the frit-less sealing method has not come to fully solve the problem of crack generation yet which is easily produced in the ceramics of the sealing portion.

[0005] According to the inventors' analysis, it turned out that the cracks produced in the ceramics of the sealing portion are mainly caused by a difference of the thermal expansion between the sealing portion of a current introducing conductor and the ceramics that is fused to the current introducing conductor. Especially, in the process of frit-less sealing, a crystal grain size of the ceramics of the sealing portion grows easily larger. Accordingly, the tendency for the difference of the thermal expansion between the current introducing conductor and the ceramics fused to the current introducing conductor becomes remarkable. For this reason, in Japanese Patent Application Laid Open No. P2009-009921, each thermal expansion coefficient of the small-diameter cylindrical portion and the current introducing conductor is closed as much as possible by using poly-crystalline alumina ceramics with small average grain size for the small-diameter cylindrical portion of the translucent ceramics discharge vessel. However, the inventors traced that the crystal grain of the ceramics grows when the fused ceramics is slowly cooled, and that the crystal grain grows up more easily than the original material.

SUMMARY OF THE INVENTION

[0006] The purpose of the present invention is to provide a high-pressure discharge lamp equipped with a translucent ceramics discharge vessel capable of suppressing generation of cracks by reducing the growth of the crystal grain size of the ceramics in the sealing portion of the translucent ceramics discharge vessel, in which the poly-crystalline alumina ceramics is fused to the current introducing conductor.

[0007] According to one aspect of the invention, a high-pressure discharge lamp includes a translucent ceramics airtight vessel (1) including an envelopment portion (1a) forming an electric discharge space in its inside and a small-diameter cylindrical portion (1b) connected to the envelopment portion (1a), at least a sealing portion (SP) of the small-diameter cylindrical portion 1b formed of poly-crystalline alumina ceramics; a current introducing conductor (2) inserted in the inside of the small-diameter cylindrical portion (1b) including a sealing metal portion (2a) and a halogen-resistant portion (2b) connected each other at respective one ends in a longitudinal direction, the other end of the sealing portion (2a) extending so as to be exposed to outside and the other end of the halogen-resistant portion (2b) extending to the inside of the envelopment portion (1a); an electrode (3) arranged at the other end of the halogen-resistant portion (2b) of the current introducing conductor (2); and a discharge medium sealed in the translucent ceramics airtight vessel (1) and wherein the sealing portion (SP) is sealed by a fusion of melted poly-crystalline alumina ceramics of the small-diameter cylindrical portion (1b) at the sealing metal portion (2a) of the current introducing conductor (2), and the melted alumina ceramics includes aluminum grain growth control additives.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings, which are incorporated in and constitute a portion of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0009]

Fig. 1 is a cross-sectional view showing a high-pressure discharge lamp according to a first embodiment of the present invention.

Fig. 2 is a cross-sectional view showing an enlarged sealing portion of the high-pressure discharge lamp shown in Fig. 1, specifically, showing an assembling state before sealing.

Fig. 3 is a cross-sectional view showing an enlarged sealing portion of the high-pressure discharge lamp shown in Fig. 1.

Fig. 4 is a cross-sectional view showing an enlarged sealing portion of a high-pressure discharge lamp according to a second embodiment of the present invention.

Figs. 5 and 6 are cross-sectional views showing an enlarged sealing portion of a high-pressure discharge lamp according to a third embodiment of the present invention.

Fig. 7 shows electron microscopic pictures of a sealing portion in a cross section of a high-pressure discharge lamp according to a sixth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0010] A high pressure discharge lamp according to an exemplary embodiment of the present invention will now be described with reference to the accompanying drawings wherein the same or like reference numerals designate the same or corresponding portions throughout the several views.

[0011] According to the present invention, alumina grain growth control additives are used to suppress the growth of the crystal grain of the ceramics and to prevent becoming large too much in the process where the sealing portion of the small-diameter cylindrical portion is melted by heating. The alumina grain growth control additives are contained inside of fused ceramics. In the embodiments, as the grain growth control additives, either a high melting point metal or a metal oxide is used.

[0012] Next, the high melting point metal as the alumina grain growth control additives is explained. The high melting point metal is diffused inside the fusion portion. At least one of the group of the metals, tantalum (Ta), niobium (Nb), molybdenum (Mo), and tungsten (W), or the alloy that contains at least one of the above metals.

[0013] In order to make the high melting point metal diffuse in the fusion portion as the alumina grain growth control additives, it is preferable to form a high melting point metal covering in an external surface of the sealing portion of the small-diameter cylindrical portion in advance of heating. Then, the high melting point metal can be diffused in the inside of the fusion portion from the high melting point metal covering in the heating fusion process of the sealing portion.

[0014] If the sealing portion is heated by arranging the high melting point metal covering on the external surface of the sealing portion of the alumina ceramics, the high melting point metal covering is also heated. As a result, the high melting point metal melts or becomes soft by the heating, and a portion of the melted high melting point metal is diffused in the fused alumina ceramics in the sealing portion. Then, the sealing portion of the translucent ceramics airtight vessel is formed by carrying out the cooling solidification of the fusion portion of the alumina ceramics. In the sealing portion, the diffused high melting point metal mainly enters into alumina crystal grain boundaries, and the high melting point metal acts so that the growth of the alumina grain is suppressed.

[0015] The high melting point metal covering is formed of either metal mesh body or a metal foil. In addition, the method to arrange the metal mesh body and the metal foil is not limited. For example, as a first method of using the metal mesh body, the metal mesh body of the high melting point metal is twisted around the sealing portion of the small-diameter cylindrical portion, or a cap made of the high melting point metal beforehand is equipped at an end portion of the small-diameter cylindrical portion. Furthermore, as the second method to use the metal foil, the high melting point metal foil is twisted around a periphery of the sealing portion of the small-diameter cylindrical portion.

[0016] Next, how to heat the high melting point metal covering is explained. In the first method, the metal mesh body and the alumina ceramics in the sealing portion are irradiated with laser from outside of the metal mesh body. According to the heating in this method, most of irradiated laser energy penetrates through pores of the metal mesh body and the poly-crystalline alumina ceramics of the small-diameter cylindrical portion, and the energy is absorbed in the current introducing conductor penetrated inside the small-diameter cylindrical portion. Therefore, the temperature of the current introducing conductor rises first, and then the heat of the current introducing conductor is transferred to the alumina ceramics. The laser energy is absorbed simultaneously in the surface of the mesh body, resulting in temperature rising of the metal mesh body, and the metal mesh body is softened or melted. Thereby, the high melting point metal is diffused in the alumina ceramics while the alumina ceramics is heated and melted as mentioned above.

[0017] In the second method, the end side of the small-diameter cylindrical portion of the poly-crystalline aluminum ceramics is directly irradiated with laser from an oblique direction. In the heating method, the laser mainly penetrates the aluminum ceramics, and the laser energy is absorbed in the current introducing conductor. The temperature of the current introducing conductor rises like the first method by this laser irradiation, then the heat of the current introducing conductor is transferred to the alumina ceramics and the high melting point metal foil. As a result, the alumina ceramics of the sealing portion is heated and melted. At this time, the high melting point metal foil is softened or melted. Conse-

quently, the high melting point metal material is diffused in the alumina ceramics from the high melting point metal foil. In addition, if the laser is irradiated through the high melting point metal foil, the time to melt the alumina ceramics becomes long.

[0018] Next, the case where sintering additives are used as the alumina grain growth control additives is explained. The sintering additives which act as the alumina grain growth control additives exist in the alumina crystal grain boundaries in the sealing portion. In the present invention, a means to make sintering additives that exist in the crystal grain boundaries of Al_2O_3 in the fusion portion of the sealing portion is not limited. For example, in advance of the sealing, the sintering additives are adhered on the surface of the small-diameter cylindrical portion. Then, if the small-diameter cylindrical portion is heated and melted after that, the sintering additives are mixed with the alumina ceramics, and enter into the alumina crystal grain boundaries. Consequently, the alumina crystal grain-growth is suppressed.

[0019] As the sintering additives, for example, magnesium oxide (MgO), yttrium oxide (Y_2O_3), lanthanum oxide (La_2O_3), scandium oxide (ScO_3), oxidized silicon (SiO_2) are used.

[0020] Moreover, the sealing portion of the small-diameter cylindrical portion can be also formed using the translucent poly-crystalline alumina ceramics which contains the sintering additives beforehand. That is, it is also possible to make the sintering additives enter into the alumina crystal grain boundaries in this method when the alumina ceramics is melted. In this method, a portion of the sintering additives evaporates and disappears when the alumina ceramics is melted. Since the concentration of the sintering additives in the fuse portion fall more comparing to other portions, it turns out that the sintering additives contained in the translucent crystalline alumina ceramics in the fusion portion function as the alumina grain growth control additives.

[0021] Then, the sealing portion of the translucent ceramics airtight vessel is formed by cooling and solidifying the fusion portion of the alumina ceramics. As a result, when the sintering additives enter into the alumina crystal grain boundaries, the sintering additives act as the alumina grain growth control additives, thereby the crack generation of the fusion portion is suppressed.

[0022] In this embodiment, it is possible to use both the high melting point metal and the sintering additives as the alumina grain growth control additives in the sealing portion. In this case, the effect of the alumina crystal grain-growth control is superior to the case where only one of the high melting point metal and the sintering additives is used. Thus, as a result of the controlling of the alumina crystal grain growth, the crack generation of the sealing portion is reduced.

[0023] Next, an alumina crystal structure of the fusion portion, which is effective for controlling the crack generation of the sealing portion, is explained. That is, the poly-crystalline alumina ceramics of the fusion portion, in which the alumina crystal grain is solidified after melted in the sealing portion, is formed by being re-crystallized after once melted. For this reason, the size and the form of the alumina crystal grain are not uniform by location. In order to measure the alumina crystal grain size and form, SEM (scanned type electron microscope) is used, for example, to take a picture, for the cross-section of the sealing portion. The alumina crystal grain is measured based on the obtained picture. The largest width size of the alumina crystal grain measured by the picture is made into a major axis L, and when the largest size is made into the minor axis W among width sizes of the direction which intersects perpendicularly with the major axis L, the minor axis W is equivalent to a diameter of an alumina crystal grain. Thus, the crack generation of the sealing portion can be controlled by managing the alumina crystal grain size and form.

[0024] In the present embodiment, the diameter of the alumina crystal grain in the fusion portion is preferably within 200-300 micrometers for not less than 50% of the total grains, and more preferably for not less than 90% of the total grains. With respect to the form of grain, it is preferable that a ratio L/W is in a range which satisfies $1.0 \leq L/W \leq 20$, (L : major axis, W : minor axis). Under this condition, it is comparatively easy to form the sealing portion while being hard to generate the crack in the formed fusion portion.

[0025] When forming the fusion portion by heating the sealing portion of the small-diameter cylindrical portion, the diameter of the alumina crystal grain becomes at least 3 micrometers by a re-crystallization. On the other hand, if the diameter of the alumina crystal grain exceeds 200 micrometers, the alumina crystal grain is too large, which results in the crack in the fusion portion.

[0026] Moreover, with respect to the form of the alumina crystal grain, if the ratio L/W is 1.0, the state of the fusion portion becomes good, and the control effect of the crack generation is fully acquired. On the contrast, the ratio L/W exceeds 20, it become very easy to generate the crack, and it becomes difficult to obtain a practical high-pressure discharge lamp to an extreme. Under above condition, the effect to suppress the cracks is obtained.

[0027] In addition, as for the alumina crystal grain in the fusion portion, it is more preferable that the grain size is not less than 5 micrometers, and the grain shape satisfies $1.0 \leq L/W \leq 10$. Within the above conditions, the higher control effect is acquired to reduce the crack generation of the sealing portion.

[0028] Moreover, with respect to a compression stress S (MPa) of the portion of the current introducing conductor which is fused by the aluminum ceramics of the sealing portion, the compression stress S (MPa) is preferably set up within the scope of $100 \leq S \leq 800$. Here, the compression stress means a negative sealing stress. The range of the sealing stress shows the range in which the sealing portion is easily formed, and the effect of the suppression of crack generation is acquired. However, if the compression stress is less than 100, the formation of the sealing portion becomes very

difficult. Moreover, the crack generation becomes remarkable if the compression stress exceeds 800.

[0029] Moreover, it is required that, in the sealing portion, the grain boundary of the adjoining alumina crystal grains stick tightly in the inside of the fusion portion, and also not to form few crevices, i.e., grain boundary crevices, which are communicated with the exterior of the fusion portion as a result. It turned out that the generation of the crack in a fusion portion is effectively controlled by the structures mentioned above. However, voids formed in the inside of the fusion portion are not included in the above-mentioned crevices.

[0030] The voids formed in the inside of the fusion portion may form big spaces which cannot be said as the crevices. However, with respect to the void, when sealing the small-diameter cylindrical portion by carrying out fusion of the ceramics like frit-less sealing, if slow cooling processing is performed over sufficient time, it is possible to prevent formation of voids. Therefore, it is desirable that the voids are not formed in the inside of the fusion portion of the sealing portion.

[0031] Next, other structures in the present invention are explained.

1. Young's modulus of the fusion portion in the sealing portion.

[0032] Young's modulus Y (GPa) of the exterior surface of the fusion portion is preferably within $100 \leq Y \leq 700$. Thereby, the control effect over crack generation of the sealing portion is acquired.

2. Hardness of the fusion portion of the sealing portion.

[0033] As for the hardness H (GPa) of the external surface, it is preferable that H (GPa) is within the range : $5 \leq H \leq 60$. Thereby, the control effect over the crack generation of the sealing portion is acquired.

3. Formation of the fusion portion in the sealing portion.

[0034] The alumina ceramics of the fusion portion melts and fills a space almost over from the inside surface of the small-diameter cylindrical portion to the surface of the current introducing conductor forming a first region after solidified. A part of the melted aluminum ceramics penetrates from the first region into a crevice between the inside surface of the small-diameter cylindrical portion and the current introducing conductor along the current introducing conductor, and is solidified forming a second region. It is preferable to form the fusion portion consisting of the first and second regions, thereby the control effect over the crack generation of the sealing portion is acquired.

[0035] Hereafter, a high-pressure discharge lamp according to a first embodiment of the present invention is explained with respect to Figs. 1 to 3. Fig. 1 is a cross-sectional view showing a high-pressure discharge lamp according to a first embodiment of the present invention. Figs. 2 and 3 are cross-sectional views showing the enlarged sealing portion of the high-pressure discharge lamp shown in Fig. 1. The high-pressure discharge lamp is equipped with a translucent ceramics airtight vessel 1, a current introducing conductor 2, an electrode 3, a high melting point metal covering MC, a sealing portion SP, and an electric discharge medium.

[Translucent ceramics airtight vessel]

[0036] The translucent ceramics airtight vessel 1 includes an envelopment portion 1a and a small diameter cylindrical portion 1b. The electric discharge space 1c is formed in the inside of the envelopment portion 1a. In this embodiment, the "translucent" means a light transmittance state to such an extent that the light generated by electric discharge is penetrated and can be derived to the outside. The translucent ceramics does not necessarily have a transparent characteristic, but may have a light diffusion characteristic. Furthermore, although the main portion of the envelopment portion 1a which surrounds a space for the discharging be translucent, other portions than the above-mentioned main portion is not necessarily to be translucent.

[0037] The inside of the envelopment portion 1a is hollow and the composition material is poly-crystalline alumina ceramics with translucency, such as single-crystal metal oxides, for example, sapphire, yttrium-aluminum-garnet (YAG), yttrium oxide (YOX), and poly-crystalline non-oxide, for example, aluminum nitride (AlN) etc., are used. Since these translucent poly-crystalline alumina ceramics can be obtained comparatively easily and they can be mass-produced industrially, they are suitable as the composition materials of the translucent ceramics airtight vessel 1.

[0038] The small-diameter cylindrical portion 1b is formed in a cylindrical shape with a small diameter and connected to an end of the envelopment portion 1a. Furthermore, the inside of the small-diameter cylindrical portion 1b is connected with the inside of the envelopment portion 1a in air tight extending from the end of the envelopment portion 1a to the outside. The small-diameter cylindrical portion 1b is integrally fabricated with the envelopment portion 1a by continuous curved surface.

[0039] Moreover, at least the sealing portion of the small-diameter cylindrical portion 1b is formed of translucent poly-crystalline aluminum ceramics. The average grain size of the aluminum ceramics used generally is about 70 micrometers.

However, the average grain size of the sealing portion in the small-diameter cylindrical portion 1b, in which the aluminum ceramics is melted in the sealing process, is generally set to 50 micrometers or less. In addition, the average grain size is preferable as small as possible, for example, it is more preferable that the size is 30 micrometers or less, and further 20 micrometers or less. Therefore, the preferable range is 0.1-30 micrometers, and more preferably 0.5-20 micrometers.

Furthermore, the formation of the sealing portion SP by the fusion of the alumina ceramics becomes easier by using the aluminum ceramics of 4 micrometers or less of the average grain size, preferably 3 micrometers or less, or more preferably 1 micrometer or less of the average crystal grain size of the sealing portion SP of the small-diameter cylindrical portion 1b.

[0040] Moreover, if the whole of the translucent ceramics airtight vessel 1 is formed of the translucent poly-crystalline alumina ceramics, the average grain size of the envelopment portion 1a is set relatively enlarged to that of the small-diameter cylindrical portion 1b, and the average grain size of the small-diameter cylindrical portion 1b is made small.

[0041] A pair of the small-diameter cylindrical portions 1b is arranged so as to face each, and similarly, a pair of electrodes are equipped in the respective ends of the small-diameter cylindrical portions 1b along the cylinder axis apart from each other. In addition, the alumina ceramics of the small-diameter cylindrical portions 1b may be substantially light blocking.

[0042] Although a capillary structure is formed in the inside of the small-diameter cylindrical portions 1b in this invention, the capillary structure does not necessarily need to be formed. Furthermore, the length of the small-diameter cylindrical portions 1b is not limited in this invention. In short, what is necessary is just the length in which a sealing portion SP is easily formed by the fusion of the small-diameter cylindrical portions 1b with the current introducing conductor 2 at least. Since the sealing portion SP can bear relatively high temperature processing, the length of the above-mentioned small-diameter cylindrical portions 1b can be obviously shortened than that in the case of sealing process using a conventional frit glass.

[0043] Next, in order to manufacture the translucent ceramics airtight vessel 1, the envelopment portion 1a and the small-diameter cylindrical portions 1b can be fabricated in one unit. However, the translucent ceramics airtight vessel 1 can be also manufactured by joining two or more components depending on the case. For example, the translucent ceramics airtight vessel 1 can be formed by joining each component, after carrying out temporary sintering of the envelopment portion 1a and the small-diameter cylindrical portions 1b separately, and then sintering together after connection.

[Current introducing conductor]

[0044] The current introducing conductor 2 is a series connected metal of a sealing metal portion 2a and a halogen-resistant portion 2b, and functions in order to support the electrode 3 to be mentioned later, to supply current to the electrode 3, and to collaborate with the small-diameter cylindrical portions 1b for sealing the translucent ceramics airtight vessel 1. Therefore, the current introducing conductor 2 is inserted in the inside of small-diameter cylindrical portions 1b of the translucent ceramics airtight vessel 1. One end side of the current introducing conductor 2 is constituted by the halogen-resistant portion 2b, and the electrode 3 is connected with the tip of the halogen-resistant portion 2b. The other end side is the sealing metal portion 2a, in which the sealing portion SP of the translucent ceramics airtight vessel 1 is formed. The sealing metal portion 2a is exposed to the outside from the translucent ceramics airtight vessel 1. In the above, "exposed to exterior" does not necessarily mean the sealing metal portion 2a is projected to the exterior from the translucent ceramics airtight vessel 1, but what is necessary is just to have faced the sealing metal portion 2a outside, to such an extent that electric power can be supplied to the sealing metal portion 2a.

[0045] Moreover, a sealing metal or a cermet is used to form the sealing metal portion 2a for the current introducing conductor 2. As the sealing metals, conductive metals in which the thermal expansion coefficient is close to that of poly-crystalline alumina ceramics which constitutes the small-diameter cylindrical portions 1b of the translucent ceramics airtight vessel 1, are selected from the group of niobium (Nb), tantalum (Ta), titanium (Ti), zirconium (Zr) hafnium (Hf), vanadium (V) and platinum (Pt). Moreover, as the cermet, the cermet formed of the alumina ceramics and the metals which are selected from the group of molybdenum (Mo) and tungsten (W) in addition to the above-mentioned metals may be used.

[0046] Furthermore, the sealing metal portion 2a of the current introducing conductor 2 may be constituted by jointing two or more material portions. For example, the sealing metal portion 2a is formed by connecting the sealing metals selected from the above metals with the cermet in series along the tube axis. Further, the sealing metal portion 2a can be formed of the structure of concentric circle-like double layers so that the cermet encloses the metal. When the cermet is used at least in one portion for the metal sealing portion 2a of the current introducing conductor 2, if the sealing between the small-diameter cylindrical portions 1b of the translucent ceramics airtight vessel 1 and the current introducing conductor 2 is conducted in a portion over the cermet portion, or in other portion which strides both the cermet portion and sealing metal portion 2a, the temperature of the ceramics rises more easily at the time of the sealing by fusion of the ceramics of the small-diameter cylindrical portions 1b for the reason mentioned later. Therefore, it becomes easy to form a good sealing portion SP.

[Electrode 3]

[0047] A pair of electrodes 3 is provided to generate electric discharge of the electric discharge medium later mentioned in the inside of the translucent ceramics airtight vessel 1. The pair of electrodes 3 is arranged facing and apart from each other so that arc discharge is generated between the electrodes 3

[0048] The electrode 3 is supported by the end of the halogen-resistant portion 2b in the predetermined position in the airtight vessel 1. That is, one end of the electrode 3 is connected to a portion of the current introducing conductor 2 which is projected in the inside of the translucent ceramics airtight vessel 1.

[0049] Furthermore, the electrode 3 may be constituted by a main portion and an electrode shaft portion. The main portion is used as the starting point of electric discharge, therefore acts mainly as the negative pole or the anode pole. Therefore, it is possible to directly connect the electrode 3 with the current introducing conductor 2 without interposing an electrode shaft portion depending on the case. Moreover, in order to radiate heat effectively by enlarging surface area of the electrode main portion, if needed, a coil of tungsten is wound around the electrode main portion, or a diameter may be made larger than the electrode shaft portion. When the electrode 3 is equipped with the electrode shaft portion, the electrode shaft portion is formed with the electrode main portion in one unit or welded to the electrode main portion, and then connected to the halogen-resistant portion 2b of the current introducing conductor 2. In addition, the electrode shaft portion may be formed in unit with the halogen-resistant portion 2b of the current introducing conductor 2 by a single tungsten material depending on the case.

[0050] Furthermore, as the material of the electrode 3, tungsten, doped tungsten, thoriated tungsten, rhenium, or a tungsten-rhenium alloy can be used. In case of using a pair of electrodes, though in an alternative lighting style, they are made into a symmetrical structure, in a direct current lighting type, they may be made into asymmetrical structure.

[High melting point metal covering MC]

[0051] In the present invention, when the alumina grain growth control additives consist of high melting point metals, as shown in Fig. 2, the high melting point metal covering MC is arranged in advance of the sealing process on the external surface of the sealing portion SP (for example, end of the small-diameter cylindrical portion 1b) of the translucent ceramics airtight vessel 1.

[0052] Moreover, a mesh-like metal covering or a metal foil made of a high melting point metal is used as the high melting point metal covering MC. The metal covering MC of mesh like is adopted according to the embodiment shown in Fig. 2. A range of the thickness t (micrometer) of the high melting point metal covering MC is $0.03 \leq t \leq 0.30$. If the thickness t of the metal covering MC is set to less than 0.03 micrometer, the thickness will be too thin, which results in increase in the difficulties of manufacturing and handling. Moreover, the metal of the mesh-like metal covering MC evaporates easily at the time of laser irradiation, and the diffusion of metal material to the fusion portion 4 becomes insufficient. On the contrary, heating time becomes long if the thickness t of the mesh-like metal covering MC exceeds 0.30 micrometer. Moreover, since the rigidity of the mesh-like metal covering MC becomes high, a process for rolling mesh-like metal covering MC around the sealing portion SP of the small-diameter cylindrical portion 1b becomes difficult, which easily results in a decrease in adhesion strength to the small-diameter cylindrical portion 1b. Accordingly, the mesh-like metal covering MC with large thickness is not preferable for practical use.

[0053] The preferable structure of the mesh-like metal covering MC is as follows. The range of the caliber ϕ (mm) of a pore of the mesh is $0.05 < \phi < 0.50$. If the caliber ϕ is 0.05 mm or less, the laser energy which penetrates the pore not only decreases, but the manufacturing of the mesh-like metal covering MC becomes difficult. On the contrary, if the caliber ϕ is set to 0.50 mm or more, handling becomes difficult. Moreover, the diffusion of the metal to the fusion portion 4 becomes insufficient.

[0054] Moreover, the range of the pore interval d (mm) of the mesh-like metal covering MC is $0.05 < d < 0.50$. If the pore interval d of the mesh-like metal covering MC is set to 0.05 mm or less, the manufacturing becomes difficult. On the contrary, if the pore interval d is set to 0.50 mm or more, the laser energy which penetrates the pore decreases. Here, the pore interval d means the length of the metal foil portion formed between the adjoining paired holes.

[Sealing portion SP]

[0055] The sealing portion SP is formed of the aluminum ceramics of the small-diameter cylindrical portion 1b, as shown by enlarging in Fig. 3. The aluminum ceramics contains the alumina grain growth control additives. According to the present invention, the aluminum ceramics melts while containing the high melting point metal diffused from the high melting point metal covering MC as the alumina grain growth control additives, and forming a fusion portion 4 after solidified in the sealing metal portion 2a. As shown in Fig. 3, the fusion portion 4 includes a fused portion 4a, an adhesion portion 4b, and a stick portion 4c.

[0056] The fused portion 4a is the first region of the fusion portion 4, formed of once melted and solidified aluminum

ceramics in a region between the sealing metal portion 2a of the current introducing conductor 2 and the inside surface of the small-diameter cylindrical portion 1b. The fused portion 4a constitutes an indispensable main portion of the fusion portion 4 in the sealing portion SP.

[0057] The adhesion portion 4b is the second region of the fusion region 4, in which the melted aluminum ceramics penetrates to a space between the internal surface of the small-diameter cylindrical portion 1b, which is not melted, and the current introducing conductor 2 (the sealing metal portion 2a and the halogen-resistant portion 2b), and solidified on the external surface of the current introducing conductor 2. The sealing portion SP does not need necessarily to have the adhesion portion 4b. However, a reliable seal can be performed when the sealing portion SP has the adhesion portion 4b in addition to the fused portion 4a.

[0058] The stick portion 4c is formed so that only a perimeter side surface of the small-diameter cylindrical portion 1b is softened or melted, and is adhered to the high melting point metal covering MC. The sealing portion SP does not necessary have the stick portion 4c.

[0059] Thus, in this embodiment, the metal of the high melting point metal covering MC is diffused as a simple substance in the fusion portion 4 of the sealing portion SP. The preferable range of the content m (mass %) of the metal is one which satisfies $0.5 < m < 30$. In addition, if the preferable range of the content m (mass %) of the metal is less than 0.5 mass %, it becomes difficult to acquire the improvement effect to adjust the thermal expansion coefficient. Moreover, if the content m (mass %) of the metal becomes more than 30 mass %, it becomes easy to produce a grain boundary fracture. Moreover, some high melting point metals supplied from the high melting point metal covering MC may be diffused inside the fusion portion 4 as an oxide.

[0060] Moreover, the high melting point metal covering MC is arranged in advance of the sealing of the translucent ceramics airtight vessel 1. After diffusing of the high melting point metal in the fusion portion 4 and forming the sealing portion SP, it is preferable that the most of the metal covering MC remains still. However, depending on the seal conditions, even if a portion of the metal covering MC dissociates, and the original form collapses, there is no influence in the characteristic.

[0061] In order to seal the translucent ceramic airtight vessel 1 according to this embodiment, the process to form the sealing portion SP by the fusion of the alumina ceramics is not limited. For example, first, when the alumina ceramics of the small-diameter cylindrical portion 1b and the metal covering MC are heated, the temperature of alumina ceramics is raised more than the fusion temperature, and the alumina ceramics melts. Further, the melted alumina ceramics becomes fit to connection ends of respective of the sealing metal portion 2a and the halogen-resistant portion 2b corresponding to the sealing portion of the current introducing conductor 2, which is inserted in the small-diameter cylindrical portion 1b, while the high melting point metal is diffused in the alumina ceramics from the high melting point metal covering MC. Next, when the heating is stopped and cooled, the melted alumina ceramics of the fit portion is solidified, and the alumina ceramics of the fusion portion 4 is adhered to the respective connection ends of the sealing metal portion 2a and the halogen-resistant portion 2b of the current introducing conductor 2. Finally, the sealing portion SP is formed, and the translucent ceramics airtight vessel 1 is sealed.

[0062] As a means to heat the alumina ceramics of the small-diameter cylindrical portion 1b, for example, a local heating means of a heat ray projection type such as a laser or a halogen bulb with a reflector, an induction-heating means, and an electric heater, etc. are used. In addition, as laser, for example, YAG laser or CO₂ laser, etc. is used, for example.

[0063] When heating entire circumference of the sealing portion SP of the small-diameter cylindrical portion 1b using the local heating means of the heat ray projection type, if the metal mesh body is used as the high melting point metal covering MC, for example, the local heating means is arranged in the side of the sealing portion SP apart from a predetermined distance. If at least, either one of the small-diameter cylindrical portion 1b of the translucent ceramic airtight vessel 1 and the local heating means is rotated while operating the local heating means, the entire circumference of the small-diameter cylindrical portion 1b can be heated uniformly. However, for example, in the case where the high melting point metal covering MC is formed of the metal foil, the laser can be irradiated from a direction where the small-diameter cylindrical portion 1b extends, that is, a direction of a tube axis. Moreover, the translucent ceramic airtight vessel 1 can be heated by fixedly arranging two or more local heating means around the small-diameter cylindrical portion arranged 16, or rotating the two or more local heating means around the circumference of the small-diameter cylindrical portion 1b. The translucent ceramic airtight vessel 1 can also be heated in the state where it remains at rest, by arranging the heating means so as to surround the entire circumference of the small-diameter cylindrical portion 1b.

[Electric discharge medium]

[0064] Although an electric discharge medium is a means for obtaining desired luminescence by the electric discharge, the structure is not limited in this embodiment. For example, the electric discharge medium is constituted by a halide of luminous metal, the lamp voltage formation medium, and rare gas of luminescence metal. In addition, in the present invention, "high-pressure electric discharge" means a concept in which the pressure of an ionization medium during

lighting exceeds atmospheric pressure, and includes what is called "a super-high pressure electric discharge".

[0065] The halide of luminous metal mainly emits visible light, and which may be any of various known metal halides. That is, the metal halide of luminous metal may be arbitrarily selected from a group of known metal halides as desired so as to achieve radiation of visible light with desired emission characteristics such as a general color rendering index Ra and luminous efficiency, further depending on the size or input power of the translucent ceramics discharge vessel

1. For example, one or more halides may be selected from a group of sodium (Na), scandium (Sc), a rare earth metal (dysprosium (Dy), thulium (Tm), holmium (Ho), praseodymium (Pr), lanthan (La), or cerium (Ce), or the like), thallium (Tl), indium (In), and lithium (Li). For the halide of a luminous metal, one or more of iodine, bromine, chlorine, and fluorine may be used as halogen.

[0066] A lamp voltage formation medium is effective in forming a lamp voltage, for example, may be mercury or a halide listed below. The halide as a lamp voltage forming medium is preferably halide of metals such as aluminum, (Al), iron (Fe), zinc (Zn), antimony (Sb), or manganese (Mn) which serve to generate a relatively high vapor pressure during lighting and which emits a smaller quantity of light in the above visible region than the above luminous metal.

[0067] The rare gas acts as a starting gas or a buffer gas and may be xenon (Xe), argon (Ar), krypton (Kr), or neon (Ne) singly or a mixture of any of them.

[0068] The example of compositions of the electric discharge medium for obtaining desired luminescence is as follows.

1. A halide of a luminous metal + mercury + rare gas: what is called metal halide lamp containing mercury.
2. A halide of a luminous metal + halide lamp voltage formation medium + rare gas: what is called a mercury free metal halide lamp configuration that does not use mercury, which imposes a heavy load on the environment.
3. Mercury + rare gas: what is called a high-pressure mercury lamp configuration.
4. Rare gas: what is called a xenon lamp using Xe as the rare gas.

[Other structures of the Present Invention]

[0069] Although not indispensable for the present invention, some or all of the structures described below may be provided as required to add corresponding functions to the high-pressure discharge lamp or to improve its performance.

(1) (Outer tube)

[0070] The high-pressure discharge lamp of the present invention can be configured to be lighted with the translucent ceramics airtight vessel exposed to the atmosphere. However, the translucent ceramics airtight vessel 1 can also be housed in an outer tube (not shown). In addition, the interior of the outer tube may be in a vacuum or may be filled with a gas or may be in communication with the atmosphere.

(2) (Reflector)

[0071] The high-pressure discharge lamp 1 of the present invention may be integrated with a reflector.

[Example 1]

[0072] The concrete structure of the high-pressure discharge lamp in the first embodiment shown in Fig. 1 is shown below.

(Translucent ceramics airtight vessel):

Integral molding formed of translucent poly crystalline alumina ceramics,
Envelopment portion;
 maximum outer diameter: 15 mm, and maximum internal diameter: 13 mm.
Small-diameter cylindrical portion;
 outer diameters: 1.2 mm, inside diameter: 1.0 mm, and length: 15 mm.
 (Current introducing conductor);
Sealing metal portion; Nb, diameter: 0.6 mm, and length:
 10 mm,
Halogen-resistant portion; Mo, diameter: 0.6 mm, and length: 5 mm.

(Electrode): W, diameter: 5 mm

(High melting point metal covering): mesh covering made from Ta, length: 2 mm, and the thickness: 0.08 micrometer,

wound once,

Sample 1; caliber: 0.5 mm, pore interval: 0.2 mm.

Sample 2; caliber 0.2 mm, pore interval: 0.2 mm.

(Electric discharge medium): Xe

(Direction of laser irradiation in the sealing process); irradiated from the outside of the mesh metal covering in the rectangular direction with respect to the tube axis.

(Sealing portion): Ta of 1.0 mass % is diffused in the fused portion, the adhesion portion, and the stick portion as alumina grain growth control additives.

(Lighting test result (10,000 hours))= the samples 1 and 2 have no crack generation.

* the lighting examinations are performed under 20-minute lighting and 10-minute putting out lights.

[Example 2]

[0073]

(High melting point metal covering) : The metal foil made from Ta, length: 2 mm, the thickness: 0.08 micrometer, 1-time wound.

(The direction of laser irradiation in a sealing process): irradiated from the outside of the metal foil in the oblique direction with respect to the tube axis.

(Sealing portion): Ta of 1.0 mass % was diffused in the fusion portion.

(Lighting test result (10,000 hours)): no crack generation.

[Comparative example 1]

[0074]

(High melting point metal covering): Ta metal foil, length: 2 mm, 1-time wound.

(Direction of laser irradiation in a sealing process): irradiated from the outside of the metal foil in the rectangular direction with respect to the tube axis.

* Other specifications are the same as those of the first example.

(Lighting test result (10,000 hours)): the crack occurred in 8000 hours.

[0075] Next, a high-pressure discharge lamp according to a second embodiment of the present invention is explained with reference to Fig. 4. Fig. 4 is a cross-sectional view showing an enlarged sealing portion of the high-pressure discharge lamp. In this embodiment, the sintering additives exist in the crystal grain boundary of the alumina ceramics intensively as alumina grain growth control additives in the fusion portion 4 of the sealing portion SP formed in the small-diameter cylindrical portion 1b of the translucent ceramics airtight vessel 1. As for the content of the sintering additives in the sealing portion SP, it is preferable that content amount is a range of 50-500 ppm. The sintering additives are adhered at the external surface of the sealing portion SP in the small-diameter cylindrical portion 1b in advance of the sealing process. However, the sintering additives may be contained in the raw material of the alumina ceramics.

[0076] As mentioned above, when the sintering additive exists in the alumina crystal grain boundary as the alumina grain growth control additives, the growth of the crystal grain of alumina ceramics in the sealing process is suppressed. As a result, the difference of the thermal expansion between the sealing portion SP and the sealing metal portion 2a and the halogen-resistant portion 2b of the current introducing conductor 2 decreases, therefore, the crack generation is prevented.

[0077] Moreover, if the high melting point metal is also contained in the sealing portion SP as the alumina grain growth control additives in addition to the sintering additives, more superior crack prevention effect can be acquired. As for the rate of a content ratio of the high melting point metal in this embodiment, it is preferable that the content ratio is the range of 0.5-30 mass %.

[Example 3]

[0078] The example of the high-pressure discharge lamp in the second embodiment shown in Fig. 4 is shown below.

(Sealing portion): MgO in the alumina ceramics of the fusion portion is 200 ppm,

* Other specifications are the same as those of the first embodiment 1.

(Lighting test result (10,000 hours)): no crack generation.

[0079] Next, a high-pressure discharge lamp of a third embodiment according to the present invention is explained with reference to Figs. 5 and 6. In the frit-less sealing process of the small-diameter cylindrical portion 1b of the translucent ceramics airtight vessel 1, a void V is easy to be formed by a gas of organic nature emitted from the alumina ceramics in the sealing portion SP. If the void V exceeds a predetermined size, the crack is easily generated.

[0080] As shown in Fig. 5, if the ratio of the length of the void V to that of the whole fusion portion 4 in the direction of the tube axis is 60% or less, it turned out that the crack generation is practically settled in a tolerance level. Moreover, when the ratio of the height of the void V to the maximum thickness of the fusion portion 4 is 80% or less, it turned out that the crack generation is practically settled in a tolerance level.

[0081] Furthermore, as shown in Fig. 6, in a face of the fusion portion 4, which intersects perpendicularly with the direction of the tube axis, if an angle which two radiate straight lines drawn from the center of the conductor 2 to the both ends of the void V make is within 30 degrees, it turned out that the crack generation is practically settled in a tolerance level.

[Example 4]

[0082] The structures of the high-pressure discharge lamp according to the third embodiment of the present invention shown in Fig. 5 are shown below.

(Sealing portion): In the void of the fusion portion, the length ratio is 50%, the height ratio is 50, and the angle made of the two lines within the surface which intersects perpendicularly with the direction of a tube axis was 30 degrees.

* Other specifications are the same as those of the first embodiment.

(Lighting test result (10,000 hours)): no crack generation.

[0083] Next, the high-pressure discharge lamp according to a fourth embodiment of the present invention is described. In this embodiment, the diameter of the alumina crystal grain in the fusion portion 4 in the sealing portion SP is set to 3-200 micrometers, more preferably 10-150 micrometers. Furthermore, a ratio of an L/W, here the minor axis and the major axis are respectively denoted as W and L, is set to a range $1.0 \leq L/W \leq 20$ and more preferably, a range $1.5 \leq L/W \leq 10$.

[Example 5]

[0084] A lighting examination of 10,000 hours was done to inspect the existence of the crack generation about the samples in which the diameter and shape of the alumina crystal grain in the fusion portion 4 of the sealing portion are different each other. Here, the high-pressure discharge lamp specifications are the same as those of Example 1. The results of the investigation are shown in Table 1. The definition of the evaluation result is as follows.

[0085] Here,

(A) means : no generation of cracks.

(B) : generation of cracks in 8000 hours or longer.

(C) : generation of cracks in 5000 hours or longer.

(D) : generation of cracks in several hours.

(E) : no lighting

[0086]

[Table 1]

Sample (No.)	Diameter (micrometer)	L/W	Test result
1.	3	1.0	C
2.	10	1.5	A
3.	10	10.0	B
4.	10	20.0	C
5.	150	1.5	B
6.	150	10.0	B
7.	150	15.0	D

(continued)

Sample (No.)	Diameter (micrometer)	L/W	Test result
8.	300	1.5	E

Next, the high-pressure discharge lamp according to a fifth embodiment of the present invention is explained. In this embodiment, the current introducing conductor 2 is configured so that the compression stress S (MPa) of a portion of the sealing portion SP which is adhered to the fusion portion 4 may be within $100 \leq S \leq 800$.

[Example 6]

[0087] A lighting examination of 10,000 hours was done to inspect the existence of the crack generation about the samples in which the compression stress S (MPa) of the current introducing conductor 2 is different each other. Here, the high-pressure discharge lamp specifications are the same as those of Example 1. The results of the investigation are shown in Table 2. The definition of the evaluation result is as follows.

[0088] Here,

(A) means : no generation of cracks.

(B) : generation of cracks in 8000 hours or longer.

(C) : generation of cracks in 5000 hours or longer.

(D) : generation of cracks in several hours.

In addition, Young's modulus of the surface of the fusion portion 4 was 500G, and the hardness Pa was 40GPa.

[0089]

[Table 2]

Sample (No.)	Compression stress S (MPa)	Test result
1.	150	A
2.	500	B
3.	800	C
4.	1000	D

Next, the high-pressure discharge lamp according to a sixth embodiment of the present invention is explained with reference to Fig. 7. In the inside of the fusion portion 4 of the sealing portion SP, the grain boundary of the adjoining alumina crystal grains is stuck in this embodiment, and the crack is rather not formed as tiny crevices in the grain boundary are not formed.

[0090] Fig. 7 shows cross-sectional electron microscopic pictures of the sealing portion 4. Fig. 7A shows a cross-sectional picture of the fusion portion 4, in which the grain boundary crevices are formed in a portion. Fig. 7B shows a cross-sectional picture of the fusion portion 4, enlarging the portion in Fig. 7A, in which the grain boundary crevices are formed. Fig. 7C shows a cross-sectional picture of the fusion portion 4, by enlarging a portion in Fig. 7A, in which the grain boundary crevices are not formed. In addition, in Fig. 7B, portions in which variant grain boundaries are appeared in black lines are grain boundary crevices of the alumina ceramics.

[0091] Since the grain boundary crevice is not connected with the exterior of the fusion portion 4, the grain boundary crevice is distinguished from the crack, and even if the grain boundary crevice is formed, it does not cause direct leak. However, if the grain boundary crevice is formed, a risk of resulting in the crack generation in a life is generated. Therefore, it is preferable that the grain boundary crevice is not formed.

[Example 7]

[0092] A lighting examination of 10,000 hours was done to inspect the existence of the crack generation about two samples in which a first sample (sample No.1) does not contain the grain boundary crevice, and a second sample (sample No.2) contains the grain boundary crevice. Here, the high-pressure discharge lamp specifications are the same as those of Example 1. The results of the investigation are shown in Table 3. The definition of the evaluation result is as follows.

Here,

(B) means: generation of cracks in 8000 hours or longer.

(C) : generation of cracks in 5000 hours or longer.

[0093]

[Table 3]

Sample (No.)	Grain boundary crevice	Test result
1.	Nothing	B
2.	Exist	C

[0094] In the high-pressure discharge lamp according to the embodiments of the present invention, since the polycrystalline alumina ceramics in the fused portion 4 of the small-diameter cylindrical portion 1b contains the alumina grain growth control additives, the growth of the alumina crystal grain in the formation process of the sealing portion is suppressed. Therefore, the difference of the thermal expansion of the alumina ceramics of the sealing portion SP and the current introducing conductor 2 becomes small, and the high-pressure discharge lamp in which the crack generation of the sealing portion is suppressed can be offered.

[0095] Moreover, according to the embodiments of the present invention, it becomes possible to suppress the crack generation of the sealing portion easily by the sintering additives which exist in the alumina crystal grain boundary and the high melting point metals diffused in the inside of the fusion portion 4 as the alumina grain growth control additives using either one at least.

[0096] Furthermore, since either one of the metal mesh body and the metal foil as the high melting point metal covering MC can be used, it becomes possible to easily diffuse the high melting point metal into the aluminum ceramics as the alumina grain growth control additives when the small-diameter cylindrical portion 1b is heated.

[0097] The present invention is not limited directly to the above described embodiments. In practice, the structural elements can be modified without departing from the spirit of the invention. Various inventions can be made by properly combining the structural elements disclosed in the embodiments. For example, some structural elements may be omitted from all the structural elements disclosed in the embodiments. Furthermore, structural elements in different embodiments may properly be combined. It is to be understood that within the scope of the appended claims, the present invention may be practiced other than as specifically disclosed herein.

Claims

1. A high-pressure discharge lamp comprising:

a translucent ceramics airtight vessel (1) including an envelopment portion (1a) forming an electric discharge space in its inside and a small-diameter cylindrical portion (1b) connected to the envelopment portion (1a), at least a sealing portion (SP) of the small-diameter cylindrical portion (1b) formed of polycrystalline alumina ceramics;

a current introducing conductor (2) inserted in the inside of the small-diameter cylindrical portion (1b) including a sealing metal portion (2a) and a halogen-resistant portion (2b) connected each other at respective one ends in a longitudinal direction, the other end of the sealing metal portion (2a) extending so as to be exposed to outside and the other end of the halogen-resistant portion (2b) extending to inside of the envelopment portion (1a); an electrode arranged at the other end of the halogen-resistant portion (2b) of the current introducing conductor (2); and

a discharge medium sealed in the translucent ceramics airtight vessel (1); and

wherein the sealing portion (SP) is sealed by a fusion of melted polycrystalline alumina ceramics of the small-diameter cylindrical portion (1b) at the sealing metal portion (2a) of the current introducing conductor (2), and the melted alumina ceramics includes aluminum grain growth control additives.

2. The high-pressure discharge lamp according to claim 1, wherein the aluminum grain growth control additives are formed of a high melting point metal diffused into inside of the fusion portion (4).

3. The high-pressure discharge lamp according to claim 2, wherein the high melting point metal includes one or more of the high melting point metals selected from a group consisting of tantalum (Ta), niobium (Nb), molybdenum (Mo), and tungsten (W), or the alloy which contains at least one of the tantalum (Ta), niobium (Nb), molybdenum (Mo),

and tungsten (W).

4. The high-pressure discharge lamp according to claim 2 or 3, further comprising a high melting point metal covering formed of either a mesh metal or a metal foil and arranged in the sealing portion (SP) of the small-diameter cylindrical portion (1b).
5. The high-pressure discharge lamp according to claim 1, wherein the aluminum grain growth control additives are formed of sintering additives, which exist in the alumina crystal grain boundaries in the sealing portion (SP).
6. The high-pressure discharge lamp according to claim 5, wherein the sintering additives include one or more metal oxides selected from a group of, magnesium oxide (MgO), yttrium oxide (Y_2O_3), lanthanum oxide (La_2O_3), scandium oxide (ScO_3), and oxidized silicon (SiO_2).
7. The high-pressure discharge lamp according to claim 1, wherein the aluminum grain growth control additives are formed of both the high melting point metal diffused in the fusion portion (4) and the sintering additives existing in the alumina crystal grain boundaries in the sealing portion (SP).
8. The high-pressure discharge lamp according to claim 7, wherein the high melting point metal includes one or more of the high melting point metal selected from a group consisting of tantalum (Ta), niobium (Nb), molybdenum (Mo), and tungsten (W), or the alloy which contains at least one of the tantalum (Ta), niobium (Nb), molybdenum (Mo), and tungsten (W), and the sintering additives include one or more metal oxides selected from a group of, magnesium oxide (MgO), yttrium oxide (Y_2O_3), lanthanum oxide (La_2O_3), scandium oxide (ScO_3), and oxidized silicon (SiO_2).
9. The high-pressure discharge lamp according to any one of claims 1 to 8, wherein the crystal grain size of the aluminum ceramics in the fusion portion (4) is within 200-300 micrometers, and a ratio L/W is in a range which satisfies $1.0 \leq L/W \leq 20$, (here, L : major axis, W : minor axis).
10. The high-pressure discharge lamp according to any one of claims 1 to 8, wherein a compression stress S (MPa) of a portion of the current introducing conductor (2) which is fused to the fusion portion (4) of the sealing portion (SP) is set within $100 \leq S \leq 800$.
11. The high-pressure discharge lamp according to any one of claims 1 to 8, wherein in a face of the fusion portion (4) intersecting perpendicularly with the direction of a tube axis, an angle which two radiated straight lines drawn from the center of the conductor (2) to the both ends of a void V make is within 30 degrees.
12. The high-pressure discharge lamp according to any one of claims 11, wherein a ratio of the length of a void V formed in the fused portion (4) to that of the whole fusion portion 4 in the direction of a tube axis is 60% or less.
13. The high-pressure discharge lamp according to claim 12, wherein a ratio of the height of the void V to the maximum thickness of the fusion portion (4) is 80% or less.

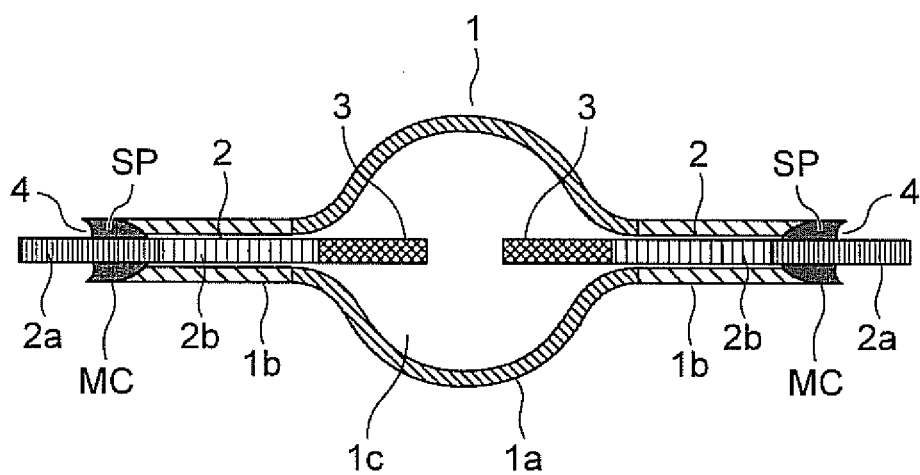


FIG. 1

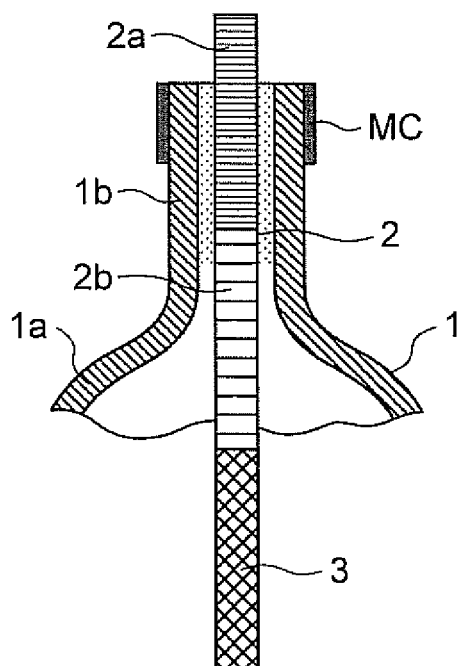


FIG. 2

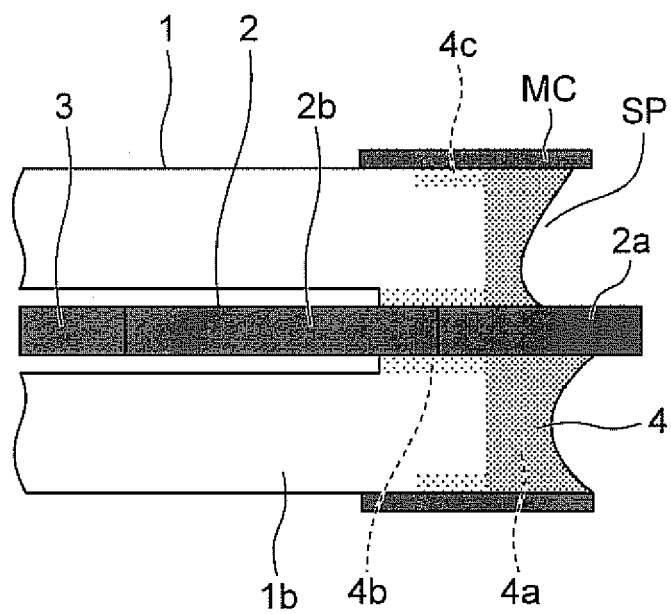


FIG. 3

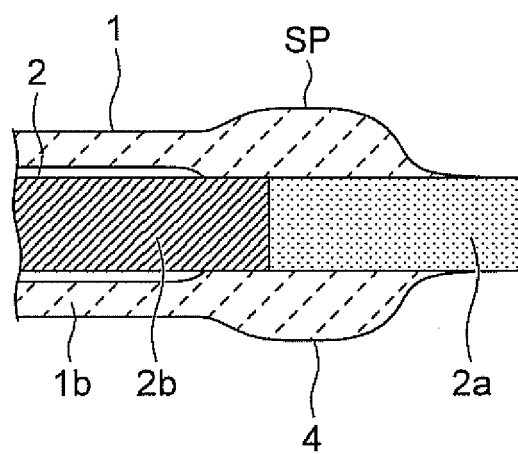


FIG. 4

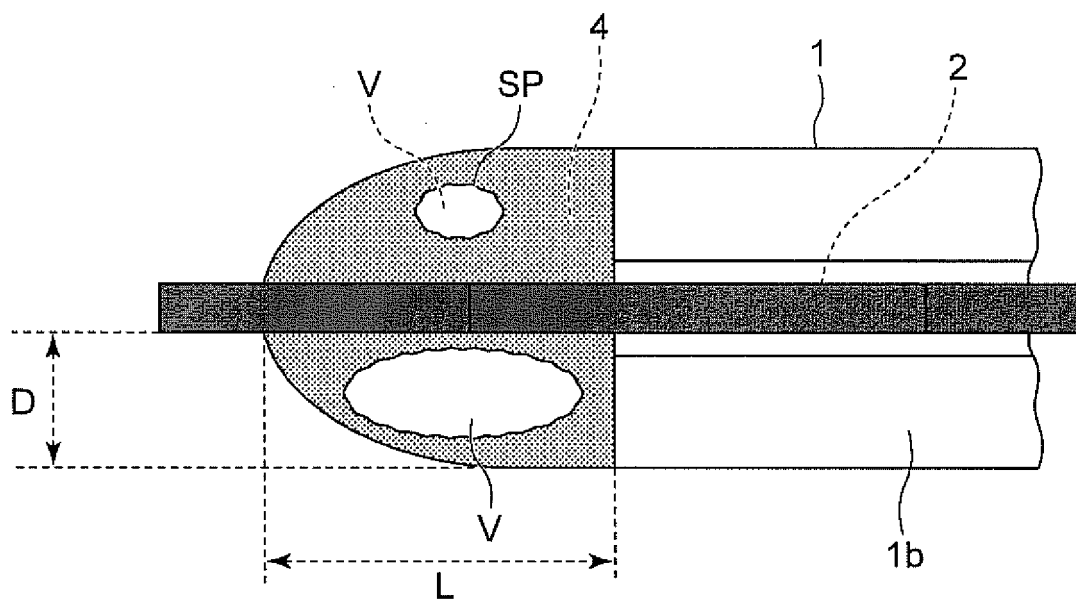


FIG. 5

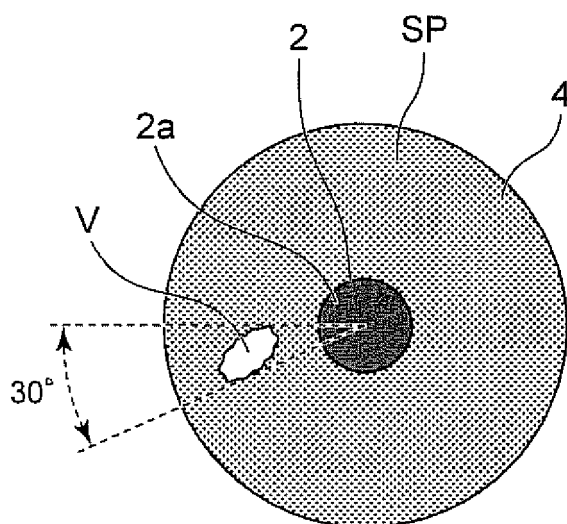


FIG. 6

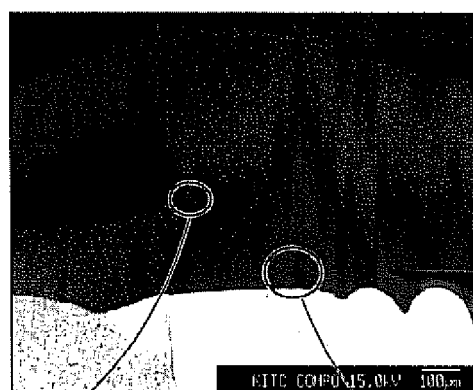


FIG. 7A

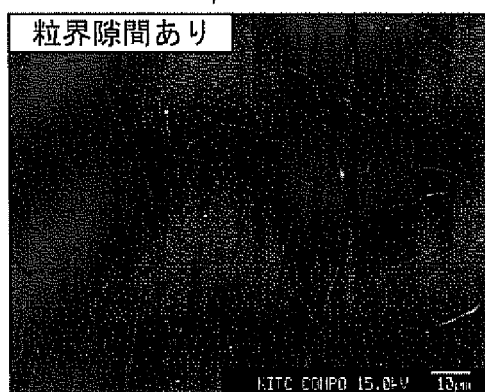


FIG. 7B



FIG. 7C

REFERENCES CITED IN THE DESCRIPTION

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