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SPECIFICATION

TITLE OF THE INVENTION

METHOD FOR FABRICATING PLASMA DISPLAY PANEL AND
PLASMA DISPLAY PANEL FABRICATED BY THE SAME

5 BACKGROUND OF THE INVENTION

The present invention relates to a method for
fabricating minute formations, more particularly, to a
method for fabricating a plasma display panel which can
fabricate a fluorescent material layer into a desired shape
10 with stability as well as to a plasma display panel
fabricated by the method.

In recent years, with the development of display
devices having high precision and yet fine image quality,
such as the high-vision system, display means have also
15 been in demands for larger size and higher definition.

The CRT display system is capable of providing
display tubes with high emission intensities, while they
have been available in sizes of 30 to 40 inches. However,
the CRT display system has a drawback that it is difficult
20 to upsize beyond 40 inches due to its structural
limitations.

Meanwhile, the liquid crystal display system,
although having some advantages including low power
consumption and the unit's compact make, has disadvantages
25 that it is incapable of providing those with high emission

intensities, and that it is too complex in structure to
upsized except the projection type.

In contrast to those systems, the plasma display
system has advantages such as the implementation of a
5 display unit comparable in emission intensity to the CRT
system, relatively simple structure, the capability of its
upsizing, and the unit's compact make. From these points
of view, the plasma display system has been receiving
growing attention as a substitute for the CRT display
10 system or liquid crystal display system.

The panel of this plasma display system has two
substrates, and a large number of cells having such a
structure that fluorescent material layers, electrodes, and
discharge gas are contained in minute spaces surrounded by
15 partition walls provided to the substrates. When the
discharge gas between the electrodes in each cell is
excited, ultraviolet rays are generated by the excited
discharge gas returning to the ground state, causing the
fluorescent materials in the fluorescent material layers to
20 emit light. This is the formation of pixels.

It has been conventional practice to employ the
screen printing process for the fabrication of the
fluorescent material layers in this plasma display panel.
This process, unfortunately, has limitations in printing
25 precision such that patterns of higher than around 100 μm

definitions could hardly be obtained. Besides, in the screen printing process, in order to form a thick film, the printing of the same pattern is repeated many times such that the pattern may shift gradually, making it impossible
5 to obtain a desired pattern as another drawback.

Recently, however, grinding techniques making use of the sandblasting process or powder beam process have come to be exploited for fine processing, lending themselves to the fabrication of the plasma display panel
10 in combination with the screen printing process.

In order to fabricate the fluorescent material layers by this process, lower electrodes, an electrode protective layer, and partition walls are first formed on the substrate on the rear surface side. Then, a
15 fluorescent material paste composition composed of high polymer binder, fluorescent material, and solvent or water is filled in desired partition walls by the screen printing process and, as required, a resist pattern having anti-blast property is provided on the partition walls, followed
20 by blowing fine powder material. Thus, the grinding process is carried out by such a blasting process.

A paste-state composition with viscosity lower than about 100,000 cP is used as the fluorescent material paste composition. Therefore, by conducting a drying
25 process after the paste-state composition is filled within

the partition walls, shrinkage occurs due to its volumetric contraction so that the paste composition results in a mortar-shape. Thus, such a paste composition is suitable for the blasting process involving the blowing of fine powder.

However, when the grinding process is implemented by the blasting process, there is a possibility that the fluorescent material layers may be finished into various shapes depending on the differences in the filled state of the dried paste or the properties of the fluorescent material powder. In other words, since different colors of the fluorescent material layers involve differences in the hardness and the shape of fluorescent material powder, the filling amount of fluorescent material powder in the paste, and the like, the processed shape of the fluorescent material layer is unstable in shape such that fluorescent material layers of the same shape is difficult to obtain. This largely affects the stability of emission intensity and color balance, causing the issue that constant quality products are difficult to obtain. In particular, lack of uniformity of the electrode exposure area makes a cause for functional deteriorations such as intensity variations, creating a significant issue that affects the quality of the plasma display panel.

Since the processing is performed by the blasting

process, it is necessary to select an organic high polymer binder that has good processibility. This leads to another issue of a narrow selective range of binder.

As yet another issue, the fluorescent material powder scattered in the processing by the blasting process may deposit on upper parts of the partition walls, thus forming bright spots of the plasma display panel, which may result in deteriorated quality.

SUMMARY OF THE INVENTION

10 It is therefore an object of the present invention to provide a method for fabricating a plasma display panel, and a plasma display panel fabricated by the same, which is capable of overcoming the instability in shape precision of the prior art and improving the
15 stability in the quality of the plasma display panel.

In accomplishing these and other aspects, according to a first aspect of the present invention, there is provided a method for fabricating a plasma display panel, comprising steps of:

20 inserting a setting type paste which is a material for forming a fluorescent material layer in spaces of partition walls in a substrate, by using a screen having openings corresponding to openings of the partition walls constituting spaces serving as discharge cells for holding
25 the fluorescent material layer on the substrate having an

electrode pattern;

curing the setting type paste;

removing uncured portions of the setting type
paste; and

5 forming the fluorescent material layer by drying
and then baking the setting type paste.

 According to a second aspect of the present
invention, there is provided the method according to the
first aspect, wherein the setting type paste is a
10 photosetting type of fluorescent-material-containing
photosensitive resin paste which contains a solvent,
monomer, polymerization initiator, and fluorescent
material, and the substrate and the partition walls are
light-transmittable.

15 According to a third aspect of the present
invention, there is provided the method according to the
second aspect, wherein the electrode pattern has an
electrode bus formed on the substrate, a light-impervious
island electrode exposed from a light-transmittable
20 insulating layer formed on the substrate, and a light-
impervious anode or cathode formed on an exposed portion of
the island electrode where the island electrode is exposed
from the insulating layer, and thereby constitutes a DC
type plasma display panel.

25 According to a fourth aspect of the present

invention, there is provided the method according to the second aspect, wherein the electrode pattern has address electrodes which are formed on the substrate and are parallel with each other, and thereby constitutes an AC
5 type plasma display panel.

According to a fifth aspect of the present invention, there is provided the method according to the second aspect, wherein the electrode pattern has address electrodes which are formed on the substrate and are
10 parallel with each other, and the panel has an insulating layer covering the substrate and the address electrodes, and thereby constitutes an AC type plasma display panel.

According to a sixth aspect of the present invention, there is provided the method according to the
15 third aspect, wherein in the curing step, light, electron beams, or radioactive rays for curing the paste is irradiated from a surface of the substrate opposite to a surface thereof where the partition walls are formed, whereby the paste is cured except a portion shadowed by the
20 anode or cathode or the island electrode.

According to a seventh aspect of the present invention, there is provided the method according to the sixth aspect, wherein irradiation of light, electron beams, or radioactive rays for curing the fluorescent-material-
25 containing photosensitive resin paste is conducted also

from the surface of the substrate where the partition walls are formed by using a mask for masking an upper part of the anode or cathode or the island electrode.

According to an eighth aspect of the present invention, there is provided the method according to the third aspect, wherein the setting type paste is a photosetting type of fluorescent-material-containing photosensitive resin paste which contains a solvent, monomer, polymerization initiator, and fluorescent material, and the substrate and the partition walls are light-transmittable, and

the solvent in the paste is filled in the spaces serving as the discharge cells is dried and then the paste is formed in a shape of a mortar, the paste is cured except a portion shadowed by the anode or cathode or the island electrode, and uncured portions of the paste are cleaned and removed, and whereby the fluorescent material layer having the mortar-shape is obtained with the anode or cathode exposed.

According to a ninth aspect of the present invention, there is provided the method according to the fourth or fifth aspect, wherein the setting type paste is a photosetting type of fluorescent-material-containing photosensitive resin paste which contains a solvent, monomer, polymerization initiator, and fluorescent

material, the substrate and the partition walls are light-transmittable, the address electrodes are light-impervious, and

the solvent in the paste is filled in the spaces
5 serving as the discharge cells is dried and then the paste is formed in a shape of a gutter, the paste is cured except portions shadowed by the address electrodes, and uncured portions of the paste are cleaned and removed, and whereby the fluorescent material layer having the gutter-shape is
10 obtained with the address electrodes exposed.

According to a tenth aspect of the present invention, there is provided the method according to the eighth or ninth aspect, wherein the partition wall has such a shape that its side surface is curved so as to outwardly
15 widen from a portion on its substrate side to a portion on its opening side with a thickness of the portion on the substrate side being larger than that of the portion on the opening side.

According to an eleventh aspect of the present
20 invention, there is provided the method according to any one of the second through tenth aspects, wherein an amount of the fluorescent-material-containing photosensitive resin paste filled in the spaces serving as the discharge cells, or an amount of the solvent therein is controlled, and an
25 amount of light, electron beams, or radioactive rays is

controlled, so that a height of the fluorescent material layer is $1/3$ or more that of the partition wall.

According to a twelfth aspect of the present invention, there is provided the method according to any
5 one of the first through eleventh aspects, wherein the light is ultraviolet ray.

According to a thirteenth aspect of the present invention, there is provided the method according to the fourth or fifth aspect, wherein the setting type paste is
10 a fluorescent-material-containing thermosetting resin paste.

According to a fourteenth aspect of the present invention, there is provided the method according to of the thirteenth aspect, wherein an amount of the fluorescent-
15 material-containing thermosetting resin paste filled in the spaces serving as the discharge cells, or an amount of the solvent contained in the paste is controlled, and an amount of light, electron beams, or radioactive rays is controlled, so that a height of the fluorescent material
20 layer is $1/3$ or more that of the partition wall.

According to a fifteenth aspect of the present invention, there is provided a plasma display panel fabricated by the method of the first aspect.

According to a sixteenth aspect of the present
25 invention, there is provided the plasma display panel

according to the fifteenth aspect, wherein the setting type paste is a photosetting type of fluorescent-material-containing photosensitive resin paste which contains a solvent, monomer, polymerization initiator, and fluorescent material, and the substrate and the partition walls are light-transmittable.

According to a seventeenth aspect of the present invention, there is provided the plasma display panel according to the sixteenth aspect, wherein the electrode pattern has an electrode bus formed on the substrate, a light-impervious island electrode exposed from a light-transmittable insulating layer formed on the substrate, and a light-impervious anode or cathode formed on an exposed portion of the island electrode where the island electrode is exposed from the insulating layer, and thereby constitutes a DC type plasma display panel.

According to an eighteenth aspect of the present invention, there is provided the plasma display panel according to the sixteenth aspect, wherein the electrode pattern has address electrodes which are formed on the substrate and are parallel with each other, and thereby constitutes an AC type plasma display panel.

According to a nineteenth aspect of the present invention, there is provided the plasma display panel according to the sixteenth aspect, wherein the electrode

pattern has address electrodes which are formed on the substrate and are parallel with each other, and the panel has an insulating layer covering the substrate and the address electrodes, and thereby constitutes an AC type plasma display panel.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a partly enlarged perspective view of a plasma display panel obtained by a plasma display panel fabrication method according to a first embodiment of the present invention;

Figs. 2A, 2B, and 2C are sectional schematic views for explaining the procedure of fabricating electrode circuits obtained in the first embodiment;

Fig. 3 is a partial plan view of resistors and electrode circuits obtained in the first embodiment;

Figs. 4A, 4B, 4C, 4D, 4E, and 4F are sectional schematic views for explaining the procedure of fabricating the resistors and an electrode pattern obtained in the first embodiment;

Figs. 5A, 5B, 5C, and 5D are sectional schematic

views for explaining the procedure of fabricating insulating layers and anodes obtained in the first embodiment;

5 Figs. 6A, 6B, and 6C are sectional schematic views for explaining the procedure of fabricating partition walls obtained in the first embodiment;

Figs. 7A, 7B, 7C, and 7D are sectional schematic views for explaining the procedure of fabricating a fluorescent material layer obtained in the first
10 embodiment;

Fig. 8 is a perspective view of a screen used in a second embodiment of the present invention;

Fig. 9 is a partial sectional view showing the sectional configuration of the fluorescent material layer
15 fabricated in the second embodiment;

Fig. 10 is a partial plan view showing the plan configuration of the fluorescent material layer fabricated in the second embodiment;

Fig. 11 is a partial sectional view showing the
20 sectional configuration of the fluorescent material layer fabricated in a comparative example;

Fig. 12 is a partial plan view showing the planar configuration of the fluorescent material layer fabricated in the comparative example;

25 Fig. 13 is an enlarged sectional view of the

fluorescent material layer of a plasma display panel obtained by a third embodiment of the present invention;

Fig. 14 is a partial plan view showing the planar configuration of the fluorescent material layer fabricated
5 by a comparative example;

Fig. 15 is a perspective view of an AC type plasma display panel obtained by a plasma display panel fabrication method according to another embodiment of the present invention;

10 Fig. 16 is an outlining explanatory view of a DC type plasma display panel;

Fig. 17 is an outlining explanatory view of an AC type plasma display panel according to an embodiment of the present invention; and

15 Fig. 18 is an outlining explanatory view of an AC type plasma display panel according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before the description of the present invention
20 proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

Fig. 1 is a partial perspective view showing a DC type color PDP (Plasma Display Panel) fabricated according
25 to a first embodiment of the present invention.

Referring to Fig. 1, the color PDP 1 comprises a back side panel 2, and a front side panel 3 opposed to the back side panel 2 with a desired interval. The back side panel 2 has a rear side substrate 10, and partition walls 11 formed on the rear side substrate 10 in correspondence to pixels. The front side panel 3 is under the control by the partition walls 11 for its opposing interval.

The rear side substrate 10 is made of light-transmittable glass. On the rear side substrate 10, island-shaped electrodes 20 arrayed into a matrix, electrode buses 22 for connecting the island electrodes 20 with one another, and resistors 21 for connecting the electrode buses 22 and the island electrodes 20 with each other are formed in pluralities. These island electrodes 20, resistors 21, electrode buses 22, and the like are respectively formed from an electrically conductive composition in which electrically conductive material such as silver or ruthenium oxide is mixed to glass. The electrode buses 22 are ladder-like members branched off to right and left, and are so structured that a pair of right-and-left ladder-like members extending in one direction (vertical direction in Fig. 1) on the rear side substrate 10 are arrayed in a large number in the horizontal direction in Fig. 1 with intervals. Between one pair of electrode buses 22 and another, an auxiliary bus 23 is

formed. The island electrodes 20 are each disposed between portions 22a corresponding to the crossbars of the ladder-like members of the electrode buses 22. The resistors 21 are each installed between the island electrode 20 and the crossbar-like portion 22a of the electrode buses 22. Voltages to be applied to the island electrodes 20 depend on the resistors 21.

On the rear side substrate 10, an insulating layer 15 is formed so as to cover the island electrodes 20, the resistors 21, and the electrode buses 22, including the regions where the auxiliary buses 23 are formed. The insulating layer 15 is made of a dielectric material such as glass, and has through holes 16 formed at portions opposite to the island electrodes 20. At the through holes 16, anodes 13 respectively connected to the island electrodes 20 are formed. The auxiliary buses 23 also have through holes 16a formed at the same pitch as the through holes 16. At the through holes 16a, auxiliary anodes 24 are formed for higher response speed of display.

The partition walls 11 are formed on the insulating layer 15 and arrayed into a matrix so as to each surround the anode 13. In each partition wall 11, either one of display cells 14_R , 14_G , or 14_B having a fluorescent material layer 17_R , 17_G , or 17_B of one of three colors, red, green, and blue is disposed. In this embodiment, two

green display cells 14_G are positioned oblique, and blue and red display cells 14_B and 14_R are positioned oblique so as to cross them. Thus, these four display cells 14_R, 14_G, 14_G, and 14_B make up one pixel.

5 The front side panel 3 has a front side substrate 12 made of light-transmittable glass. On a surface of the front side substrate 12 facing the rear side substrate 10, a cathode line 25 extending perpendicularly to the electrode bus 22 is buried in at a position facing the
10 anode 13. This cathode line 25 is formed in a way that paste-state electrically conductive ink containing aluminium etc. is filled in a groove formed in the front side substrate 12 by a screen printing process or the like. Further, priming spaces (not shown) for leading charges to
15 the display cells 14_R, 14_G, 14_B are also formed on the front side substrate 12.

Next, the procedure of fabricating the back side panel 2 of the DC type color PDP adopting the first embodiment of the present invention is explained with
20 reference to Figs. 2 through 7.

In the first embodiment of the present invention, the conductor circuit for the electrode buses 22, the resistors 21, and the like is first formed on the rear side substrate 10. Then, the insulating layer 15, and the
25 partition walls 11 are stacked thereon one by one.

Finally, the fluorescent material layers 17_R , 17_G , 17_B are formed within the partition walls 11, by which the back side panel 2 is fabricated.

In this fabrication procedure, first, an
5 electrically conductive photosensitive resin film 30 that will result in the rear side substrate 10, the island electrodes 20, the electrode buses 22, and the auxiliary buses 23, an insulating photosensitive resin film 40 that will result in the insulating layer 15, an electrically
10 conductive resin paste 38 that will result in the resistors 21, and a partition wall-forming film 45 that will result in the partition walls 11 are prepared. Besides, a fluorescent-material-containing photosensitive resin paste 50 (50_R , 50_G , 50_B) that will result in the fluorescent
15 material layers 17_R , 17_G , 17_B is also prepared.

The electrically conductive photosensitive resin film 30 that will result in the electrode buses 22 and the auxiliary buses 23 is preferably prepared by mixing a
20 powder including conductive metal powder composed of glass powder and silver, and filler, with a resin composition containing crosslinking or other type organic high polymer binder, photoreaction initiator, and photoreaction
accelerator, and then by developing the mixture into a sheet state on a separate film, with the resulting
25 thickness in the range of 5 - 10 μm uniform. The filler

may not be contained in the film 30. The insulating photosensitive resin film 40 that will result in the insulating layer 15 is preferably prepared by mixing a powder containing lead-series, zinc-series, or other like glass powder and filler such as boron oxide or silicon dioxide, with a resin composition containing crosslinking or other type organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film, with the resulting thickness in the range of 5 - 100 μm uniform. The electrically conductive resin paste 38 that will result in the resistors 21 is preferably a paste prepared by mixing a powder including metal oxide powder containing glass powder and ruthenium oxide, or other like which imparts the electrical conductivity with a crosslinking or other type organic high polymer binder. The partition wall-forming film 45 that will result in the partition walls 11 is preferably prepared by mixing a powder containing lead-series, zinc-series, or other like glass powder and filler such as boron oxide or silicon dioxide, with a crosslinking or other type organic high polymer binder. The fluorescent-material-containing photosensitive resin paste 50 that will result in the fluorescent material layers 17_R , 17_G , 17_B is preferably a paste prepared by mixing an ultraviolet-ray emission type

fluorescent material powder with a resin composition containing crosslinking or other type organic high polymer binder, photoreaction initiator, and photoreaction accelerator, with the possibly uniform.

5 Over the preparation of these materials, the electrode buses 22, the auxiliary buses 23, and the island electrodes 20 are first formed on the rear side substrate 10. As shown in Fig. 2A, the electrically conductive photosensitive resin film 30 is adhered first to the rear
10 side substrate 10. For this adhesion, the separate film, positioned on top, is developed and adhered onto the rear side substrate 10 with a roll or the like. Subsequently, as shown in Fig. 2B, a mask 31 having light-transmitting portions 31a provided at places corresponding to the shapes
15 and positions of the electrode buses 22, the auxiliary buses 23, and the island electrodes 20 is positioned and set above the rear side substrate 10, in which state the electrically conductive photosensitive resin film 30 is exposed to light. Then, as shown in Fig. 2C, through a
20 developing process with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water solution of sodium hydroxide, for example, exposed portions 30a are cured so that the electrically conductive resin that will
25 result in the electrode buses 22, the auxiliary buses 23,

and the island electrodes 20 is formed. After drying, this is baked with temperature held at 620 to 650°C for about 0.5 hour as one example, by which organic components or any excess components contained in uncured resin film or cured electrically conductive resin are removed. As a result, the electrode buses 22 each in the form of ladder-like member, the auxiliary buses 23 each in linear form, and the island electrodes 20 arrayed into a matrix can be obtained at a uniform thickness of 4.8 to 5.2 μm . In this way, by using the electrically conductive photosensitive resin film 30 with uniform thickness in the formation of the conductor circuit of the electrode buses 22 and the like, as compared with their formation performed by the screen printing process variation in electrical resistance value due to time deterioration which is caused by evaporation of ink solvent or the like, as well as variation in electrical resistance value due to deviation of component particles of the mixture within ink can be suppressed. Thus, a stable electrical circuit can be obtained.

Subsequently, the resistors 21 are formed in such a way that the electrode buses 22 and the island electrodes 20 are connected to each other via the resistors 21. For the formation of the resistors 21, as shown in Fig. 4A, photo-resist 35 is applied uniformly to the rear side substrate 10. Then, as shown in Fig. 4B, a mask 36 having

light-shielding portions 36b provided at places corresponding to the shapes and positions of the resistors 21 is positioned and set above the rear side substrate 10, in which state the photo-resist 35 is exposed to light. 5 Then, as shown in Fig. 4C, through a developing process with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water solution of sodium hydroxide, for example, rectangular recessed portions 37 that will result 10 in the pattern of the resistors 21 are formed at unexposed portions 35a, so as to be partly exposed between the electrode buses 22 and the island electrodes 20.

Now that the recessed portions 37 are formed, as shown in Fig. 4D, an electrically conductive resin paste 38 15 is filled into the recessed portions 37 and dried. This filling and drying processes of the electrically conductive resin paste 38 are carried out to a plurality of times, taking into account the possible contraction due to drying. Upon completion of the filling and drying processes, as 20 shown in Fig. 4E, the surface is ground smooth by a wrapping device 400 and, besides, the filled conductive resin paste 38 is controlled to a specified value of thickness (surface height) (e.g., 10 to 15 μm). Then, through a baking with temperature kept at 600 to 620°C for 25 about 0.5 hour as one example, organic components and the

like contained in the photo-resist 35 of unexposed portions or the conductive resin paste 38 are removed, by which the resistors 21 are obtained as shown in Fig. 4F and Fig. 3. The resistors 21 obtained in this way are height-controlled
5 so as to be uniform in thickness. Thus, variation in resistance value is reduced and variation in discharge voltage is less likely to occur. As a result, a successful color PDP with less variation in brightness for each pixel can be obtained.

10 After the resistors 21 are formed, the insulating layer 15 is fabricated so as to cover the resistors 21, the island electrodes 20, the electrode buses 22, and the auxiliary buses 23 while the portions where the auxiliary anodes 24 of the auxiliary buses 23 are formed and the
15 portions where the anodes 13 of the island electrodes 20 are formed are exposed. Further, the anodes 13 and the auxiliary anodes 24 are formed by the screen printing process. In the formation of the insulating layer 15, as shown in Fig. 5A, the light-transmittable insulating
20 photosensitive resin film 40 with the separate film up is developed and adhered onto the rear side substrate 10 with a roll or the like. Next, as shown in Fig. 5B, a mask 41 having light-shielding portions 41a provided at places corresponding to such shapes and positions that the
25 portions where the anodes 13 of the island electrodes 20

are formed and the portions where the auxiliary anodes 24 of the auxiliary buses 23 are formed are exposed is positioned and set above the rear side substrate 10, in which state the insulating photosensitive resin film 40 is
5 exposed. Through a developing process with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water solution of sodium hydroxide, as shown in Fig. 5C, the through holes 16 for formation of the
10 anodes 13 and the through holes 16a for formation of the auxiliary anodes 24 are bored, for example, at unexposed portions 40a. Then, through a baking with temperature kept at 550 to 600°C for about 0.5 hour as one example, the insulating layer 15 can be obtained. After the insulating
15 layer 15 has been obtained, the electrically conductive resin paste is filled into the through holes 16, 16a by the screen printing process, and dried and baked, by which the anodes 13 and the auxiliary anodes 24 are obtained as shown in Fig. 5D. In this way, by using the insulating
20 photosensitive resin film 40 with uniform thickness for the formation of the insulating layer 15, the insulating layer 15 can be formed into more smooth, uniform thickness, compared to when it is formed by the screen printing. Therefore, variation in the distance between the anode 13
25 and the cathode is reduced, so that the variation in

discharge gap is reduced.

With the anodes 13 formed, the partition walls 11 are then formed so as to surround the anodes 13. For the formation of the partition walls 11, as shown in Fig. 6A, 5 the light-transmittable partition wall-forming film 45 with the separate film up is developed and adhered onto the insulating layer 15 of the rear side substrate 10 with a roll or the like. Subsequently, in order that low molecular weight substances contained in the partition 10 wall-forming film 45 are urged to evaporate and that subsequent processing uniformity is obtained, heating is carried out for a certain time, followed by cooling. Then, a photosensitive film 53 with a separate film up is developed and adhered onto the partition wall-forming film 15 with a roll or the like.

Next, as shown in Fig. 6B, a mask 46 having light-shielding portions 46a provided at places corresponding to the shapes and positions of the partition walls 11 is positioned and set above the rear side 20 substrate 10, in which state the photosensitive film 53 is exposed. Through a developing process with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water solution of sodium hydroxide, for 25 example unexposed portions 53a are removed and matrix-

shaped recessed portions 47 that will be the origin of the partition walls 11 are formed there.

Subsequently, glass beads etc. are blown onto portions 45a of the partition wall-forming film 45 exposed
5 through the recessed portions 47 via air by using a sandblasting machine. As a result, as shown in Fig. 6C, each of the matrix-shaped recessed portions 48 surrounded by the partition wall 11 having such a shape that the thickness of the lower end portion on its substrate side is
10 larger than that of the upper end portion on its opening side is formed on each of the anodes 13.

After the partition walls 11 have been formed, the fluorescent material layers 17_R , 17_G , 17_B are formed within the partition walls 11. For the formation of the
15 fluorescent material layers 17_R , 17_G , 17_B , as shown in Fig. 7A, for example, red-fluorescent-material-containing photosensitive resin paste 50_R is dropped from a screen 151 into the partition walls 11 with a squeegee 150 or the like. Next, hot air drying is carried out at about 100°C
20 for 10 minutes as one example, followed by cooling. In this way, the fluorescent material resin paste 50_R is formed within the partition walls 11 as shown in Fig. 7B. Subsequently, as shown in Fig. 7C, the layer of the fluorescent material resin paste 50_R is exposed to light by
25 irradiating ultraviolet rays from below the rear side

substrate 10. Then, through a developing process with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water solution of sodium hydroxide, the fluorescent-material-containing photosensitive resin paste 50_R is left only at, for example, exposed portions 50a as shown in Fig. 7D and then the layer of the red fluorescent-material-containing photosensitive resin paste 50_R is obtained. These processes to the above are repeated similarly by using a green-fluorescent-material-containing photosensitive resin paste 50_G and a blue-fluorescent-material-containing photosensitive resin paste 50_B, by which green and blue fluorescent material layers 17_G and 17_B are obtained sequentially. Then, through a baking with temperature kept at 450 to 520°C for about 0.5 hour as one-example, organic components contained in the fluorescent-material-containing photosensitive resin pastes 50_R, 50_G, 50_B are evaporated with the result that the red fluorescent material layer 17_R is obtained. When the height of the fluorescent material layer obtained in the above fluorescent material layer-forming process is not sufficient, the fluorescent material layer-forming process is repeated desired times to overlap the layer with the previously-formed layer to obtain the fluorescent material layer having a desired height.

The fluorescent material layers 17_R, 17_G, 17_B obtained in this way are formed in a U-curved shape, or inverted temple bell shape, along the partition walls 11 with the help of the effect of such a configuration of the partition wall 11 that the thickness of the lower end portion is larger than that of the upper end portion. Therefore, the light emitted from the fluorescent material layers 17_R, 17_G, 17_B is irradiated forward with high efficiency. This allows the light emission efficiency to be improved so that a color PDP with high brightness and good contrast can be obtained. Further, since the removed fluorescent materials contained in the fluorescent-material-containing photosensitive resin pastes 50_R, 50_G, 50_B are removed prior to the curing process, it becomes possible to recycle the removed materials. Thus, expensive fluorescent material is less wasted in vain, as compared with the prior art.

Once the back side panel 2 is fabricated over these steps, it is bonded together with the front side panel 3 fabricated by separate process, and inside air is replaced with inert gas such as helium and xenon, or helium and neon. Thus, the display section is completed. Finally, electronic circuits and a chassis are assembled, by which the PDP1 is completed.

Now, a method for fabricating a plasma display

panel according to a second embodiment of the present invention is described with reference to Figs. 1 and Figs. 8 to 10.

Fig. 1 shows the substrate of a plasma display panel 1, where reference numeral 10 denotes a transparent substrate made of an about 2 mm thick glass substrate as one example; 20 denotes island electrodes formed on the transparent substrate 10 in a matrix in correspondence to pixels; 22 denotes electrode buses for constituting anode buses each extended along one direction of columns of the matrix-shaped island electrodes 20 and each connected to the island electrodes 20; 21 denotes resistors stretched over the connecting portions between the electrode buses 22 and the island electrodes 20; 15 denotes an insulating layer formed on the transparent substrate 10 so that the island electrodes 20 are exposed; 11 denotes partition walls made of glass fine particles etc. which are formed so as to surround the island electrodes 20; 17 (17_R, 17_G, 17_B) denote(s) fluorescent material layers formed within the partition walls 11; and 25 denotes a cathode line for constituting the cathode electrode provided on the partition walls 11 along the other direction of columns of the matrix-shaped island electrodes 20.

Next described is the molding process of the fluorescent material layers 17_R, 17_G, 17_B. The transparent

substrate 10 on which the island electrodes 20, the electrode buses 22, the resistors 21, the insulating layer 15, and the partition walls 11 are formed, as well as a screen (mask) 31 as shown in Fig. 8 are set to a screen printing machine. Then, after the alignment of the position on the transparent substrate 10 where the partition walls 11 are formed, with the screen 31 is carried out, the fluorescent-material-containing photosensitive resin paste for forming the fluorescent material layers 17 is placed on the screen 31 in a necessary amount, and filled within the partition walls 11 of the transparent substrate 10 by using a squeegee. Compositions as shown in Table 1 were used as five Examples of the fluorescent-material-containing photosensitive resin pastes for forming the fluorescent material layers 17:

Table 1:

(Wt%)

Examples	Fluorescent material powder- filled amount	Resin-filled amount	Crosslinking agent-filled amount
1	59.2	40.7	0.1
2	59.2	40.6	0.2
3	59.1	40.5	0.4
4	58.4	40.1	1.5
5	58.1	39.9	2.0

After the fluorescent-material-containing photosensitive resin paste filling process was carried out for each color, the transparent substrate 10 was set to an ultraviolet-curing apparatus, and ultraviolet rays were irradiated from the rear side of the transparent substrate 10 at a total quantity of light of 7.2 mW/cm^2 for about 3.5 seconds.

Next, the transparent substrate 10 over the photo-irradiation was set to a developing machine with the

end faces of the partition walls 11 downward. Then, development was carried out for about 1 minute by spraying about 23°C pure water at a pressure of 1 kg/cm² as one example.

5 Upon completion of the development, the water deposited on the transparent substrate 10 was removed with an air knife (i.e., curtain-like air blow), followed by drying at about 80°C for 30 minutes as one example. Thus, the fluorescent material layers 17 of a DC type plasma
10 display panel each having a configuration as shown in Figs. 9 and 10 were obtained.

 After the drying process, an about 1 hour baking process was carried out in a 520°C air atmosphere oven as one example, followed by cooling. Then, a front side
15 substrate to be paired was combined with the transparent substrate 10, by which the plasma display panel was completed.

 Next, a Comparative Example is described. As in the Examples, with the use of the transparent substrate 10
20 as shown in Fig. 1 and the screen 31 as shown in Fig. 8, conventional thermo-drying type fluorescent material ink was filled into the partition walls 11 of the transparent substrate 10 as shown in Fig. 1. Subsequently, a drying process was carried out at about 120°C for 10 minutes,
25 followed by cooling. Thereafter, fluorescent material

layers formed in the partition walls 11 were processed by the blasting process. Then, foreign matters deposited on the surface of the substrate 10 were removed by air, by which fluorescent material layers 217 as shown in Figs. 11 and 12 were obtained. After that, an about 1 hour baking process was carried out in a 520°C air atmosphere oven, followed by cooling. Then, a front side substrate to be paired was combined with the transparent substrate 10, by which a plasma display panel was completed.

10 With regard to the products obtained in the above Examples and Comparative Example, their brightness and electrode-exposure hole precision were evaluated. In more detail, on the basis of the brightness of the product obtained in the Comparative Example (Comparative Example
15 taken as 100), the brightnesses of the products obtained in the Examples were compared relatively. Also, the electrode-exposure hole precision was represented by a circularity characteristic given by a ratio of Y to X, where X is the minor diameter and Y is the major diameter,
20 by measuring the planar configurations of the electrode-exposure holes of the fluorescent material layers 17, 117 formed in the partition walls 11, with a comparison to the Comparative Example. The evaluation results are shown in Table 2:

Table 2:

		Relative comparison of brightness (%)	Precision of electrode-exposure hole diameter (Y/X)
5 Examples	1	115	1.00
	2	107	1.03
	3	100	1.05
	4	90	0.75
	5	87	0.7
Comparative Example		100	1.3

10 As apparent from Table 2, Examples 1, 2, and 3
showed superior characteristics over the Comparative
Example.

 It is noted that ultraviolet rays have been used
as the curing means in the embodiments described above and
15 later, electron beams or other like means may also be used
to produce similar advantages.

 According to the method for fabricating the
plasma display panel, as apparent from the foregoing
description, the fluorescent-material-containing
20 photosensitive resin paste filled in the partition walls is
cured in correspondence to the mask pattern by irradiating
light from the rear side of the substrate. Therefore, by
removing uncured portions thereafter, the fluorescent
material layers of the plasma display panel of a specified

pattern can be formed with high pattern precision in the partition walls.

According to the method in the present invention, since the fluorescent-material-containing photosensitive resin paste filled in the partition walls is exposed to light from a surface opposite to the surface on which the electrodes are formed, the electrode-exposure holes to be formed in the fluorescent material layers can be formed into uniform, stable configuration, while the fluorescent material layers can be formed up to a proximity to the electrode-exposure holes. Therefore, the light emission area of the fluorescent material layers is increased so that the brightness as well as the uniformity of brightness are improved. Besides, the developing process can be accomplished only by removing the uncured portions. Thus, bright spots, a fault of image quality in assembled complete products, can be prevented from occurring due to the deposition of the fluorescent material powder at end portions of the partition walls, as would occur with the conventional mechanical processing technique by the sandblasting process. Further, there can also be eliminated a possibility that no formation of exposure electrode holes due to differences in hardness of fluorescent material layers causes no-lighting spots to be generated, advantageously.

According to the method in the present invention, the fluorescent-material-containing photosensitive resin paste filled in spaces within the partition walls is cured by irradiating light from the rear side of the substrate.

5 Therefore, the electrode pattern formed on the substrate functions as a mask, so that fluorescent material layers of constant configuration can be formed in the partition walls at constant volume. Besides, the configuration of the electrode-exposure holes becomes uniform so that a

10 functional deterioration due to unstable configuration of the electrode-exposure holes in the blasting process can be prevented. Further, since there is no need of carrying out the exposure process after alignment with the use of an exposure mask, as would be involved in general exposure

15 process, there occur no variations in the positions where the electrode-exposure holes are formed, which is due to precision variations in the exposure mask alignment. Thus, the electrode-exposure holes can be formed at positions corresponding to the electrodes.

20 Next, a plasma display panel and its fabrication method according to a third embodiment of the present invention are described with reference to Figs. 1 and 13.

Referring to Fig. 1, which is a perspective view showing the construction of an anode-side glass substrate

25 (back side panel) 2 of the plasma display panel, reference

numeral 10 denotes an about 2 mm thick glass substrate as one example; 20 denotes an island electrode; 21 denotes resistors for constituting adjustment resistors; 22 denotes electrode buses for constituting primary electrodes to be
5 connected to the island electrodes 20 via the resistors 21; 23 denotes auxiliary buses for constituting auxiliary electrodes for normally applying a voltage close to the excitation voltage so that the electrode buses 22 can excite discharge gas without time delay; 15 denotes a
10 light-transmittable insulating layer formed by screen-printing and baking glass powder paste more than one time so that only the island electrodes 20 are exposed; 13 denotes light-impervious exposed electrode, anode electrodes, formed by inserting and baking electrically
15 conductive paste into the portions where the island electrodes 20 are exposed; and 11 denotes light-transmittable partition walls formed by screen-printing and baking glass powder paste more than one time on the insulating layer 15, where the spaces within the partition
20 walls 11 will result in discharge cells.

Table 3:

(Unit: Wt%)

	Composition	Red paste	Green paste	Blue paste
5	Fluorescent material powder	48.3	43.4	41.4
	Resin	39.1	42.9	44.1
	Polymerization initiator	0.08	0.17	0.26
10	Polymerization promotor	0.16	0.34	0.26
	Dispersion stabilizer	0.70	0.43	0.79
	Solvent	11.66	12.76	13.19
15	Paste viscosity [cps]	Approx. 18000	Approx. 14000	Approx. 20000

Table 3 lists the blending of fluorescent-
20 material-containing photosensitive resin pastes containing
solvents used as examples in the third embodiment.

In the application process of the paste, the back

side panel 2 as shown in Fig. 1 is set to a printing machine, and the screen is positioned on the back side panel 2 so that screen printing can be effected in the spaces of the partition walls 11. Then, the paste as shown
5 in Table 3 is placed on the screen in a specified amount, and filled into the spaces of the partition walls 11 with the use of a squeegee as indicated by 17a in Fig. 13, followed by drying. This process is carried out for each color of red, green, and blue.

10 In this process, the paste 17a as shown in Fig. 13 is formed into a mortar-shape with the central portion recessed down, because the organic solvent or water content used in the paste 17a is dissipated. The degree at which the paste 17a is recessed differs depending on the blending
15 of the paste. In either case where it is recessed to a little degree or to a large degree, the paste 17a is formed into a mortar-shape. However, the anode electrodes 13 are covered with the bottom of the mortar-shaped paste 17a so as not to be exposed.

20 In the ultraviolet-ray irradiation process, the back side panel 2 over the application of the paste 17a and drying is set to an ultraviolet curing apparatus, and ultraviolet rays are irradiated from the rear side of the back side panel 2 at a total quantity of light of 7.2
25 mW/cm² for about 3.5 seconds as one example. With this

irradiation, since the glass substrate 10 is transparent and both the insulating layer 15 and the partition walls 11 formed by printing and baking glass powder paste more than one time are semitransparent, the ultraviolet rays
5 irradiated from the rear side are transmitted except upper opaque portions where the island electrodes 20 and the anode electrodes 13 are present, and irregularly reflected and diffused by the semitransparent insulating layer 15 and partition walls 11. In this way, the paste 17a is cured
10 except the shadow portions of the island electrodes 20 and the anode electrodes 13 where the ultraviolet rays are not transmitted. Generally, the diameter of the anode electrodes 13 is slightly larger than that of the island electrodes 20. Accordingly, the paste 17a is cured,
15 outside the island electrodes 20 and the anode electrodes 13, into a mortar-shape as shown in the minute fluorescent material layer 17 of Fig. 13. Also, since the top surface of the partition walls 11 is blackened for better clarity of the screen, the ultraviolet rays will not reach the
20 paste 17a deposited on the top surface of the partition walls 11, so that cured paste 17a will never be deposited on the top surface of the partition walls 11.

In the cleaning process, the back side panel 2 over the ultraviolet-ray irradiation is set to a cleaning
25 apparatus with the surface having the partition walls 11

positioned down, and about 23°C pure water is sprayed at a pressure of 1 kg/cm² as one example. Thus, as shown in Fig. 13, the uncured paste 17a is cleaned away except the mortar-shaped cured portion.

5 In the drying process, water deposited on the cleaned back side panel 2 is removed by an air knife, followed by a 30 minute drying process at 80°C as one example. Thus, a mortar-shaped minute fluorescent material layers 17 as shown in Fig. 13 are obtained.

10 In the baking process, the back side panel 2 is baked for about 1 hour in an about 520°C air atmosphere oven as one example.

 In the assembling process, the back side panel 2 and the front side panel 3 having the cathode side glass
15 substrate are combined together, by which a plasma display panel is completed.

 In seven examples of the third embodiment, the plasma display panels were fabricated with the ultraviolet-ray irradiation time varied as 3.5 sec., 10 sec., 30 sec.,
20 60 sec., 90 sec., 120 sec., and 180 sec., as shown in Table 4 below.

 Now, a plasma display panel and its fabrication method according to a fourth embodiment of the present invention are described with reference to Figs. 1 and 13.

25 The back side panel 2 of the plasma display panel

shown in Fig. 1 has the same construction as in the third embodiment, and so its description is omitted.

The difference of the fourth embodiment from the third embodiment is that, in the ultraviolet-ray irradiation process, ultraviolet rays are first irradiated from the rear surface of the panel 2 at a total quantity of light of 7.2 mW/cm^2 for about 3.5 seconds as one example, and then with a mask for masking the portions of the anode electrodes 13 positioned on the surface of the back side panel 2, ultraviolet rays are irradiated at a total quantity of light of 7.2 mW/cm^2 for about 3.5 seconds as one example.

Next, as a comparative example, with the same back side panel 2 as used in the examples of the third and fourth embodiments, conventional thermo-drying type fluorescent material paste 7a is applied into the spaces of the partition walls 11, and dried at about 120°C for 10 minutes, followed by cooling. Then, a grinding process into the configuration of the fluorescent material layer 7a as shown in Fig. 14 is conducted by sandblasting. Foreign matters deposited on the glass substrate 10 are removed by air, and baked in an about 520°C air atmosphere oven for about 1 hour, followed by cooling. Then, the back side panel 2 and the front side panel 3 are combined together, by which a plasma display panel is completed.

The data of the examples of the third embodiment and the fourth embodiment, and the comparative example are shown in Table 4 below:

5 Table 4:

	Item	Ultraviolet-ray irradiation time	Brightness	Height of minute fluorescent material layer	Height of partition wall
10	Examples of third embodiment	3.5 sec, from rear side of substrate	0.7	50 μm	200 μm
15		10 sec, from rear side of substrate	0.98	70 μm	200 μm
		30 sec, from rear side of substrate	1.13	140 μm	200 μm
20		60 sec, from rear side of substrate	1.13	145 μm	200 μm
		90 sec, from rear side of substrate	1.15	150 μm	200 μm
25		120 sec, from rear side of substrate	1.17	160 μm	200 μm
30		180 sec, from rear side of substrate	1.18	170 μm	200 μm
35	Examples of fourth embodiment	3.5 sec, from rear side of substrate	1.2	190 μm	200 μm
		3.5 sec, from front side of substrate			
	Comparative Example	-	1.0	190 μm	200 μm

As shown in Table 4, by relative comparisons of brightness of the discharge cells in the plasma display panel with the value of the comparative example taken as 1.0, in the examples of the third embodiment in which
5 ultraviolet rays are irradiated from only the rear sides of the back side panels, the ultraviolet-ray irradiation time and the height of the minute fluorescent material layer are proportional to each other, where if the height of the minute fluorescent material layer is $1/3$ or more that of
10 the partition wall, then the brightness becomes equal to that of the comparative example, and if the height of the minute fluorescent material layer is $2/3$ or more that of the partition wall, then the brightness is ten odd percent brighter than that of the comparative example. In the
15 example of the fourth embodiment in which ultraviolet rays are irradiated from both rear side and front side of the back side panel, the height of the fluorescent material layer becomes close to that of the partition wall in short time, where the brightness is 20% higher than that of the
20 comparative example.

The reason of this can be inferred as follows. That is, each minute fluorescent material layer 7 of the comparative example is formed into a cylindrical shape adjoined to the inner side face of the partition wall 11 as
25 shown in Fig. 14, with the result of low light emission

efficiency. In contrast, the minute fluorescent material layer 17 in each example of the third and fourth embodiments is formed into a mortar-shape as shown in Fig. 13, in which case the mortar-shape is good at light
5 emission efficiency.

The reason that the minute fluorescent material layer 17 is mortar-shaped could be inferred as follows.

Examples of paste 17a, each of which is blended as shown in Table 3, contains a solvent. Therefore, when
10 it is filled into the spaces of the partition walls 11 and then dried, the solvent contained therein is dissipated, so that the central portion is recessed. The degree of this recess differs depending on the blending of the paste, where it can be controlled to slight to large recesses
15 depending on the blending of the paste. If the blending is controlled so that the recess over the processes of filling the paste into the spaces of the partition walls 11 and drying it becomes as shown by the paste 17a of Fig. 13, and if ultraviolet rays are irradiated from only the rear side
20 of the back side panel 2, then the ultraviolet rays reach within the paste 17a except the portions shadowed by the opaque anode electrodes 13. In this case, the ultraviolet rays decay soon in the paste 17a, and transmitted and diffused by the semitransparent insulating layer 15 and
25 partition walls 11, which have been made by baking glass

powder paste. Therefore, the ultraviolet rays that reach within the paste 17a result in a superimposition of ultraviolet rays passing the insulating layer 15 upward and ultraviolet rays diffusing from the partition walls 11 transverse. As a result, the vicinity of the anode electrodes 13, which is originally poor in the paste 17a and low in amount of ultraviolet rays, is cured in such a way that the bottom of the mortar-shape is formed with the anode electrodes 13 exposed. Meanwhile, the vicinity of the partition wall 11, which is rich in the paste 17a and high in amount of ultraviolet rays, forms the top of the mortar-shape.

Other than the above characteristic comparisons, fabrication process can be compared as below.

15 In the comparative example, the anode electrodes are exposed by using the sandblasting process. Therefore, the degree of exposure is affected by many factors such as differences in the grinding effect of sandblasting, differences in hardness of the fluorescent material layers, and differences in the configuration of the applied and dried fluorescent material layers, each with instability. In the present embodiment, ultraviolet rays are irradiated from the rear side of the back side panel, so that the fluorescent-material-containing photosensitive resin paste is cured except the portions shadowed by the island

20

25

electrodes and the anode electrodes. Then, uncured portions are cleaned and removed. In this way, the anode electrodes can be appropriately and securely exposed with simplicity.

5 In the comparative example, the grinding process is accomplished by sandblasting. Therefore, the back side panel is overlaid and assembled as the ground fluorescent material particles remain deposited on the top surfaces of the partition walls 11. Thus, there is a possibility that
10 those fluorescent material particles form bright spots, causing a deterioration in the quality of the plasma display panel. The present invention is free from this issue.

 As the light that cures the fluorescent-material-
15 containing photosensitive resin paste, ultraviolet rays are of good efficiency and easy to handle. However, other types of light or radioactive rays may be applied without the limitation to ultraviolet rays.

 According to the plasma display panel and its
20 fabrication method of the present invention, a fluorescent-material-containing photosensitive resin paste containing a solvent is used, and ultraviolet or other light or radioactive rays are irradiated from the rear side of the back side panel, so that the paste is cured except the
25 portions where the light or radioactive rays are shadowed

by the island electrodes and/or the anode electrodes. Then, uncured portions are cleaned and removed. As a result, the anode electrodes can be appropriately and securely exposed with simplicity. Besides, the shape
5 precision of the minute fluorescent material layers is excellent and stable, so that the characteristics such as brightness uniformity and color balance are excellent, advantageously.

In the present invention, with an additional
10 process of irradiating, from the partition wall side of the back side panel, light or radioactive rays serving for curing the fluorescent-material-containing photosensitive resin paste containing a solvent by using a mask that masks upper part of the anode electrodes and/or the island
15 electrodes, minute fluorescent material layers with larger height can be formed in short time irradiation of light or radioactive rays, and a bright plasma display panel can be obtained, advantageously.

In the present invention, if the height of each
20 of the minute fluorescent material layers is $1/3$ or more that of each of the partition walls, then a bright plasma display panel can be obtained, advantageously.

In the present invention, if ultraviolet rays are used as the light, the workability is good advantageously.

25 According to the plasma display panel fabrication

method of the present invention, for the formation of minute fluorescent material layers, a fluorescent-material-containing photosensitive resin paste containing a solvent is first filled in the spaces where the discharge cells are
5 formed. Then, the contained solvent is dissipated away, so that the central portion of the surface is recessed down, with the paste cured into a mortar-shape. In this state, the anode electrodes are covered with the paste.

Next, light or radioactive rays that cure the
10 paste are irradiated from the rear side of the back side panel. In this case, the glass substrate that constitutes the back side panel is transparent, while the insulating layer and the partition walls, which are prepared by applying and overlaying glass powder paste on a glass
15 substrate and baking them, are semitransparent so as to transmit the light or radioactive rays and diffuse part of them. As a result, the light or radioactive rays will not reach the portions shadowed by the opaque anode electrodes and/or the island electrodes, while the paste present at
20 the other portions is cured.

Subsequently, the paste of the uncured portions is cleaned and removed. Thus, mortar-shaped minute fluorescent material layers with the anode electrodes exposed are formed. The minute fluorescent material layers
25 of mortar-shape are good at light emission efficiency due

to discharge.

In this way, without troublesome burdens of the control for various types of fabrication conditions under which the minute fluorescent material layers are
5 fabricated, there can be provided a plasma display panel having a stable configuration precision of the mortar-shape of the minute fluorescent material layers, an appropriate exposure of the anode electrodes, and superior characteristics of brightness uniformity, and color
10 balance.

In the embodiments, the screen (mask) may also be a mesh screen, as well as a screen made from a metal plate having openings formed at the same pitch precision as those of the partition walls.

15 The term, "solvent," in the specification and claims refers to a liquid to be removed from the paste during the drying process, including water as well as organic solvents. The fluorescent-material-containing photosensitive resin paste refers to at least one which
20 contains monomer, polymerization initiator, and fluorescent material. The paste further contains polymer, contains solvent, or contains photosensitizer or polymerization inhibitor, as needed.

The means for curing the paste may be light
25 including ultraviolet rays or electron beams, radioactive

rays, or heat, or the like.

The first to fourth embodiments have been described with the use of the DC type plasma display panel. However, the invention may also be applied to an AC type plasma display panel as shown in Fig. 15. In this AC type plasma display panel, as shown in Fig. 15, the back side panel has a large number of strip-shaped, parallel address electrodes 120 formed on a glass substrate 110. Partition walls 111 are formed parallel between the address electrodes. The spaces between the adjacent partition walls 111 are in a string like a gutter, and the address electrodes 120 do not need to be exposed. Accordingly, the AC type plasma display panel largely differs from the DC type plasma display panel in which the exposed anode electrodes 13 are surrounded by the partition walls 11. In the AC plasma display panel, the fluorescent material layer 117 has a gutter-like cross section of a generally C shape. Meanwhile, two parallel write electrodes 125 are disposed on a glass substrate 103 of the front side panel. Accordingly, as shown in Fig. 17, in the AC type plasma display panel, discharge occurs first between one of the two write electrodes 125 and the address electrode 120, and thereafter the discharge is continuously effected between the two write electrodes 125. Thus, the fluorescent material layer 117 emits light as shown by an arrow 200.

In contrast to this, in the DC type plasma display panel, as shown in Fig. 16, discharge occurs between the cathode lines 25 of the front side panel substrate 12 and anodes 13 of the back side panel substrate 10, by which the fluorescent material layer 17 emits light as shown by an arrow 201. Thus, the anodes 13 need to be exposed.

In the DC type plasma display panel, photosetting is preferable from the viewpoint of the need for making electrodes exposed in the back side panel. Meanwhile, in the AC type plasma display panel as shown in Fig. 15, the electrodes do not need to be exposed in the back side panel, so that thermosetting may be applied as well as photosetting. In this case, the thermosetting can be accomplished by various means such as blowing hot air to a fluorescent-material-containing thermosetting resin paste, or putting the rear side panel having the paste into a high-temperature oven. The thermosetting is capable of reliably thermo-curing the paste up to its interior, so that the portions to be cured can be cured more reliably than the photosetting.

Further, when the back side panel having the paste is put into an oven that can be accurately controlled in temperature, it becomes possible to first conduct a curing process with the temperature controlled to one

necessary for the paste to be cured, and over the curing process, to subsequently conduct a baking process with the temperature elevated to a high necessary for baking. In this case, the curing process and the baking process of the
5 paste can be conducted in succession, so that the fabrication efficiency can be enhanced.

Although the AC type plasma display panel has no insulating layer, an insulating layer 115 may be provided on the address electrodes 120 and the glass substrate 110
10 and the partition walls 111 may be provided on the insulating layer 115 as shown in Fig. 18.

The sectional shape of each partition wall 11, 111 is not limited to such a shape that its side surface is a flat surface with the thicknesses of the whole portions
15 from its substrate side to its opening side being the same as each other, but may be of such a shape that its side surface is curved so as to outwardly widen from the portion on its substrate side to the portion on its opening side with the thickness of the substrate side-portion being
20 larger than that of the opening side-portion so as to easily form the mortar-shape or gutter shape, as shown in Fig. 9.

In the DC type and AC type plasma display panels, the arrangement of the anodes and cathodes can be replaced
25 with each other. That is, the electrodes 13, 120 arranged

on the anode-side in the panels may be functioned as the electrodes 13, 120 on the cathode-side while the electrodes 25, 125 arranged on the cathode-side in the panels may be functioned as the electrodes 25, 125 on the anode-side.

5 Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and
10 modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.



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WHAT IS CLAIMED IS:

1. A method for fabricating a plasma display panel, comprising steps of:

inserting a setting type paste (17a,50) which is
5 a material for forming a fluorescent material layer (17,117) in spaces of partition walls (11,111) in a substrate (10,110), by using a screen (31,151) having openings corresponding to openings of the partition walls (11,111) constituting spaces serving as discharge cells for
10 holding the fluorescent material layer (17,117) on the substrate (10,110) having an electrode pattern (20,21,22,23,120);

curing the setting type paste;

removing uncured portions of the setting type
15 paste; and

forming the fluorescent material layer (17,117) by drying and then baking the setting type paste.

2. The method according to Claim 1, wherein the setting type paste (17a,50) is a photosetting type of
20 fluorescent-material-containing photosensitive resin paste which contains a solvent, monomer, polymerization initiator, and fluorescent material, and the substrate (10,110) and the partition walls (11,111) are light-transmittable.

25 3. The method according to Claim 2, wherein the



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electrode pattern (20,21,22,23) has an electrode bus (22) formed on the substrate (10), a light-impervious island electrode (20) exposed from a light-transmittable insulating layer (15) formed on the substrate, and a light-
5 impervious anode or cathode (13) formed on an exposed portion of the island electrode where the island electrode is exposed from the insulating layer, and thereby constitutes a DC type plasma display panel (1).

4. The method according to Claim 2, wherein the
10 electrode pattern (120) has address electrodes (120) which are formed on the substrate (110) and are parallel with each other, and thereby constitutes an AC type plasma display panel.

5. The method according to Claim 2, wherein the
15 electrode pattern (120) has address electrodes (120) which are formed on the substrate (110) and are parallel with each other, and the panel has an insulating layer (115) covering the substrate and the address electrodes, and thereby constitutes an AC type plasma display panel.

20 6. The method according to Claim 3, wherein in the curing step, light, electron beams, or radioactive rays for curing the paste is irradiated from a surface of the substrate opposite to a surface thereof where the partition walls are formed, whereby the paste is cured except a
25 portion shadowed by the anode or cathode or the island



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electrode.

7. The method according to Claim 6, wherein irradiation of light, electron beams, or radioactive rays for curing the fluorescent-material-containing
5 photosensitive resin paste is conducted also from the surface of the substrate (10) where the partition walls are formed by using a mask for masking an upper part of the anode or cathode (13) or the island electrode (20).

8. The method according to Claim 3, wherein the
10 setting type paste (17a,50) is a photosetting type of fluorescent-material-containing photosensitive resin paste which contains a solvent, monomer, polymerization initiator, and fluorescent material, and the substrate (10) and the partition walls (11) are light-transmittable, and
15 the solvent in the paste (17a,50) is filled in the spaces serving as the discharge cells is dried and then the paste is formed in a shape of a mortar, the paste is cured except a portion shadowed by the anode or cathode (13) or the island electrode (20), and uncured portions of the
20 paste are cleaned and removed, and whereby the fluorescent material layer having the mortar-shape is obtained with the anode or cathode exposed.

9. The method according to Claim 4 or 5, wherein the setting type paste (17a,50) is a photosetting type of
25 fluorescent-material-containing photosensitive resin paste



which contains a solvent, monomer, polymerization initiator, and fluorescent material, the substrate (110) and the partition walls (111) are light-transmittable, the address electrodes are light-impervious, and

5 the solvent in the paste (17a,50) is filled in the spaces serving as the discharge cells is dried and then the paste is formed in a shape of a gutter, the paste is cured except portions shadowed by the address electrodes (120), and uncured portions of the paste are cleaned and removed,
10 and whereby the fluorescent material layer having the gutter-shape is obtained with the address electrodes exposed.

10. The method according to Claim 8 or 9, wherein the partition wall has such a shape that its side surface is
15 curved so as to outwardly widen from a portion on its substrate side to a portion on its opening side with a thickness of the portion on the substrate side being larger than that of the portion on the opening side.

11. The method according to any one of Claims 2-10,
20 wherein an amount of the fluorescent-material-containing photosensitive resin paste filled in the spaces serving as the discharge cells, or an amount of the solvent therein is controlled, and an amount of light, electron beams, or radioactive rays is controlled, so that a height of the
25 fluorescent material layer is $1/3$ or more that of the



partition wall.

12. The method according to any one of Claims 1-11, wherein the light is ultraviolet ray.

13. The method according to Claim 4 or 5, wherein the
5 setting type paste is a fluorescent-material-containing thermosetting resin paste.

14. The method according to of Claim 13, wherein an amount of the fluorescent-material-containing thermosetting resin paste filled in the spaces serving as the discharge
10 cells, or an amount of the solvent contained in the paste is controlled, and an amount of light, electron beams, or radioactive rays is controlled, so that a height of the fluorescent material layer is $1/3$ or more that of the partition wall.

15. A plasma display panel fabricated by a method for fabricating the plasma display panel, comprising steps of:

inserting a setting type paste (17a,50) which is a material for forming a fluorescent material layer (17,117) in spaces of partition walls (11,111) in a
20 substrate (10,110), by using a screen (31,151) having openings corresponding to openings of the partition walls (11,111) constituting spaces serving as discharge cells for holding the fluorescent material layer (17,117) on the substrate (10,110) having an electrode pattern
25 (20,21,22,23,120);



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curing the setting type paste;
removing uncured portions of the setting type
paste; and

forming the fluorescent material layer (17,117)
5 by drying and then baking the setting type paste.

16. The plasma display panel according to Claim 15,
wherein the setting type paste (17a,50) is a photosetting
type of fluorescent-material-containing photosensitive
resin paste which contains a solvent, monomer,
10 polymerization initiator, and fluorescent material, and the
substrate (10,110) and the partition walls (11,111) are
light-transmittable.

17. The plasma display panel according to Claim 16,
wherein the electrode pattern (20,21,22,23) has an
15 electrode bus (22) formed on the substrate (10), a light-
impervious island electrode (20) exposed from a light-
transmittable insulating layer (15) formed on the
substrate, and a light-impervious anode or cathode (13)
formed on an exposed portion of the island electrode where
20 the island electrode is exposed from the insulating layer,
and thereby constitutes a DC type plasma display panel (1).

18. The plasma display panel according to Claim 16,
wherein the electrode pattern (120) has address electrodes
(120) which are formed on the substrate (110) and are
25 parallel with each other, and thereby constitutes an AC



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type plasma display panel.

19. The plasma display panel according to Claim 16,
wherein the electrode pattern (120) has address electrodes
(120) which are formed on the substrate (110) and are
5 parallel with each other, and the panel has an insulating
layer (115) covering the substrate and the address
electrodes, and thereby constitutes an AC type plasma
display panel.