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SPECIFICATION

TITLE OF THE INVENTION

FILM, METHOD FOR FORMING PROTRUDED PORTIONS OF
PLASMA DISPLAY USING THE SAME, AND PLASMA DISPLAY
5 FABRICATED BY THE METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a film for
forming protruded portions, to a method for forming
10 protruded portions on a substrate of a color plasma display
using the film, and to a plasma display fabricated by the
method.

In recent years, in the fields of office
automation as well as audio and video technologies, there
15 has been a growing desire for the coloring of large-size
flat displays. The color plasma display panel
(hereinafter, referred to as color PDP) is one of the
techniques that meet the desire.

The color PDP comprises a front-side glass
20 substrate (front side panel), a rear-side glass substrate
(rear side panel), and partition walls that are arranged
therebetween so as to form a large number of cells. On
opposing surfaces of those substrates, electrodes
respectively corresponding to the cells are formed and
25 arrayed so as to perpendicularly cross each other. The

partition walls are provided regardless of whether they are of the AC or DC discharge type. By restricting the spacing between the two glass substrates with these partition walls, an appropriate discharging gap can be ensured while
5 crosstalk to adjacent cells can be prevented. Normally, the partition walls of the AC type color PDP are formed into a striped shape, whereas the partition walls of the DC type color PDP are formed into a matrix shape. Within the
10 partition walls, fluorescent material layers of three colors, R, G, and B, are formed and besides inert gas is enclosed. In such a color PDP, with a voltage applied between electrodes responsive to an image signal, gas discharge is effected within desired cells so that the fluorescent material layers are caused to emit light, by
15 which a color image is displayed.

This type of color PDP is fabricated in the following way. First, a front side panel and a rear side panel are fabricated by forming various types of protruded portions, which will serve as electrodes and partition
20 walls or the like, on glass substrates. The two panels are opposed to each other and sealed at their peripheries, and then inert gas is enclosed therein. Finally, a control circuit and chassis are assembled, by which the color PDP is completed.

25 For fabricating the rear side panel, in the case

of the DC type, electrodes and buses for connecting them are formed by screen printing process on a glass substrate. Subsequently, resistors for connecting the buses and the electrodes to each other are formed. On top of the
5 resistors formed, glass paste is applied by screen printing process, by which insulating layers are formed. In these insulating layers, holes are formed so that cathodes are exposed at cathode-forming portions of the layers. Metal paste is filled into the holes by screen printing process,
10 by which cathodes are formed. With the cathodes formed, partition walls are formed into a matrix shape around the cathodes by a plurality of times of screen printing process or shot blast process. Finally, fluorescent material layers are formed in spaces surrounded by the partition
15 walls by using screen printing process and shot blast process.

In the case of the AC type, address electrodes are formed on a glass substrate by screen printing process, and then after the electrodes are formed, a glass paste is
20 applied thereon by screen printing process to form an insulating layer, and then, partition walls are formed into a striped shape by screen printing process so that the address electrodes formed in rows are covered therewith. Finally, fluorescent material layers are formed between the
25 partition walls by screen printing process.

As described above, in the fabricating processes of color PDPs, the conductor circuits of protruded portions such as resistors, electrodes, and buses, or the insulator structures of protruded portions such as partition walls are formed on the substrate by the screen printing process. However, when the conductor circuits are formed by the screen printing process, components within ink would deviate due to variation with time of the printing ink, such that electrical properties such as resistance values would vary in different portions. Also, when the insulator structures are formed by the screen printing process, mechanical properties such as strength and shrinkage factor would vary in different portions, as an issue.

15 SUMMARY OF THE INVENTION

An object of the present invention is to provide a film for forming protruded portions, to a method for forming protruded portions of a plasma display using the film, and to a plasma display fabricated by the method which protruded portions are as uniform as possible, by preventing the components from deviation with time.

In accomplishing these and other objects, according to a first aspect of the present invention, there is provided a film for forming protruded portions on a substrate, which is formed by developing into a filmy state

a resin composition comprising at least glass powder, organic high polymer binder, photoreaction initiator, and photoreaction accelerator.

According to a second aspect of the present invention, there is provided a film for forming protruded portions on a substrate as defined in the first aspect, wherein the substrate is a glass substrate to be used for a plasma display.

According to a third aspect of the present invention, there is provided a film for forming protruded portions on a substrate as defined in the first aspect, wherein the resin composition further comprises electrically conductive powder. In this case, the conductor circuits can be prevented from variations in electrical properties.

According to a fourth aspect of the present invention, there is provided a film for forming protruded portions on a substrate as defined in the second aspect, wherein the resin composition further comprises electrically conductive powder.

According to a fifth aspect of the present invention, there is provided a film for forming protruded portions on a substrate as defined in the second aspect, wherein partition walls of the plasma display are formed by the pattern, and the film is an insulating photosensitive

resin film that will form the partition walls is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing
5 crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

According to a sixth aspect of the present invention, there is provided a film for forming protruded
10 portions on a substrate as defined in the second aspect, wherein electrodes of the plasma display are formed by the pattern, and the film is a conductive photosensitive resin film that will form the electrodes is one formed by mixing together at least glass powder, a powder containing
15 conductive metal powder composed of silver, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film.

20 According to a seventh aspect of the present invention, there is provided a film for forming protruded portions on a substrate as defined in the second aspect, wherein an insulating layer of the plasma display are formed by the pattern, and the film is an insulating
25 photosensitive resin film that will form the insulating

layer is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing crosslinking organic high polymer
5 binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film.

According to an eighth aspect of the present invention, there is provided a film for forming protruded
10 portions on a substrate as defined in the second aspect, wherein fluorescent material layers of the plasma display are formed by the pattern, and the film is a fluorescent-material-containing photosensitive resin film that will form the fluorescent material layers is one formed by
15 mixing together at least an ultraviolet-emitting type fluorescent material powder, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate
20 film.

In the first to eighth aspects, the components within the film are fixed in state, unlikely to be fluidized. Thus, protruded portions of the most possible uniformity and of desired configuration can be obtained
25 with high precision.



According to a ninth aspect of the present invention, there is provided a method for forming protruded portions on a substrate, the method comprising:

placing onto the substrate a film for forming
5 protruded portions, the film being formed by developing into a filmy state a resin composition comprising at least glass powder, organic high polymer binder, photoreaction initiator, and photoreaction accelerator; and

forming protruded portions of desired
10 configuration on the substrate through a process that the film placed on the substrate is exposed and developed with a pattern.

According to a tenth aspect of the present invention, there is provided a method for forming protruded
15 portions on a substrate, as defined in the ninth aspect, wherein in placing onto the substrate the film, the substrate is a glass substrate to be used for a plasma display.

According to an 11th aspect of the present
20 invention, there is provided a method for forming protruded portions on a substrate, as defined in the ninth aspect, wherein in placing onto the substrate the film, the resin composition further comprises electrically conductive powder.

25 According to a 12th aspect of the present

invention, there is provided a method for forming protruded portions on a substrate, as defined in the tenth aspect, wherein the resin composition further comprises electrically conductive powder.

5 According to a 13th aspect of the present invention, there is provided a method for forming protruded portions on a substrate, as defined in the ninth aspect, wherein in forming the protruded portions, partition walls of the plasma display are formed by the pattern, and the
10 film is an insulating photosensitive resin film that will form the partition walls is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing crosslinking organic
15 high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

 According to a 14th aspect of the present invention, there is provided a method for forming protruded
20 portions on a substrate, as defined in the ninth aspect, wherein in forming the protruded portions, electrodes of the plasma display are formed by the pattern, and the film is a conductive photosensitive resin film that will form the electrodes is one formed by mixing together at least
25 glass powder, a powder containing conductive metal powder

composed of silver, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate
5 film.

According to a 15th aspect of the present invention, there is provided a method for forming protruded portions on a substrate, as defined in the ninth aspect, wherein in forming the protruded portions, an insulating
10 layer of the plasma display are formed by the pattern, and the film is an insulating photosensitive resin film that will form the insulating layer is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon
15 dioxide, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film.

According to a 16th aspect of the present
20 invention, there is provided a method for forming protruded portions on a substrate, as defined in the ninth aspect, wherein in forming the protruded portions, fluorescent material layers of the plasma display are formed by the pattern, and the film is a fluorescent-material-containing
25 photosensitive resin film that will form the fluorescent

material layers is one formed by mixing together at least
an ultraviolet-emitting type fluorescent material powder,
and a resin composition containing crosslinking organic
high polymer binder, photoreaction initiator, and
5 photoreaction accelerator, and by developing the mixture
into a sheet state on a separate film.

According to a 17th aspect of the present
invention, there is provided a method for forming protruded
portions on a substrate, as defined in the 13th aspect,
10 wherein in forming the protruded portions, the partition
walls are formed into a striped shape on the substrate.

According to a 18th aspect of the present
invention, there is provided a method for forming protruded
portions on a substrate, as defined in the 13th aspect,
15 wherein in forming the protruded portions, the partition
walls are formed into a matrix shape on the substrate.

In the ninth to 18th aspects, the components
within the film are fixed in state, unlikely to be
fluidized. Thus, protruded portions of the most possible
20 uniformity and of desired configuration can be obtained
with high precision only by exposing the film to light via
a mask corresponding to the desired configuration.

According to a 19th aspect of the present
invention, there is provided a plasma display fabricated by
25 the method defined in the ninth aspect.

According to a 20th aspect of the present invention, there is provided a plasma display fabricated by the method defined in the 13th aspect.

5 BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects 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
10 drawings, in which:

Fig. 1 is a partial perspective view of a DC type PDP obtained in an embodiment of the invention method;

Figs. 2A, 2B, and 2C are schematic sectional views for explaining the procedure of fabricating the
15 electrode circuit of the embodiment;

Fig. 3 is a partial plan view of the resistor and electrode circuits of the embodiment;

Figs. 4A, 4B, 4C, 4D, 4E, and 4F are schematic sectional views for explaining the procedure of fabricating
20 the resistors of the embodiment;

Figs. 5A, 5B, 5C, and 5D are schematic sectional views for explaining the procedure of fabricating the insulating layer of the embodiment;

Figs. 6A, 6B, and 6C are schematic sectional
25 views for explaining the procedure of fabricating the

partition walls of the embodiment; and

Figs. 7A, 7B, 7C, and 7D are schematic sectional views for explaining the procedure of fabricating the fluorescent material layers of the embodiment;

5 Fig. 8 is a perspective view of an AC type plasma display panel obtained by a method according to another embodiment of the present invention;

Fig. 9 is an outlining explanatory view of an AC type plasma display panel according to an embodiment of the
10 present invention;

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

Fig. 11 is an outlining explanatory view of an AC type plasma display panel according to another embodiment
15 of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

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

A film, a method for forming protruded portions of a plasma display using the film, and a plasma display fabricated by the method, according to one embodiment of
25 the present invention will be described hereinbelow. Fig.

1 is a partial perspective view showing a DC type color PDP fabricated by the method of the first embodiment of the method of the present invention.

Referring to the figure, a color PDP 1 has a rear side panel 2, and a front side panel 3 opposed to the rear side panel 2 with a desired spacing thereto. The rear 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 controlled for its opposition spacing by the partition walls 11.

The rear side substrate 10 is made of light-transmittable glass. On the rear side substrate 10, electrodes 20 arrayed into a matrix shape, electrode buses 22 for connecting the electrodes 20 to one another, and resistors 21 for connecting the electrode buses 22 and the electrodes 20 to one another are provided each in a multiplicity. These electrodes 20, resistors 21, electrode buses 22, and the like are formed from a conductor composition in which glass is mixed with electrical conductors such as silver, ruthenium oxide, or the like. The electrode buses 22 are ladder-like members branched off to right and left, and are so arranged that a pair of right-and-left ladder-like members extending in one direction of the rear side substrate 10 (vertical direction of Fig. 1) are arrayed in a multiplicity so as to be spaced

from one another in the transverse direction in Fig. 1. Between one pair of electrode buses 22 and another, an auxiliary bus 23 is formed. The electrodes 20 are placed between the portions 22a corresponding to the crossbars of the ladder-like member, electrode buses 22. The resistors 21 are each installed between the electrodes 20 and the crossbar-like-portions 22a of the electrode buses 22, where voltages to be applied to the electrodes 20 are determined by the resistors 21.

10 On the rear side substrate 10, an insulating layer 15 is formed so as to cover the electrodes 20, the resistors 21, and the electrode buses 22, except the portions where the auxiliary buses 23 are formed. The insulating layer 15 is made from a dielectric such as
15 glass, and has through holes 16 formed at portions facing the electrodes 20. At these through holes 16, cathodes 13 connected to the electrodes 20 are formed. Through holes 16a are formed also to the auxiliary buses 23, at the same pitch as the through holes 16, where auxiliary cathodes 24
20 for speeding up the response of display are formed at the through holes 16a.

 The partition walls 11 are formed on the insulating layer 15, and arranged into a matrix shape so as to surround the cathodes 13. Within each partition wall
25 11, either one of display cells 14_R , 14_G , 14_B having three-

color R (Red), G (Green), B (Blue) fluorescent material layers 17_R, 17_G, 17_B, respectively, is placed. In this embodiment, two green display cells 14_G are positioned diagonal, and blue and red display cells 14_B, 14_R are
5 positioned diagonal so as to cross the green display cells 14_G. These four display cells 14_R, 14_G, 14_B constitute one pixel.

The front side panel 3 has a front side substrate 12 made of light-transmittable glass. On a surface of the
10 front side substrate 12 opposite to the rear side substrate 10, an anode line 25 extending in a direction perpendicular to the electrode buses 22 is buried at a position opposite to the cathodes 13. This anode line 25 is formed by the process that paste-state electrically conductive ink
15 containing aluminium or the like is filled in a groove formed in the front side substrate 12 by the screen printing process. Also formed on the front side substrate 12 are priming-use spaces (not shown) for leading electric charges to the display cells 14_R, 14_G, 14_B.

20 Next, the procedure for fabricating the rear side panel 2 of a DC type color PDP employing the embodiment of the invention is described with reference to Figs. 2 to 7.

In the embodiment of the invention, conductor circuits of electrode buses 22, resistors 21, and the like
25 are first formed on the rear side substrate 10. Then, the

insulating layer 15 and the 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. Thus, the rear side panel 2 is fabricated.

5 In this fabrication procedure, first prepared are a rear side substrate 10, an electrically conductive photosensitive resin film that will form the electrodes 20, the electrode buses 22, and the auxiliary buses 23, an insulating photosensitive resin film that will form the
10 insulating layer 15, an electrically conductive resin paste 38 that will form the resistors 21, and an insulating photosensitive resin film that will form the partition walls 11. Also prepared is a fluorescent-material-containing photosensitive resin film that will form the
15 fluorescent material layers 17_R, 17_G, 17_B.

 Preferably, the conductive photosensitive resin film 30 that will form the electrode buses 22 and the auxiliary buses 23 is one having a uniform thickness of 5 - 10 μ m and formed by mixing together, for example, a powder
20 containing glass powder, conductive metal powder composed of silver or the like, and filler, and a resin composition containing crosslinking or other type organic high polymer binder, photoreaction initiator, and photoreaction accelerator etc., and then by developing the mixture into
25 a sheet state on a separate film.

Preferably, the insulating photosensitive resin film 40 that will form the insulating layer 15 is one having a uniform thickness of 50 - 100 μm and formed by mixing together, for example, a powder containing lead-series or zinc-series or other like glass powder and filler
5 such as boron oxide or silicon dioxide, and a resin composition containing crosslinking or other type organic high polymer binder, photoreaction initiator, and photoreaction accelerator etc., and then by developing the
10 mixture into a sheet state on a separate film.

Preferably, the conductive resin paste 38 that will form the resistors 21 is a paste formed by mixing together a powder containing glass powder, conductivity-imparting metal oxide powder of ruthenium oxide or the
15 like, and filler, a crosslinking or other type organic high polymer binder, and photoreaction initiator, and photoreaction accelerator etc.

Preferably, the insulating photosensitive resin film 45 that will form the partition walls 11 is one having
20 a uniform thickness of 170 - 200 μm and formed by mixing together, for example, a powder containing lead-series or zinc-series or other like glass powder and filler such as boron oxide or silicon dioxide, and a resin composition containing crosslinking or other type organic high polymer
25 binder, photoreaction initiator, and photoreaction

accelerator etc., and by developing the mixture into a sheet state on a separate film.

Preferably, the fluorescent-material-containing photosensitive resin film 50_R, 50_G, 50_B that will form the
5 fluorescent material layers 17_R, 17_G, 17_B is one having a uniform thickness of 20 - 100 μ m and formed by mixing together an ultraviolet-emitting type fluorescent material powder, and a resin composition containing crosslinking or other type organic high polymer binder, photoreaction
10 initiator, and photoreaction accelerator etc., and by developing the mixture into a sheet state on a separate film. In this fluorescent-material-containing photosensitive resin film, minute holes are prepared beforehand at positions corresponding to the cathodes 13.

15 With these members prepared, the electrode buses 22, the auxiliary buses 23, and the electrodes 20 are first formed on the rear side substrate 10. At the beginning, as shown in Fig. 2A, the conductive photosensitive resin film 30 is adhered onto the rear side substrate 10. For this
20 adhesion, with the separate film upside, the conductive photosensitive resin film 30 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 in which light-transmittable portions 31a are provided at places
25 corresponding to the configurations and positions of the

electrode buses 22, auxiliary buses 23, and electrodes 20 to be formed is positioned and arranged above the rear side substrate 10, in which state the conductive photosensitive resin film 30 is exposed to light such as ultraviolet
5 light. Then, as shown in Fig. 2C, development process is carried out 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 a result, for example, exposed portions 30a
10 are cured so that the conductive resin that will form the electrode buses 22, the auxiliary buses 23, and the electrodes 20 is formed. This product is dried, and then baked with a temperature of 620 - 650°C held for about 0.5 hour, by which organic components and excess components
15 contained in uncured resin film or cured conductive resin are removed. As a result, the electrode buses 22 of a ladder-like member, the auxiliary buses 23 of linear shape, and the electrodes 20 arrayed into a matrix shape are obtained on the rear side substrate 10 at a uniform
20 thickness of 4.8 - 5.2 μm , as shown in Fig. 3. In this way, by using the conductive photosensitive resin film 30 having a uniform thickness for the formation of the conductor circuits of the electrode buses 22 and the like, it becomes possible to suppress variations in electrical
25 resistance value due to time deterioration caused by

evaporation of ink solvent or other reasons, as well as variations in electrical resistance value due to deviations of component particles of the mixture within the ink, as compared with the case where the conductor circuits are
5 formed by the screen printing process. Thus, stable electrical circuits can be obtained.

Subsequently, the resistors 21 are formed so as to interconnect the electrode buses 22 and the electrodes 20. For the formation of the resistors 21, as shown in
10 Fig. 4A, photoresist 35 is applied uniformly onto the rear side substrate 10. Then, as shown in Fig. 4B, a mask 36 in which light-shielding portions 36a are provided at places corresponding to the configurations and positions of the resistors 21 is positioned and arranged above the rear side
15 substrate 10, in which state the photoresist 35 is exposed to light such as ultraviolet light. Then, as shown in Fig. 4C, development process is carried out with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium
20 hydroxide, or water solution of sodium hydroxide. As a result, for example, rectangular recessed portions 37 that will form 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 electrodes 20.

25 With the recessed portions 37 formed, as shown in

Fig. 4D, the conductive resin paste 38 is filled into the recessed portions 37 and then dried. This filling and drying processes of the conductive resin paste 38 may be carried out to a plurality of times, taking into account
5 the possible contraction due to the drying process. When the filling and drying process is completed, the surface of the conductive resin paste 38 is ground smooth by a lapping device 400, and the thickness (surface height) of the filled conductive resin paste 38 is adjusted to a specified
10 value (e.g., 10 - 15 μm) as shown in Fig. 4E. Then, the product is baked with a temperature of 600 - 620°C held for about 0.5 hour, by which organic components and the like contained in the photoresist 35 of unexposed portions and the conductive resin paste 38 are removed. As a result,
15 the resistors 21 are obtained as shown in Figs. 4F and Fig. 3. The resistors 21 obtained in this way are adjusted in height so as to be uniform in thickness, so that variation in electrical resistance value is lessened and the discharge voltage is less likely to vary. Thus, a good
20 color PDP with less variations in lightness for each pixel can be obtained.

After the resistors 21 are formed, the insulating layer 15 is formed so that the resistors 21, the electrodes 20, the electrode buses 22, and the auxiliary buses 23 are
25 covered and that portions of the auxiliary buses 23 where

the auxiliary cathodes 24 will be formed as well as portions of the electrodes 20 where the cathodes 13 will be formed are exposed. Then, the cathodes 13 and the auxiliary cathodes 24 are formed by screen printing
5 process. For the formation of the insulating layer 15, as shown in Fig. 5A, with the separate film upside, the insulating photosensitive resin film 40 is developed and adhered onto the rear side substrate 10 with a roll or the like. Subsequently, as shown in Fig. 5B, a mask 41 in
10 which light-shielding portions 41a are provided at places corresponding to such configurations and positions that the portions where the cathode 13 of the electrodes 20 are formed and the portions where the auxiliary cathode 24 of the auxiliary buses 23 are formed are exposed is positioned
15 and arranged above the rear side substrate 10, in which state the insulating resin film 40 is exposed to light such as ultraviolet light. Then, development process is carried out with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl
20 ammonium hydroxide, or water solution of sodium hydroxide. As a result, the through holes 16 for forming the cathodes 13 as well as the through holes 16a for forming the auxiliary cathodes 24 are bored at, for example, unexposed portions 40a as shown in Fig. 5C. Then, the product is
25 baked with a temperature of 550 - 600°C held for about 0.5

hour, by which the insulating layer 15 is obtained. With the insulating layer 15 obtained, conductive resin paste is filled into the through holes 16, 16a by the screen printing process and then dried and baked, by which the cathodes 13 and the auxiliary cathodes 24 are obtained as shown in Fig. 5D. In this way, by using the insulating photosensitive resin film 40 having a uniform thickness for the formation of the insulating layer 15, the insulating layer 15 can be formed into a smooth, uniform thickness, as compared with the formation by the screen printing process. Thus, variations in distance between the cathodes 13 and the anodes are lessened, and variations in discharging gap are lessened.

After the formation of the cathodes 13, the partition walls 11 are formed so as to surround the cathodes 13. For the formation of the partition walls 11, as shown in Fig. 6A, with the separate film upside, the insulating photosensitive resin film 45 is developed and adhered onto the insulating layer 15 of the rear side substrate 10 with a roll or the like. Subsequently, as shown in Fig. 6B, a mask 46 in which light-transmittable portions 46a are provided at places corresponding to the configurations and positions of the partition walls 11 is positioned and arranged above the rear side substrate 10, in which state the insulating photosensitive resin film 45

is exposed to light such as ultraviolet light. Then, development process is carried out with a desired developer such as pure water, water solution of sodium carbonate, water solution of tetramethyl ammonium hydroxide, or water
5 solution of sodium hydroxide. As a result, exposed portions 45a are cured so that the portions that will form the partition walls 11 are formed. Then, the product is baked with a temperature of 520 - 550°C held for about 0.5 hour, by which organic components and the like of the
10 insulating photosensitive resin film of unexposed portions or cured portions are removed. As a result, as shown in Fig. 6C, protruded portions of a matrix shape that will form the partition walls 11 are formed at, for example, the exposed portions 45a so as to surround the cathodes 13.

15 In this embodiment, the partition walls 11 are formed by using the insulating photosensitive resin film 45 that has previously been molded so as to have a uniform thickness. Therefore, the partition walls 11 are adjusted in height so as to be uniform in thickness, so that
20 discharge spaces can be formed with high precision and an appropriate discharging gap is obtained. Thus, a good color PDP with less variation in lightness for each pixel can be obtained. Further, since the mixture within the film is fixed in the mixed state, uniform mechanical
25 characteristics are obtained, so that variations in height

due to non-uniformities in shrinkage in the baking process are reduced.

After the formation of the partition walls 11, the fluorescent material layers 17_R, 17_G, 17_B are formed within the partition walls 11. For the formation of the fluorescent material layers 17_R, 17_G, 17_B, as shown in Fig. 7A, with the separate film upside, for example, a red fluorescent-material-containing photosensitive resin film 50_R is positioned on the partition walls 11 with a roll or the like so that via holes 52 are opposed to the cathodes 13. Subsequently, as shown in Fig. 7B, the red fluorescent-material-containing photosensitive resin film 50_R is heated and softened at a temperature of about 50 - 120°C, and after softened, fallen down between the partition walls 11 into a U-like shape. In this process, since the film 50_R has been positioned so that the via holes 52 are opposed to the cathodes 13, the cathodes 13 are exposed through the via holes 52. Next, as shown in Fig. 7C, a mask 51 in which light-transmittable portions 51a are provided at places corresponding to red pixels is positioned and arranged above the rear side substrate 10, in which state the red fluorescent-material-containing photosensitive resin film 50_R is exposed to light such as ultraviolet light. Then, development process is carried out 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 a result, the fluorescent-material-containing photosensitive resin film remains only at, for example, 5 exposed portions 50a as shown in Fig. 7D. Then, the product is baked with a temperature of 450 - 520°C held for about 0.5 hour, by which organic components and the like contained in the fluorescent-material-containing photosensitive resin film 50_R are evaporated, so that the 10 fluorescent material layer 17_R is obtained. By iterating this sequence of steps with a green fluorescent-material-containing photosensitive resin film 50_G and a blue fluorescent-material-containing photosensitive resin film 50_B in a similar procedure, green and blue fluorescent 15 material layers 17_G, 17_B are obtained one by one.

The fluorescent material layers 17_R, 17_G, 17_B obtained in this way are formed into a U-curved shape of a tilted hanging bell along the partition walls 11. This allows the light emitted from the fluorescent material 20 layers 17_R, 17_G, 17_B to be irradiated forward with high efficiency. Therefore, the light-emitting efficiency is enhanced so that a color PDP with high brightness and good contrast can be obtained. Further, fluorescent material contained in the removed fluorescent-material-containing 25 photosensitive resin films 50_R, 50_G, 50_B is removed before

the curing process, so that it can be recycled. Thus, expensive fluorescent material is not wasted, as compared with the conventional method. Furthermore, based on the arrangement that the via holes 52 are previously provided
5 in the films 50_R, 50_G, 50_B, even if the films 50_R, 50_G, 50_B are fallen down to regions surrounded on all sides by the partition walls 11, as in the DC type, the films 50_R, 50_G, 50_B can be securely fallen down into the regions by allowing the air within the regions to escape through the
10 via holes 52.

Now that the rear side panel 2 is completely fabricated in this way, it is united with the front side panel 3 fabricated by separate process, and the inside air is substituted by inert gas such as helium and xenon, or
15 helium and neon, by which the display unit is completed. Finally, electronic circuits and chassis are assembled, with the result that the PDP 1 is completed.

The means for curing the paste may be light including ultraviolet rays or electron beams, radioactive
20 rays, or heat, or the like.

The embodiment has 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. 8. In this AC type plasma display panel, as
25 shown in Fig. 8, 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 120. The spaces between the adjacent partition walls 111 are in a string
5 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,
10 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. 9, in the AC type plasma display panel, discharge occurs first
15 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.

20 In contrast to this, in the DC type plasma display panel, as shown in Fig. 10, 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
25 as shown by an arrow 201. Thus, the anodes 13 need to be

exposed.

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
5 and the partition walls 111 may be provided on the insulating layer 115 as shown in Fig. 11.

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
10 from its substrate side to its opening side being the same as each other as shown in Fig. 1, 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
15 side-portion being larger than that of the opening side-portion so as to easily form the mortar-shape or gutter shape, as shown in Fig. 11.

In the DC type and AC type plasma display panels, the arrangement of the anodes and cathodes can be replaced
20 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.

25 The partition walls may be transparent or opaque.

With the film according to the present invention, since the components within the film are fixed in state, unlikely to be fluidized, pattern of the most possible uniformity and a desired configuration, for example, 5 protruded portions can be obtained with high precision.

With the method for forming protruded portions of a plasma display according to the present invention, since the components within the film are fixed in state, unlikely to be fluidized, protruded portions of the most possible 10 uniformity and a desired configuration can be formed with high precision only by exposing the film to light via a mask corresponding to the desired configuration.

With the display panel fabricated by the method for forming protruded portions of a plasma display, the 15 protruded portions such as the partition walls or electrodes are as uniform as possible, by preventing the components from deviation with time, thus maintaining stable quality.

Although the present invention has been fully 20 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 modifications are to be understood as included within the 25 scope of the present invention as defined by the appended

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claims unless they depart therefrom.

CLAIMS

1. A film for forming protruded portions on a substrate, which is formed by developing into a filmy state a resin composition comprising at least glass powder, organic high polymer binder, photoreaction initiator, and photoreaction accelerator.

2. A film for forming protruded portions on a substrate as defined in Claim 1, wherein the substrate is a glass substrate to be used for a plasma display.

3. A film for forming protruded portions on a substrate as defined in Claim 1, wherein the resin composition further comprises electrically conductive powder.

4. A film for forming protruded portions on a substrate as defined in Claim 2, wherein the resin composition further comprises electrically conductive powder.

5. A film for forming protruded portions on a substrate as defined in Claim 2, wherein partition walls (11,111) of the plasma display are formed by the pattern, and the film is an insulating photosensitive resin film (45) that will form the partition walls is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing



crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

6. A film for forming protruded portions on a
5 substrate as defined in Claim 2, wherein electrodes (22,23) of the plasma display are formed by the pattern, and the film is a conductive photosensitive resin film (30) that will form the electrodes is one formed by mixing together at least glass powder, a powder containing conductive metal
10 powder composed of silver, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film.

15 7. A film for forming protruded portions on a substrate as defined in Claim 2, wherein an insulating layer (15) of the plasma display are formed by the pattern, and the film is an insulating photosensitive resin film (40) that will form the insulating layer is one formed by
20 mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by
25 developing the mixture into a sheet state on a separate



film.

8. A film for forming protruded portions on a substrate as defined in Claim 2, wherein fluorescent material layers (17_R, 17_G, 17_B) of the plasma display are
5 formed by the pattern, and the film is a fluorescent-material-containing photosensitive resin film (50_R, 50_G, 50_B) that will form the fluorescent material layers is one formed by mixing together at least an ultraviolet-emitting type fluorescent material powder, and a resin composition
10 containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

9. A method for forming protruded portions on a
15 substrate, the method comprising:

placing onto the substrate a film for forming protruded portions, the film being formed by developing into a filmy state a resin composition comprising at least glass powder, organic high polymer binder, photoreaction
20 initiator, and photoreaction accelerator; and

forming protruded portions of desired configuration on the substrate through a process that the film placed on the substrate is exposed and developed with a pattern.

25 10. A method for forming protruded portions on a



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substrate, as defined in claim 9, wherein in placing onto the substrate the film, the substrate is a glass substrate to be used for a plasma display.

11. A method for forming protruded portions on a
5 substrate, as defined in claim 9, wherein in placing onto the substrate the film, the resin composition further comprises electrically conductive powder.

12. A method for forming protruded portions on a
10 substrate, as defined in claim 10, wherein the resin composition further comprises electrically conductive powder.

13. A method for forming protruded portions on a
substrate, as defined in claim 9, wherein in forming the protruded portions, partition walls (11,111) of the plasma
15 display are formed by the pattern, and the film is an insulating photosensitive resin film (45) that will form the partition walls is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a
20 resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

14. A method for forming protruded portions on a
25 substrate, as defined in claim 9, wherein in forming the



protruded portions, electrodes (22,23) of the plasma display are formed by the pattern, and the film is a conductive photosensitive resin film (30) that will form the electrodes is one formed by mixing together at least
5 glass powder, a powder containing conductive metal powder composed of silver, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate
10 film.

15. A method for forming protruded portions on a substrate, as defined in claim 9, wherein in forming the protruded portions, an insulating layer (15) of the plasma display are formed by the pattern, and the film is an
15 insulating photosensitive resin film (40) that will form the insulating layer is one formed by mixing together at least a powder containing lead-series or zinc-series glass powder and filler of boron oxide or silicon dioxide, and a resin composition containing crosslinking organic high
20 polymer binder, photoreaction initiator, and photoreaction accelerator, and then by developing the mixture into a sheet state on a separate film.

16. A method for forming protruded portions on a substrate, as defined in claim 9, wherein in forming the
25 protruded portions, fluorescent material layers



(17_R, 17_G, 17_B) of the plasma display are formed by the pattern, and the film is a fluorescent-material-containing photosensitive resin film (50_R, 50_G, 50_B) that will form the fluorescent material layers is one formed by mixing
5 together at least an ultraviolet-emitting type fluorescent material powder, and a resin composition containing crosslinking organic high polymer binder, photoreaction initiator, and photoreaction accelerator, and by developing the mixture into a sheet state on a separate film.

10 17. A method for forming protruded portions on a substrate, as defined in claim 13, wherein in forming the protruded portions, the partition walls are formed into a striped shape on the substrate.

15 18. A method for forming protruded portions on a substrate, as defined in claim 13, wherein in forming the protruded portions, the partition walls are formed into a matrix shape on the substrate.

19. A plasma display fabricated by the method defined in Claim 9.

20 20. A plasma display fabricated by the method defined in Claim 13.

