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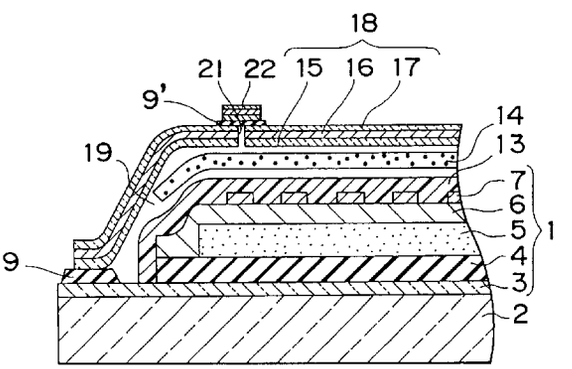
(54) Moisture proof thin film electroluminescent panel.

(57) A thin film electroluminescent panel in which a thin film electroluminescent device formed on a transparent substrate is covered with a black silicone resin layer at back side thereof and further covered by a moistureproof sheet the periphery of which is adhered to that of the substrate. Desirably, a moisture absorber is arranged between the black silicone resin layer and the moistureproof sheet. Further, the moistureproof sheet has at least one small hole pierced therein for dehydrating the inner space of the EL panel which is scaled after dehydration.

Fig. 7



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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to moistureproof thin film electroluminescent panel used for a display device of a personal computer, a wordprocessor or the like.

2. Description of the Prior Art

In a conventional manufacturing method of thin film electroluminescent panels, as shown in Fig. 9, lower transparent electrodes 3, a lower insulating layer 4, an electroluminescent layer 5, an upper insulating layer 6 and upper electrodes 7 are deposited on a glass substrate 2 in a stacked manner to form an electroluminescent (herein after referred to as EL for brevity) device 1 and, thereafter, a lining backup glass plate 8 is put on said EL device 1 by adhering the periphery thereof to that of the glass substrate 2 with an adhesive agent 9 of epoxy resin in order to prevent moisture from penetrating into the EL device. Further, to guarantee a high credibility against moisture, silicon oil in which silicagel powder and black powder are dispersed to give a moisture absorbing property is filled into a space 11 between the EL device 1 and the backup glass plate 8 through a hole 10 of the same and, thereafter, the hole 10 is sealed tightly by plugging a "TORR SEAL ®" 12 thereinto.

Also, in Japanese patent laid-open publication No. S61-290693, there is disclosed a moistureproof structure of the EL device wherein a laminated film is used for preventing moisture from penetrating.

However, in the former manufacturing method, the cost of the silicone oil is high and the filling process thereof is very time-consuming and, accordingly, it is very difficult to lower the manufacturing cost thereof. Further, due to the thickness and the weight of the backup glass 8, it is difficult to make the EL device of this type thinner and lighter.

On the other hand, in the latter manufacturing method, any structure for absorbing moisture penetrated is not provided and nothing is considered to enhance the contrast of the EL device.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a thin film EL panel having a high moistureproof structure without using silicone oil.

Another object of the present invention is to provide a thin film EL panel with a high contrast being advantageous in minimizing the manufacturing cost thereof and making it thinner and lighter without lowering the credibility against moisture.

A further object of the present invention is to enhance the moistureproof property of a thin film EL panel by dehydrating the inner space thereof before sealing the same finally.

In order to achieve these objects, according to the present invention, there is provided a thin film EL panel comprising a transparent substrate being characterized in that the back surface of said thin film EL device is coated with black silicone resin and that the back surface of said thin film EL device is covered over the black silicone coating by a moistureproof sheet.

In the thin film EL panel, the back side of the thin film EL device is double-sealed with the coating layer of black silicone resin and the moistureproof sheet.

Preferably, powder-like or pellet-like moisture absorbing material is arranged for absorbing moisture penetrating through the moistureproof sheet.

In one aspect of the present invention, the powder-like or pellet-like material is arranged by dispersing it in the black silicone resin beforehand.

In another aspect of the present invention, it is arranged between the black silicone coating and the moisture-proof sheet.

In one more aspect of the present invention, it is arranged therebetween in a manner contained in a gaspermeable sack.

In a further aspect of the present invention, a sheet-like moisture-absorbing body is arranged between the black silicone coating and the moistureproof sheet.

In the present invention, the black silicone resin is preferably of a type hardened by the additional reaction.

These moisture-absorbers mentioned above can enhance the moisture resistance of the thin film EL panel.

In order to enhance the moistureproof of the thin film EL panel, it is desirable to pierce at least one hole of a small diameter in the moistureproof sheet through which moisture existing inside of the EL panel can be dehydrated. After dehydration, said at least one hole is sealed by a suitable sealing means. In this case, the moisture introduced into the EL panel during the fabrication process thereof can be dehydrated and, accordingly, the reliability of moisture-proof is enhanced much more.

Further, the contrast thereof is highly enhanced since the EL device is lined with the black coating and, thereby, the quality of display is much improved.

Also, according to the present invention, since the lining backup glass and the silicone oil become unnecessary, the manufacturing process is simplified and the EL panel can be made thinner and lighter.

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

embodiment thereof with reference to the accompanying drawings, in which:

Fig. 1 is a partial sectional view of the thin film EL panel according to the first preferred embodiment of the present invention,

Fig. 2 is a partial sectional view of the thin film El panel according to the second preferred embodiment of the present invention,

Fig. 3 is a partial sectional view of the thin film EL panel according to the third preferred embodiment of the present invention,

Fig. 4 is a partial sectional view of the thin film EL panel according to the fourth preferred embodiment of the present invention,

Fig. 5 is a partial sectional view of the thin film EL panel according to the fifth preferred embodiment of the present invention,

Fig. 6 is a graph showing a relation between the hardness of the black silicone resin and the number of pixels broken regarding the thin film EL panel,

Fig. 7 is a partial sectional view of the thin film EL panel according to the sixth preferred embodiment of the present invention,

Fig. 8 is a graph for showing the life time of sealing according to the present invention, and,

Fig. 9 is a partial sectional view of a conventional thin film EL panel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 1 to 5 and 7 show partial sectional views of thin film EL panels according to the present invention. Through all these Figs., same reference numerals denote same elements as those used in Fig. 9.

The thin film EL panels shown in Figs. 1 to 3 have a substantially same fundamental structure except for the manner of arrangement of moisture absorbing means.

In Figs. 1 to 3 , the reference numeral 1 denotes a thin film EL device. Thin film EL device 1 is comprised of lower transparent stripe electrodes 3 formed on a transparent substrate 2 such as a glass substrate in parallel to each other at an equal pitch, a lower insulating layer 4, an EL layer 5, an upper insulating layer 6 and upper stripe electrodes 7 arranged in parallel to each other at an equal pitch and in direction orthogonal to that of the lower transparent electrodes 3. These elements 3 to 7 are formed stacked one on the other.

The reference numeral 13 denotes a layer of a black silicone resin. This black silicone resin layer 13 is formed by painting the black silicone resin so as to cover the EL device 1. The reference numeral 14 denotes powder like or pellet-like moisture absorber comprised of powder or pellets of silica(SiO_2), molecular sieve or the like. In the structure shown in Fig. 1, the moisture absorber 14 is dispersed in the black silicone resin 13. In the structure shown in Fig. 2, it is arranged on the black silicone layer 13.

Further, in Fig. 3, it is contained in a gaspermeable sack 20 and the sack 20 is arranged on the black silicone layer 13.

Further, the reference numeral 18 denotes a moistureproof sheet which is comprised of a laminated sheet having such a structure that a metal foil 16 of 5 to 50 μm thickness is sandwiched with organic resin films 15 and 17 of 5 to 50 μm thickness such as polyester films. These organic resin films 15 and 17 may be made of different materials.

The moistureproof effect of said sheet 18 is mainly obtained by the metal foil 16 since it is impermeable against moisture. The organic resin films 15 and 17 are mainly for protection of the surface of the metal foil 16 and for insulation to the EL device 1 but are desirably made of a resin material having a low moisture-permeability.

Said moistureproof sheet 18 covers the EL device 1 so as to define a space 19 therebetween and is bonded to the transparent substrate 2 along the periphery thereof with an epoxy resin adhesive agent 9 to seal the inside of the EL panel completely.

Since the moisture absorber 14 absorbs moisture existing inside of said moistureproof sheet 18, the credibility of the EL panel against moisture is highly enhanced.

In order to prevent said moistureproof sheet 18 from suffering damages due to sharp edges of the moisture absorber 14, it is desirable to arrange a non woven fabric, woven fabric, paper sheet, plastic film or the like inside thereof.

Next, the fabrication method of the thin film EL panel is explained.

After forming the thin film EL device 1 on the transparent substrate 2, gas discharge from the EL device 1 is done by raising the temperature up to 200°C or more in a vacuum to remove residual moisture as much as possible.

These processes are common to all embodiments shown in Fig. 1 to 3.

Next, in the case of Fig. 1, the black silicone resin 13 in which powder-like or pellet-like moisture absorber 14 is dispersed is painted or printed on the thin film EL device 1 in dry N_2 gas or dry air at a room temperature. In this case, the liquid of black silicone resin is prepared by mixing, at a room temperature, powder-like or pellet-like moisture absorber 14 having been vacuum-dehydrated at a temperature of 100°C or more into the liquid of black silicone resin having been dehydrated and deformed in a vacuum.

Thereafter, the black silicone resin 13 is hardened by maintaining the same at a constant temperature for a constant time predetermined according to the property thereof (for instance at 150°C for one hour). After hardening of the black silicone resin 13,

the moistureproof sheet 18 is adhered with an epoxy adhesive agent 9 in dry N_2 gas or dry air. Accordingly, dry N_2 gas or dry air is filled in the space 19.

It is desirable to arrange a buffer sheet of non woven fabric, woven fabric, paper, plastic film or the like inside of the moistureproof sheet 18. This is common to all embodiments shown in Figs. 1 to 3.

In the case of Fig. 2 or Fig. 3, after moving the EL panel in dry N_2 gas dry air, the black silicone resin having been dehydrated and deformed in a vacuum beforehand is applied or printed on the surface of the EL panel. Thereafter, it is hardened by heating the same up to a predetermined temperature.

In the case of Fig. 2, the predetermined amount of the moisture absorber 14 having been vacuum-dehydrated by heating the same at 100°C or more is arranged on the hardened black silicone resin 13.

In the case of Fig. 3, the gaspermeable sack 20 containing a predetermined amount of the moisture absorber 14 is vacuum-dehydrated by heating the same up to 100°C or more beforehand, and it is put on the hardened black silicone resin 13. The use of the sack makes treatment of the moisture absorber easier.

After these processes, the moistureproof sheet 18 is adhered to the periphery of the substrate 2 with the epoxy resin adhesive agent 9 in dry N_2 gas or dry air.

In the preferred embodiment shown in Fig. 4, the moisture absorber 14 is a sheet made from non woven fabric or the like which contains silica micro powder, molecular sieve powder or the like therein.

With respect to the EL panel having such a structure as shown in Fig. 4, an endurance test for estimating the life thereof was done under heating and humidicating conditions.

In this test, two types of the black silicone resin were used. One was of condensation reaction type and the other was of addition reaction type. The life estimated based on results of the test was 16,000 to 24,000 hours with respect to the condensation reaction type and was 50,000 to 70,000 hours with respect to the addition reaction type.

Thus, it was confirmed that the EL panel using the latter type of the black silicone resin might be enough for practical use.

This black silicon resin 13 enhances the contrast of the EL panel by forming the black background and contributes to relax stresses generated in the EL panel.

Fig. 6 shows the number of broken pixels of the EL panel in relation with the hardness of the black silicone resin hardened. The EL panel vibrates with a small amplitude during action thereof and, accordingly, the breaking property of the pixel is affected by stresses exerted thereto from the black silicone resin 13 coated thereon. In other words, it is deeply related to the hardness of the black silicone resin after hardened.

As is apparent from the result shown in Fig. 6, the hardness of the black silicone resin 13 should be smaller or equal to 20 when it is measured according to JIS C 2123.

Further, it is desirable for the black silicone resin to have a dielectric strength equal to or larger than 1×10^5 V/cm in order to avoid damage to electrodes and pixels due to discharges among electrodes during action of the EL panel.

In Fig. 5, there is disclosed a thin film EL panel having no moisture absorber therein. If it is used in an atmosphere conditioned well, a reasonably long life will be guaranteed even in this case.

Fig. 7 shows a sixth preferred embodiment of the present invention.

The thin film EL panel shown in Fig. 7 has a substantially same structure as that shown in Fig. 4 except for a hole 21 of a small diameter, for example of about 6mm, pierced in the moistureproof sheet 18. This small hole 21 is provided for dehydrating the inner space 19 of the EL panel to remove the moisture introduced thereinto during the fabricating process of the EL panel.

Upon dehydrating the inner space 19, the EL panel is charged into a vacuum chamber (not shown) and is vacuum-dehydrated therein by raising the inner temperature up to 100°C or more. Then, dry N_2 gas or air is filled into the vacuum chamber and the hole 21 is sealed quickly by adhering a small strip 22 having the same layered structure as that of the moistureproof sheet 18 from the outside thereof. By heating and hardening epoxy resin 9′ applied to the under side of the small strip 22, the hole 21 is sealed surely and, thus, the fabrication process of the EL panel is completed.

The number of small holes to be pierced may be two or more. Further, it is desirable to pierce the small hole in the moistureproof sheet 18 beforehand for smooth and quick dehydrating operation. However, it is also possible to pierce the small hole upon dehydrating the EL panel.

According to the sixth preferred embodiment of the present invention, the moisture having been penetrated into the inner space of the EL panel during the fabrication process thereof is surely dehydrated resulting in a much higher reliability against degradation due to moisture.

Fig. 8 shows experimental data related to the lifetime of sealing obtained under three sealing conditions. The life-time of sealing at room temperature and humidity was estimated from an acceleration lifetime test wherein thin film EL panels were operated to repeat light emission in an atmosphere at a temperature of 85°C and a relative humidity of 85%.

As is apparent from Fig. 8, the life-time of sealing is greatly affected by an ambient humidity upon sealing the EL panel but the dehydration operation can

remove undesirable effects based on a high ambient humidity perfectly. The life-time of sealing demanded for actual use is about 5 x 10^4 hours and this criterion can easily satisfied by the present preferred embodiment of the present invention, as indicated by the case C in Fig. 8.

Since the EL panel 1 is backed up by the black silicone resin 13, the background of the display is black. This enhances the contrast of display, the quality of display and the appearance of the panel.

The sealing process of the EL panel is simplified since the moistureproof sheet is adhered to the substrate in a dry atmosphere in the present invention. Further, the EL panel according to the present invention can be made thinner and lighter when compared with the conventional one wherein the backup glass plate is used.

It is to be noted that the present invention can be applied to both dot matrix type and segment type EL devices.

It is understood that various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of the present invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be construed as encompassing all the features of patentable novelty that reside in the present invention, including all features that would be treated as equivalents thereof by those skilled in the art to which the present invention pertains.

Claims

1. Thin film electroluminescent panel comprising a transparent substrate and a thin film electroluminescent device formed on said transparent substrate being characterized in
   that the back surface of said thin film electroluminescent device is coated with black silicone resin and
   that the back surface of said thin film electroluminescent device is covered over the black silicone coating by a moistureproof sheet.

2. The thin film electroluminescent panel as claimed in claim 1 being characterized further in that a sheet-like moisture absorber is arranged between said black silicone coating and said moistureproof sheet.

3. The thin film electroluminescent panel as claimed in claim 1 in which said black silicone resin is hardened by addition reaction.

4. The thin film electroluminescent panel as claimed in claim 1 wherein said black silicone resin is hardened to a hardness of twenty or less when measured according to a testing method according to JIS C 2123.

5. The thin film electroluminescent panel as claimed in claim 1 being further characterized in that said moisture-proof sheet has at least one small hole pierced therein through which the inner space of said panel is dehydrated and
   that said at least one small hole is sealed by a sealing means after dehydration of said inner space.

6. Thin film electroluminescent panel comprising a translucent substrate and a thin film electroluminescent device formed on said translucent substrate being characterized in that the back surface of said thin film electroluminescent device is coated with black silicone resin wherein powder-like or pellet-like moisture absorber is dispersed and that the back surface of said thin film electroluminescent device is covered over the black silicone coating by a moistureproof sheet.

7. The thin film electroliminescent panel as claimed in claim 6 being further characterized in that said moisture-proof sheet has at least one small hole pierced therein through which the inner space of said panel is dehydrated and
   that said at least one small hole is sealed by a sealing means after dehydration of said inner space.

8. Thin film electroluminescent panel comprising a transparent substrate and a thin film electroluminescent device formed on said transparent substrate being characterized in
   that the back surface of said thin film electroluminescent device is coated with black silicone resin,
   that powder-like or pellet-like moisture absorber is arranged on said black silicone coating and
   that the back surface of said thin film electroluminescent device is covered over said moistureabsorber by a moistureproof sheet.

9. The thin film electroluminescent panel as claimed in claim 8 in which said powder-like or pellet-like moisture absorber is contained in a gaspermeable sack.

10. The thin film electroliminescent panel as claimed in claim 8 being further characterized in that said moisture-proof sheet has at least one small hole pierced therein through which the inner space of said panel is dehydrated and

that said at least one small hole is sealed by a sealing means after dehydration of said inner space.

11. A display apparatus comprising a transparent substrate and a thin film electroluminescent panel formed on said substrate, characterized by a protective seal structure for said panel comprising a coating which envelopes the exposed surface of said panel and a flexible moisture-proof sheet which covers said coating and is sealed to said substrate around the periphery of said panel.

Fig. 1

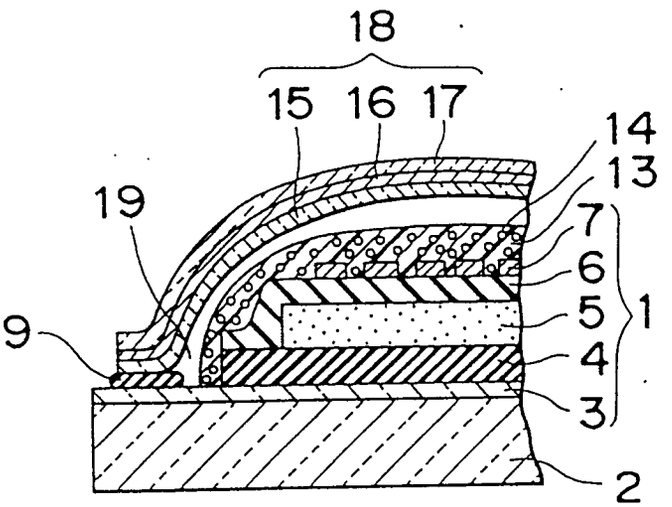

Fig. 2

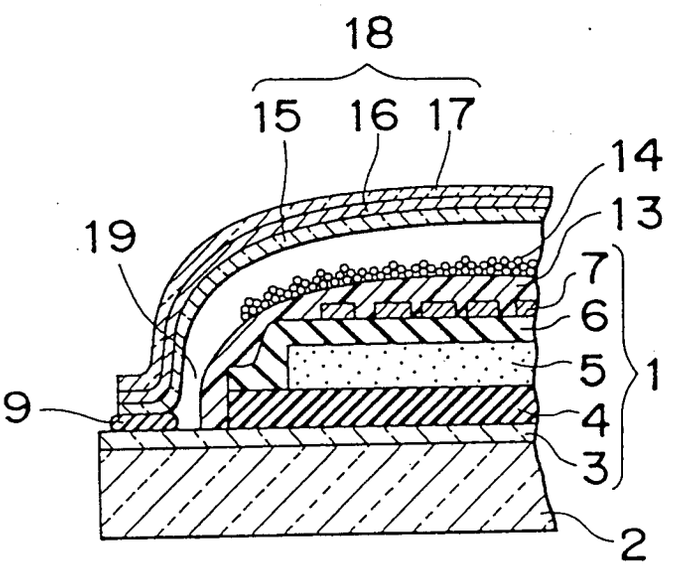

Fig. 3

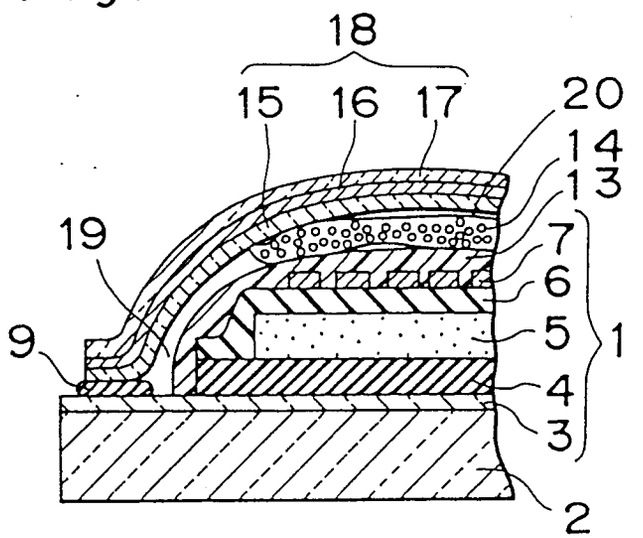
18
15
16
17
20
14
13
19
7
6
5
1
9
4
3
2

Fig. 6

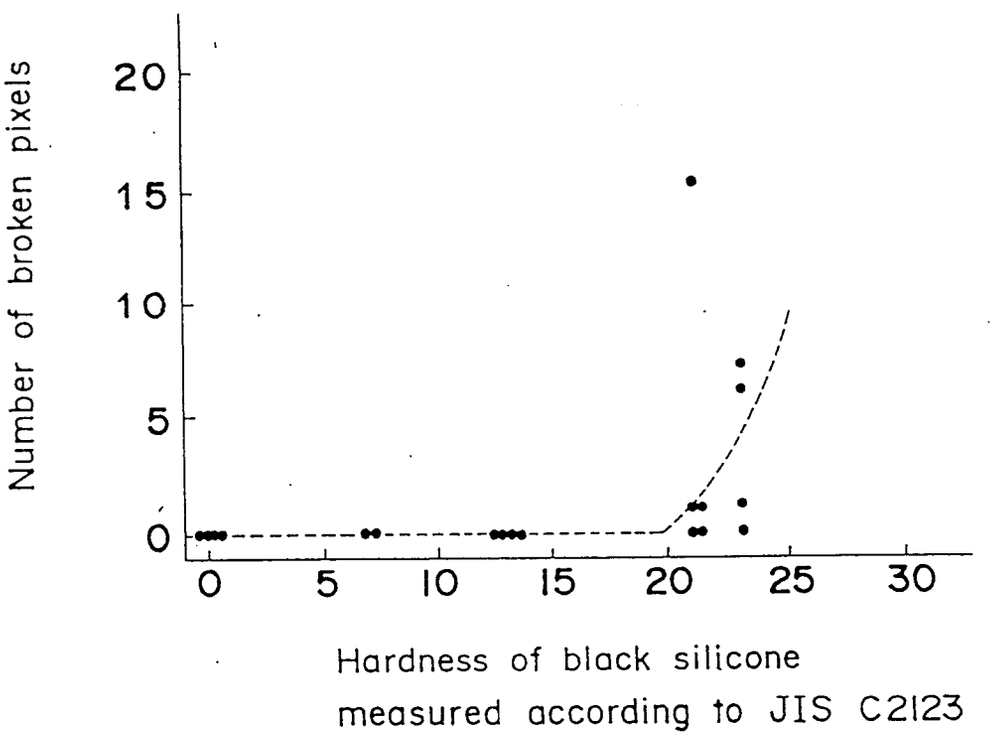
Number of broken pixels
20
15
10
5
0
0
5
10
15
20
25
30
Hardness of black silicone
measured according to JIS C2123

Fig. 4

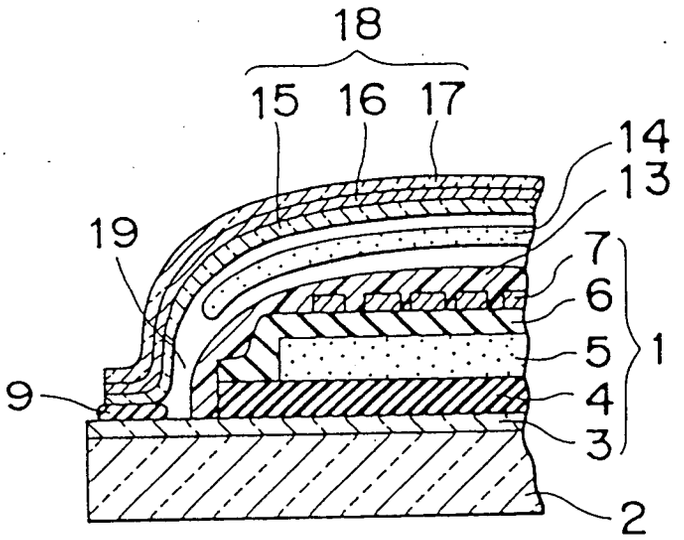

Fig. 5

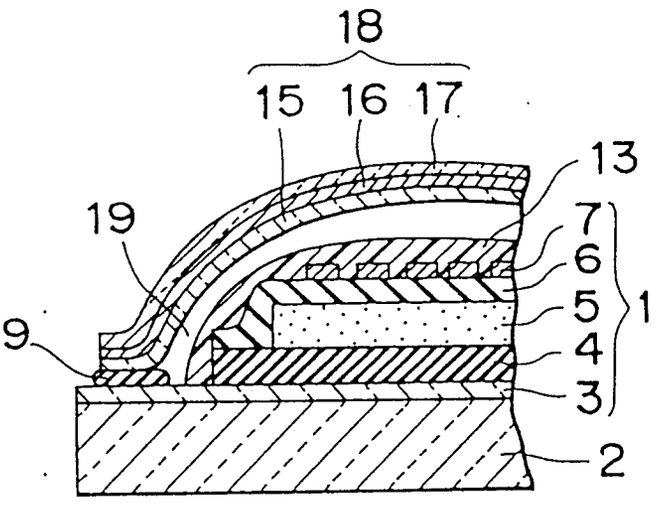

Fig. 7

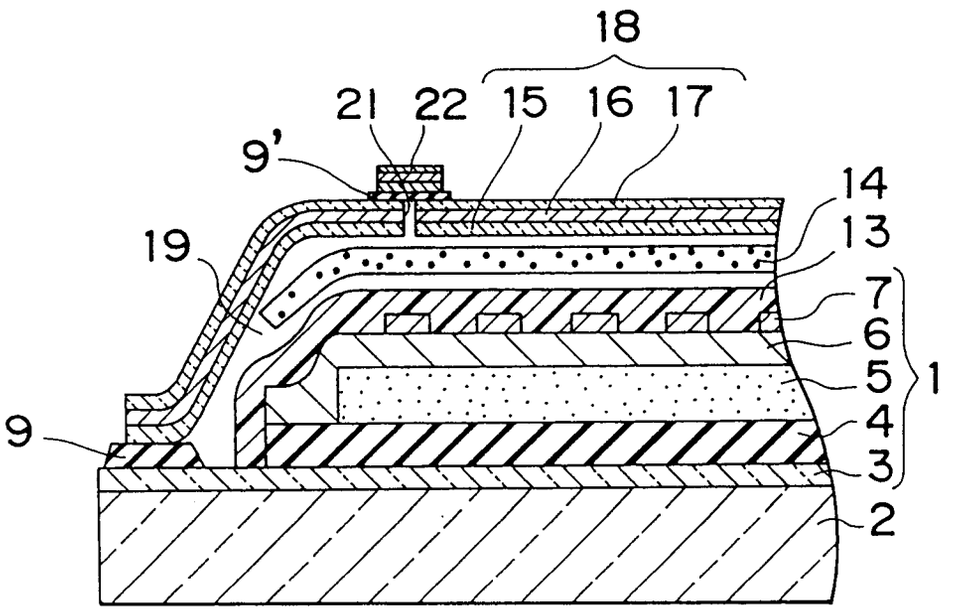

Fig. 8

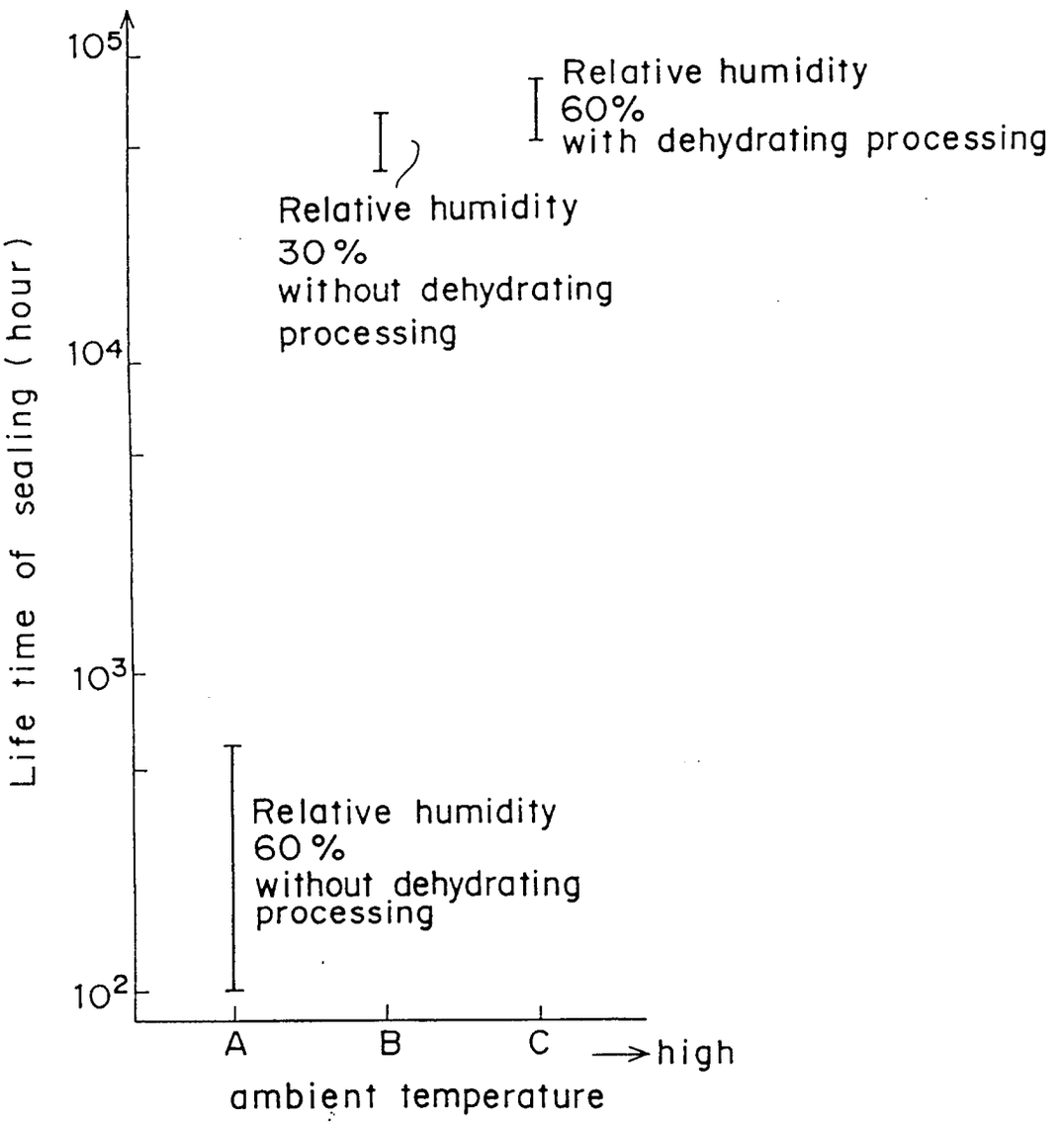
Life time of sealing (hour)
10^5
10^4
10^3
10^2
Relative humidity
60%
with dehydrating processing
Relative humidity
30%
without dehydrating
processing
Relative humidity
60%
without dehydrating
processing
A
B
C
high
ambient temperature

Fig. 9