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Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

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(12) **United States Patent**
Sawai et al.

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(54) **SPACER AND IMAGE DISPLAY PANEL USING THE SAME**

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See application file for complete search history.

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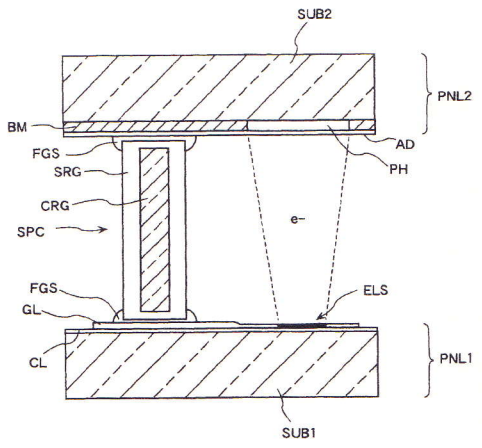
(57) **ABSTRACT**

It is an object of the present invention to provide a spacer which has an adequate Young's modulus for a spacer used in an image display panel and allows free adjustment of an electric resistance value, and an image display panel using the spacer. The spacer SPC holds a gap between a back panel PNL1 including a signal line CL, a scanning line GL, and an electronic source ELS provided for the main surface of a back substrate SUB1, and a front panel PNL2 including a fluorescent material PH, a black matrix BM, and an anode AD provided for the main surface of a front substrate SUB2. The spacer comprises phosphate glass including the same transition metal element with different valences. For electrical conduction, the included same transition metal element with different valences allows the use of hopping conduction between transition metal atoms with different valences to perform adjustment of electric resistance relatively easily. The transition metal element is at least one of vanadium (V), tungsten (W), molybdenum (Mo), niobium (Nb), and iron (Fe).

18 Claims, 5 Drawing Sheets



negative resistance temperature coefficients and not containing dispersed metal particles is more excellent in the stability of performance as a product.

Example 4-3

FIG. **7** is a graph for explaining the resistance temperature characteristics of the spacer and the bonding material. The horizontal axis represents the temperature (T ° C.) and the vertical axis represents the resistance value (Ωcm) on arbitrary scales. In FIG. **7**, a curve A shows the resistance temperature characteristic of the spacer in Example 4-1, and a curve B shows the resistance temperature characteristic of the bonding material in Example 4-1. A curve C shows the resistance temperature characteristic of the spacer in Example 4-2, and a curve D shows the resistance temperature characteristic of the bonding material in Example 4-2. In FIG. **7**, the respective characteristics curves are shown by straight lines for ease of explanation.

It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the present invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

The invention claimed is:

1. A spacer which holds a gap between insulating substrates at a predetermined value, the gap forming a decompressed space or an evacuated space, the spacer comprising phosphate glass containing a transition metal element, and the spacer bridging the insulating substrates, wherein the spacer comprises at least one of (a) 20 to 40 wt % of V_2O_5, 30 to 45 wt % of P_2O_5, 1 to 20 wt % of WO_3, and 5 to 20 wt % of BaO, (b) 20 to 45 wt % of WO_3, 20 to 40 wt % of P_2O_5, 10 to 25 wt % of V_2O_5, and 10 to 25 wt % of BaO, (c) 20 to 45 wt % of WO_3, 25 to 40 wt % of P_2O_5, 10 to 25 wt % of V_2O_5, 10 to 25 wt % of BaO, and 5 to 15 wt % of MoO_3, and (d) 1 to 10 wt % of SrO, and 1 to 5 wt % of Gd_2O_3, and 0.1 to 1.0 wt % of CeO_2.

2. The spacer according to claim **1**, wherein the phosphate glass includes the same element with different valences.

3. The spacer according to claim **1**, wherein the transition metal element includes at least one of vanadium (V), tungsten (W), molybdenum (Mo), niobium (Nb), and iron (Fe).

4. The spacer according to claim **1**, wherein the spacer has a surface electrical resistance of 1×10^8 to $1\times10^{12}\Omega/\square$ and a three-point bending strength of 350 MPa or higher.

5. The spacer according to claim **1**, wherein the spacer has a surface electrical resistance of 1×10^8 to $1\times1\Omega/\square$ and a three-point bending strength of 350 MPa or higher.

6. The spacer according to claim **1**, wherein the spacer comprises 0.5 to 10 wt % of a compound selected from the group consisting of Sb_2O_3, ZrO_2, GeO_2, Cr_2O_3, Nb_2O_5, Al_2O_3, Y_2O_3, MgO, ErO_2, CaO, and TiO_2.

7. The spacer according to claim **1**, wherein the spacer comprises an alkali metal element of 0.5 wt % or lower in terms of oxide (R_2O).

8. An image display panel comprising:

a back panel including an insulating substrate, a plurality of scanning lines provided for a main surface of the insulating substrate, extending in a first direction, and arranged in a second direction intersecting with the first direction, a plurality of signal lines extending in the second direction and arranged in the first direction, and an electronic source provided near the intersection of the scanning line and the signal line;

a front panel including a transparent insulating substrate, a fluorescent material layer provided for a main surface of the transparent insulating substrate and forming a pair with each of the electronic sources, an anode;

a sealing frame inserted into the inner periphery at ends of the back panel and the front panel disposed such that their main surfaces are opposed with a predetermined gap between them, to form a decompression vessel together with the panels; and

a spacer which holds the gap between the back panel and the front panels;

wherein the spacer comprises phosphate glass containing a transition metal element; and

wherein the spacer comprises at least one of (a) 20 to 40 wt % of V_2O_5, 30 to 45 wt % of P_2O_5, 1 to 20 wt % of WO_3, and 5 to 20 wt % of BaO, (b) 20 to 45 wt % of WO_3, 20 to 40 wt % of P_2O_5, 10 to 25 wt % of V_2O_5, and 10 to 25 wt % of BaO, (c) 20 to 45 wt % of WO_3, 25 to 40 wt % of P_2%, 10 to 25 wt % of V_2O_5, 10 to 25 wt % of BaO, and 5 to 15 wt % of MoO_3, and (d) 1 to 10 wt % of SrO, and 1 to 5 wt % of Gd_2O_3, and 0.1 to 1.0 wt % of CeO_2.

9. The image display panel according to claim **8**, wherein the phosphate glass includes the same element with different valences.

10. The image display panel according to claim **8**, wherein the transition metal element includes at least one of vanadium (V), tungsten (W), molybdenum (Mo), niobium (Nb), and iron (Fe).

11. The image display panel according to claim **8**, wherein the spacer has a surface electrical resistance of 1×10^8 to $1\times10^{12}\Omega/\square$ and a three-point bending strength of 350 MPa or higher.

12. The image display panel according to claim **8**, wherein the spacer has a surface electrical resistance of 1×10^8 to $1\times10^{10}\Omega/\square$ and a three-point bending strength of 350 MPa or higher.

13. The image display panel according to claim **8**, wherein the spacer comprises 0.5 to 10 wt % of a compound selected from the group consisting of Sb_2O_3, ZrO_2, GeO_2, Cr_2O_3, Nb_2O_5, Al_2O_3, Y_2O_3, MgO, ErO_2, CaO, and TiO_2.

14. The image display panel according to claim **8**, wherein the spacer comprises an alkali metal element of 0.5 wt % or lower in terms of oxide (R_2O).

15. A display comprising:

a back panel including an insulating substrate, a plurality of scanning lines provided for a main surface of the insulating substrate, extending in a first direction, and arranged in a second direction intersecting with the first direction, a plurality of signal lines extending in the second direction and arranged in the first direction, and an electronic source provided near the intersection of the scanning line and the signal line;

a front panel including a transparent insulating substrate, a fluorescent material layer provided for a main surface of the transparent insulating substrate and forming a pair with each of the electronic sources, an anode;

a sealing frame inserted into the inner periphery at ends of the back panel and the front panel disposed such that their main surfaces are opposed, to form a decompressed container together with the panels; and

a spacer standing structure bonded between the back panel and the front panel and formed of a spacer which holds a gap at a predetermined value between the panels and an adhesion layer;

wherein the spacer is formed of core glass and coat glass which covers a surface of the core glass;