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**United States Patent**

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(54) **DISPLAY DEVICE AND PRODUCTION METHOD THEREOF**

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(56) **References Cited**

#### U.S. PATENT DOCUMENTS

4,743,302	A *	5/1988	Dumesnil et al.	106/1.23
5,013,360	A *	5/1991	Finkelstein et al.	106/1.23
5,051,381	A *	9/1991	Ohji et al.	501/26
5,188,990	A *	2/1993	Dumesnil et al.	501/19
5,336,644	A *	8/1994	Akhtar et al.	501/15
7,425,518	B2 *	9/2008	Yoshida et al.	501/15
7,452,489	B2 *	11/2008	Sawai et al.	252/520.4
7,585,798	B2 *	9/2009	Yoshida et al.	501/15
2007/0159056	A1 *	7/2007	Sawai et al.	313/495
2007/0286973	A1 *	12/2007	Sawai et al.	428/34.4
2008/0238315	A1 *	10/2008	Hojo et al.	313/582
2008/0238316	A1 *	10/2008	Hayashibara et al.	313/582
2009/0199897	A1 *	8/2009	Naito et al.	136/256

#### FOREIGN PATENT DOCUMENTS

JP	06263478	A *	9/1994
JP	07-065710		3/1995
JP	08-022782		1/1996
JP	09-283059		10/1997
JP	10-153979		6/1998
JP	2000-021335		1/2000
JP	2003-192378		7/2003
JP	2004-250276		9/2004
JP	2004356394	A *	12/2004
JP	2004356395	A *	12/2004
JP	2000-206905		7/2005
JP	2006342044	A *	12/2006
SU	1497168	A *	7/1989
SU	1497169	A *	7/1989
WO	WO 9302980	A1 *	2/1993
WO	WO 2004074198	A1 *	9/2004
WO	WO 2005000755	A1 *	1/2005
WO	WO 2010016318	A1 *	2/2010

\* cited by examiner

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(57) **ABSTRACT**

A bonding glass containing V<sub>2</sub>O<sub>5</sub>: 25 to 50 wt %, TeO<sub>2</sub>: 20 to 40 wt % and BaO: 5 to 30 wt %, and not containing lead.

**8 Claims, 8 Drawing Sheets**



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It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the 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.

#### ADVANTAGES OF THE INVENTION

According to the present invention, a sufficient adhesive strength between the first glass substrate, the second glass substrate, and the sealing frame is secured. Moreover, a decrease in the adhesive strength due to the degradation of the adhesive layer by the affect of moisture outside the airtight container is suppressed, thereby allowing a highly reliable display device to be provided.

The invention claimed is:

1. A bonding glass containing  $V_2O_5$ : 25 to 50 wt %,  $TeO_2$ : 20 to 40 wt %,  $BaO$ : 5 to 30 wt %,  $WO_3$ : 1 to 25 wt %, and  $P_2O_5$ : 0 to 20 wt %, and not containing lead.

2. The bonding glass according to claim 1, containing  $V_2O_5$ : 35 to 45 wt %,  $BaO$ : 10 to 20 wt %,  $TeO_2$ : 20 to 30 wt %,  $WO_3$ : 5 to 15 wt %, and  $P_2O_5$ : 0 to 5 wt %.

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3. The bonding glass according to claim 1, containing 5 to 30 volume % of ceramic filler material.

4. The bonding glass according to claim 3, wherein the ceramic filler material is any one of  $SiO_2$ ,  $ZrO_2$ ,  $Al_2O_3$ ,  $ZrSiO_4$ , zirconium phosphate ( $(ZrO)_2P_2O_7$ ,  $(ZrO)_2P_2O_7$ ,  $Ca_{0.5}Zr_2(PO_4)_3$ ,  $Zr_2(WO_4)(PO_4)_2$ ), cordierite, mullite, and eucryptite, or is a mixture of two or more thereof.

5. The bonding glass according to claim 1, wherein  $V_2O_5$ ,  $BaO$ ,  $TeO_2$  are contained in an amount of 62 wt % or more in total.

6. The bonding glass according to claim 1, wherein  $V_2O_5$ ,  $BaO$ ,  $TeO_2$  are contained in an amount of 75 wt % or more in total.

7. A bonding glass containing  $V_2O_5$ : 35 to 45 wt %,  $BaO$ : 5 to 30 wt %,  $TeO_2$ : 20 to 35 wt %,  $WO_3$ : 1 to 15 wt %,  $ZnO$ : 1 to 10 wt %, and  $Sb_2O_3$ : 1 to 10 wt %, and not containing lead.

8. A bonding glass containing  $V_2O_5$ : 25 to 50 wt %,  $TeO_2$ : 20 to 40 wt %,  $BaO$ : 5 to 30 wt %, and 0.5 to 10 wt % of compound selected from the group consisting of  $SrO$ ,  $GeO_2$ ,  $La_2O_3$ ,  $Cr_2O_3$ ,  $Nb_2O_5$ ,  $Y_2O_3$ ,  $MgO$ ,  $CeO_2$ , and  $Er_2O_3$ , and not containing lead.

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