LOW TEMPERATURE SEALING COMPOSITION

BACKGROUND OF THE INVENTION

This invention relates to a low temperature sealing composition, and more particularly, to a low temperature sealing glass composition suitable for hermetically sealing ceramic packages for integrated circuits (ICs) and quartz resonators, and sealing display panels such as vacuum fluorescent displays (VFDs).

A sealing material for hermetically sealing packages for an IC or quartz resonators, and display panels are required to be sealable at a low temperature so as not to deteriorate the enclosed devices due to thermal effects. In addition, it is also necessary that the thermal coefficient of expansion (hereinafter, abbreviated to TCE) of the material is compatible with that of the ceramics or a display panel glass to be used. In particular, the IC packages should be sealed with the material that is high in mechanical strength besides meeting the aforementioned requirements. The material for sealing the IC package is also required to have superior insulating properties to avoid undesirable leak of signal currents. Further, the material for the IC package should have the least possible content of α-particle emitting impurities because the soft error often occurs when an IC chip such as DRAM and CCD is exposed to the α-particle.

Various sealing materials have been proposed that meet the above mentioned requirements. One of such materials is a PbO-B_2O_3 glass of a low melting temperature. It has also been proposed to use the low melting temperature glass as an admixture with refractory fillers. For example, Japanese Patent Unexamined Publication 229738/1990 discloses a sealing material comprising PbO-B_2O_3 glass powder, lead titanate ceramic powder and low expansion ceramic powder.

It is known about the PbO-B_2O_3 glass that lowering content of B_2O_3 generally lowers the glass transformation point resulting in a lower sealing temperature. However, sufficient content of B_2O_3 is necessary to make the glass stable, which limites glass composition and makes it impossible to obtain sealing materials usable below 400° C. The sealing temperature of 400° C. or lower is thus difficult to be achieved. This means that the sealing material of the type described is not suitable for sealing packages for heat sensitive devices such as a highly integrated IC, or quartz resonators.

Several sealing materials have also been proposed which are sealable at the temperature of 400° C. or lower. For example, Japanese Patent Publication No. 8060/1988 discloses a sealing material consisting of PbO-B_2O_3 glass powder with Tl_2O contained therein. In addition, U.S. Pat. No. 4,743,302 discloses another sealing material comprising PbO-V_2O_5-TeO_2 glass powder. However, both of these materials are unfavorable because of the following reasons. The sealing material disclosed in the Japanese Patent Publication No. 8060/1988 includes a highly toxic component, i.e., thallium carbonate in the raw material for the glass. Such a toxic material should be handled using special protective instrument. The sealing material disclosed in U.S. Pat. No. 4,743,302 is more likely to be crystallized and thus requires application of a large load to the package to be sealed.

SUMMARY OF THE INVENTION

Accordingly, a primary object of the present invention is to provide a low temperature sealing composition which meets the requirements for sealing material of IC packages or display panels and which is sealable at the temperature of 400° C. or lower without application of load during sealing operation.

Another object of the present invention is to provide a low temperature sealing composition without use of highly toxic components.

A low temperature sealing composition according to the present invention is glass powder which essentially consists of 45.0 to 85.0 wt. % of PbO, 1.0 to 11.0 wt. % of B_2O_3, 1.0 to 45.0 wt. % of Bi_2O_3, 0.2 to 10.0 wt. % of Fe_2O_3, 0 to 15.0 wt. % of ZnO, 0 to 5.0 wt. % of CuO, 0 to 5.0 wt. % of V_2O_5, 0 to 3.0 wt. % of SnO_2, 0 to 5.0 wt. % of SiO_2 plus Al_2O_3, 0 to 7.0 wt. % of BaO, 0 to 5.0 wt. % of TiO_2, 0 to 5.0 wt. % of ZrO_2 and 0 to 6.0 wt. % of F_2.

In addition, a low temperature sealing glass composition according to the present invention comprises 45% to 80% by volume of glass powder and 20% to 55% by volume of refractory filler powder. The glass powder essentially consists of 45.0 to 85.0 wt. % of PbO, 1.0 to 11.0 wt. % of B_2O_3, 1.0 to 45.0 wt. % of Bi_2O_3, 0.2 to 10.0 wt. % of Fe_2O_3, 0 to 15.0 wt. % of ZnO, 0 to 5.0 wt. % of CuO, 0 to 5.0 wt. % of V_2O_5, 0 to 3.0 wt. % of SnO_2, 0 to 5.0 wt. % of SiO_2 plus Al_2O_3, 0 to 7.0 wt. % of BaO, 0 to 5.0 wt. % of TiO_2, 0 to 5.0 wt. % of ZrO_2 and 0 to 6.0 wt. % of F_2.

DESCRIPTION OF THE INVENTION

The present inventors have found that, as a result of tremendous studies and considerations, Fe_2O_3 is considerably effective for stabilizing PbO-B_2O_3 glass, in particular to PbO-B_2O_3 glass with Bi_2O_3 contained therein, and that the above mentioned objects can be achieved with the reduced content of B_2O_3 by means of adding Fe_2O_3 to the glass composition.

Briefly, the low temperature sealing composition according to the present invention is obtained by means of substituting Fe_2O_3 for a part of B_2O_3 of the PbO-B_2O_3 glass, thereby reducing the content of B_2O_3.

In the low temperature sealing composition according to the present invention, the ingredients of the glass powder are limited as set forth above because of the following reasons.

The content of PbO ranges from 45.0 to 85.0 wt. %, and preferably, from 50.0 to 83.0 wt. %. PbO content of lower than 45 wt. % increases the viscosity of the glass, impeding sufficient flow of the glass at a temperature of 400° C. or lower. On the other hand, PbO content of higher than 85 wt. % causes crystallization upon sealing, which hinders flowing of the glass.

The content of B_2O_3 ranges from 1.0 to 11.0 wt. %, and preferably, from 2.0 to 10.0 wt. %. B_2O_3 content of lower than 1.0 wt. % makes the glass unstable to cause crystallization upon sealing. Such crystallization behavior also hinders flowing of the glass. B_2O_3 content of higher than 11.0 wt. % increases the viscosity of the glass, impeding the glass from sufficient flow at a temperature of 400° C. or lower.

Bi_2O_3 has the effect of stabilizing the glass without increasing the viscosity and the content thereof is between 1.0 and 45.0 wt. %, and preferably, between 1.2 and 35.0 wt. %. The above mentioned effect cannot be achieved by Bi_2O_3 of less than 1.0 wt. %. Bi_2O_3 of more than 45 wt. % is responsible for the increased viscosity of the glass, inhibiting sufficient flow of the glass at a temperature of 400° C. or lower.