HERMETIC SEAL AND METHOD TO CREATE THE SAME

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ABSTRACT

An electronic display screen is created by processing a mirror on a substrate glass. A back plate glass is then placed on top of the substrate glass and sealed to the back plate glass. A hermetic seal that includes an adhesive mixed with zeolites is disclosed. The hermetic seal can seal the back plate glass with the substrate glass. The application of the hermetic seal is not limited to the electronic display screen. Rather, the hermetic seal can be used to seal a variety of surfaces including metals, polymers, plastics, alloys, ceramics and the like.

26 Claims, 1 Drawing Sheet


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HERMETIC SEAL AND METHOD TO CREATE THE SAME

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

FIELD OF THE INVENTION

The present invention relates to a hermetic seal and methods to create the same. Specifically, a functional hermetic seal is disclosed that includes an adhesive mixed with an active component that can act as an absorbing filter on a molecular level.

BACKGROUND

To create an electronic display screen, a microelectromechanical systems (MEMS) based device such as a mirror is sandwiched between two glass plates: the back plate glass and the substrate glass. The mirror is typically processed on the substrate glass. The back plate glass is then placed on top of the substrate glass to form the sandwich. The purpose of the back plate glass is to act as a viewing surface and to provide mechanical and environmental protection to the mirror. The sandwich is also referred to as the package.

The MEMS based device that is packaged in this manner is susceptible to problems associated with moisture and other harmful contaminants. The presence of moisture can cause siction (static friction). The siction can result because of the physical hydrogen bonding between the two glass surfaces. In contact or because of the surface tension forces that result when the moisture between the two glass surfaces undergoes capillary condensation during the actuation of the MEMS based device. The presence of moisture can also cause electrochemical corrosion; for example, if the mirror includes an aluminum mirror.

The presence of harmful contaminants and moisture can pose a danger to the functioning of MEMS based device. For example, chlorine and moisture can combine to form an acidic environment that can be harmful to the MEMS based device. It is important that the package is moisture and contaminant free for the life of the device.

There are various channels by which water vapor or the contaminant can find its way inside the package. The moisture can enter the package from the environment in which the MEMS device is packaged. The moisture can permeate into the package from outside. The contaminant can be formed as a result of the outgassing of package components such as glass and polymers, especially at elevated temperatures.

In the prior art, to prevent the moisture and the contaminant from entering the package, the back plate glass and the substrate glass of the package are sealed to each other by using techniques such as welding and soldering, and by using o-rings. These prior art techniques are lacking in at least two respects. One, welding and soldering materials and o-rings occupy space. Real estate in MEMS based device packages is tight and there is a growing need for smaller form factors. Two, these prior art techniques do not eliminate the moisture and contaminants that are formed inside the package as a result of, for example, outgassing.

A simple technique to effectively seal two surfaces to each other that does not occupy additional real estate is desirable.

BRIEF DESCRIPTION OF THE DRAWING

The present invention is illustrated by way of example and not limitation in the figure of the accompanying drawing, in which:

FIG. 1 illustrates an exemplary embodiment of package components that can be sealed with the hermetic seal of the present invention.

SUMMARY OF THE INVENTION

The hermetic seal including an adhesive mixed with an active component that can act as an absorbing filter on a molecular level is disclosed. The material can include a zeolite.

Additional features and advantages of the present invention will be apparent from the accompanying drawing and the detailed description that follows.

DETAILED DESCRIPTION

In the following descriptions for the purposes of explanation, numerous details are set forth such as examples of specific materials and methods in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that these specific details are not required in order to practice the present invention. In other instances, well known materials and methods have not been described in detail in order to avoid unnecessarily obscuring the present invention.

In this description, a hermetic seal and methods to create the same are disclosed. The hermetic seal includes an adhesive mixed with molecular sieves or zeolites. In one embodiment, the zeolites can include aluminosilicate-structured minerals such as sodium aluminosilicate. In another embodiment, the zeolites can include microporous silicate-structured minerals. It will be appreciated that active components other than zeolites that can act as absorbing filters on a molecular level can also be used. In one embodiment, the adhesive can include an adhesive with low outgassing numbers. In other embodiments, the adhesives can include adhesives with various outgassing numbers.

In one embodiment, the zeolites are mixed with the adhesive in a weight ratio of 50:50. In other embodiments, the zeolites are mixed with the adhesive in various weight ratios.

In one embodiment, the zeolites include zeolites in the powder form. In another embodiment, the zeolites include zeolite pellets. In yet another embodiment, the zeolites include zeolite beads.

The hermetic seal of the present invention can be applied as a bead between two surfaces to seal the two surfaces. The surfaces can include glass, metal, polymer, plastic, alloy or ceramic surfaces, or a combination thereof. The amount of bead that is applied can depend on the estimated amount of moisture or contaminant gases that will have to be removed from the package during the life of the package. This amount can be calculated by considering factors such as the amount of moisture/contaminant that is present inside the package when the package is formed, the permeation rate of the adhesive, and the outgassing potential of the package components.

The zeolites can absorb water molecules at high temperatures. Zeolites of different pore sizes can be selected to absorb different contaminants. In one embodiment, the zeolites are selected to absorb contaminant molecules such as aromatic branched-chain hydrocarbons that have critical diameters of up to ten angstroms. In another embodiment, zeolites of pore sizes between two and three angstroms can be selected to absorb molecules of diameters less than two angstroms, namely hydrogen and moisture molecules. In yet another embodiment, zeolites of pore sizes of fifty angstroms are used to absorb nitrogen and carbon dioxide.
The hermetic seal 130 acts as an environmental barrier by blocking humidity and chemical contaminants from entering the package 100. The hermetic seal 130 includes an adhesive mixed with an active component such as the zeolites. The adhesive alone, even a low permeation rate adhesive, cannot serve as a perfect environmental barrier because it eventually allows the contaminants and moisture to permeate. The active component can grab the contaminants and moisture that try to permeate into the package 100, instead of merely blocking their entry. The active component can grab the contaminant gases that result from outgassing of the components 100 after the package 100 is formed. The active component can grab the contaminant gases that can penetrate into the package 100 while the adhesive is curing. The thickness of the bead 130 and the amount of active component that is mixed with the adhesive can depend on the package 100 estimated life time and the estimated amount of contaminants and moisture that can penetrate the package 100 during the expected life time.

In some embodiments, an outer bead 150 of adhesive is applied around the perimeter of the bead 130. The outer bead 150 can include a low permeation rate adhesive. The outer bead 150 can provide additional environmental protection to the package 100. The outer bead can be useful for the aggressive environment in which the bead 130 alone cannot serve as an effective hermetic seal without being loaded with an impractical amount of the active component. If the bead 130 includes a very high portion of zeolites in the zeolites adhesive mixture, for example more than sixty percent zeolites by weight, the bead 130 can become microscopically porous. The bead 130 can also become highly non-viscous and thus difficult to apply. Also, the bead 130 with a high percentage of zeolite by weight may not provide a robust mechanical support to the package 100. In aggressive environments, the application of the outer bead 150 can slow down the penetration process of contaminants and moisture into the package 100.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:
1. A micro-electromechanical systems [based] device [package] comprising:
   - a back plate glass;
   - a substrate glass;
   - at least one mirror located between the substrate glass and the back plate glass; and
   - a bead of an adhesive mixed with a zeolite, the adhesive applied between the back plate glass and the substrate glass;
   - wherein the adhesive is applied substantially around the outer perimeter of the at least one mirror.

2. The micro-electromechanical systems based device package of claim 1, including the bead being applied around the perimeter of the mirror.


4. The micro-electromechanical systems [based] device [package] of claim 1, wherein the [bead] adhesive traps moisture and other contaminant gases that can be harmful to the mirror.
5. The micro-electromechanical systems based device package of claim 1, wherein the micro-electromechanical systems device includes an electronic display screen.

6. A micro-electromechanical systems [based] (MEMS) device [package] comprising:
   a back plate glass;
   a substrate glass;
   at least one MEMS structure located between the substrate glass and the back plate glass; and
   [a bend of] an adhesive mixed with zeolites of different pore sizes, the adhesive applied between the back plate glass and the substrate glass, wherein the zeolites of different pore sizes are selected to absorb molecules of different diameters, wherein the adhesive is applied substantially around the perimeter of the at least one MEMS structure.

7. The micro-electromechanical systems [based] device [package] of claim 6, wherein some of the zeolites have a pore size to allow absorption of molecules having a diameter of up to ten angstroms.

8. The micro-electromechanical systems [based] device [package] of claim 6, wherein some of the zeolites have a pore size to allow absorption of molecules having a diameter of less than two angstroms.


10. A micro-electromechanical systems [based] (MEMS) device [package] comprising:
    a back plate glass;
    a substrate glass;
    at least one MEMS structure located between the substrate glass and the back plate glass, the at least one MEMS structure being configured to be actuated; and
    [a bend of] an adhesive mixed with a zeolite, the adhesive applied between the back plate glass and the substrate glass, wherein the zeolite is selected to have a pore size which allows the zeolite to absorb a contaminant gas that is outgassed by components of the package, the at least one MEMS structure, and wherein said pore size is up to about fifty Angstroms, wherein the adhesive is supplied substantially around the outer perimeter of the at least one MEMS structure.

11. The micro-electromechanical systems [based] device [package] of claim 10, wherein the zeolite has a pore size that allows it to absorb aromatic branched-chain hydrocarbons.

12. The micro-electromechanical systems [based] device [package] of claim 10, wherein the zeolite has a pore size that allows it to absorb hydrogen molecules.

13. The micro-electromechanical systems [based] device [package] of claim 10, wherein the zeolite has a pore size that allows it to absorb nitrogen and carbon dioxide molecules.

14. A micro-electromechanical systems (MEMS) device, comprising:
    a back plate;
    a substrate;
    at least one reflective MEMS device located between the substrate glass and the back plate glass; and
    an adhesive mixed with a zeolite, the adhesive applied between the back plate and the substrate, wherein the zeolite is selected to absorb contaminant molecules outgassed by the at least one MEMS device, said contaminant molecules having a diameter of up to about ten angstroms, and wherein the adhesive is applied substantially around the outer perimeter of the at least one MEMS device.

15. The micro-electromechanical systems device of claim 14, wherein the zeolite is selected to absorb molecules having a diameter less than about two angstroms.

16. The micro-electromechanical systems device of claim 14, wherein the zeolite is selected to have a pore size between about two and three angstroms.

17. The micro-electromechanical systems device of claim 14, wherein the zeolite is selected to absorb aromatic branched-chain hydrocarbons.

18. The micro-electromechanical systems device of claim 14, wherein the zeolite is selected to absorb hydrogen molecules.

19. The micro-electromechanical systems device of claim 14, wherein the zeolite is selected to absorb moisture molecules.

20. A micro-electromechanical systems device, comprising:
    a back plate;
    a substrate;
    at least one mirror located between the substrate and the back plate, the at least one mirror being configured to be actuated; and
    an adhesive mixed with a zeolite, the adhesive applied between the back plate and the substrate, wherein the zeolite is selected to have a pore size of about fifty angstroms, and wherein the adhesive is applied substantially around the outer perimeter of the at least one mirror.

21. The micro-electromechanical systems device of claim 20, wherein the zeolite is selected to absorb nitrogen.

22. The micro-electromechanical systems device of claim 20, wherein the zeolite is selected to absorb carbon dioxide.

23. The micro-electromechanical systems device of claim 1, wherein the adhesive is applied as a bead between the back plate glass and the substrate glass.

24. The micro-electromechanical systems device of claim 6, wherein the adhesive is applied as a bead between the back plate glass and the substrate glass.

25. The micro-electromechanical systems device of claim 6, wherein the adhesive acts as a hermetic seal.

26. The micro-electromechanical systems device of claim 10, wherein the adhesive is applied as a bead between the back plate glass and the substrate glass.

27. The micro-electromechanical systems device of claim 10, wherein the adhesive acts as a hermetic seal.

28. The micro-electromechanical systems device of claim 1, wherein the at least one mirror comprises a plurality of mirrors, and wherein the adhesive is applied substantially around the perimeter of the plurality of mirrors.

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