BRIEF SUMMARY

[0006] Stress relief structures and methods that can be applied to MEMS sensors, including MEMS sensors that require a hermetic seal, and that can be simply manufactured are disclosed herein below.

[0007] In one or more embodiments, the system of these teachings includes a sensor having a first surface and a second surface, the second surface being disposed away from the first surface, the second surface also being disposed away from a package surface and located between the first surface and the package surface. The system also includes one or more support members, each support member extending from the second surface to the package surface. The support members are disposed on and operatively connected to only a portion of the second surface. The one or more support members are configured to reduce stress produced by package-sensor interaction, wherein a first support member from the one or more support members surrounds a central region of the second surface, and a second support member from the one or more support members surrounds the first support member.

[0008] In further embodiments of the system of these teachings, each support member from the one or more support members comprises a closed structure and/or a hollow cylindrical structure, wherein the closed curves in the cylindrical structure are not circles. Each one of the closed curves comprises a plurality of sections, each section from the plurality of sections being joined to another section from the plurality of sections at one or more points, a slope of each section not being equal to a slope of another section at at least one of the one or more points.

[0009] In yet further embodiments of the system of these teachings, each support member from the one or more support members is comprised of the same material as a section of the sensor proximate to the second surface and/or the same material as the package surface. The one or more support members comprise one or more first support members extending away from the second surface and one or more second support members extending from the package surface to the second surface, the one or more second support members configured to receive the one or more first support members. Each support member from the one or more first support members extends a distance away from the second surface, where the distance is smaller than a distance between the second surface and the package surface. In one instance, each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface. In one embodiment, the cross-sectional area decreases with distance away from the second surface. In another embodiment, the cross-sectional area increases with distance

away from the second surface. In yet other embodiments, each support member from the one or more support members comprises two subcomponents: a first subcomponent extending from the second surface to a predetermined location between the second surface and the package surface and a second subcomponent extending from the predetermined location to the package surface. In one instance, a cross-sectional area of the first subcomponent is larger than a cross-sectional area of the second subcomponent. In another instance, a cross-sectional area of the first subcomponent is smaller than a cross-sectional area of the second subcomponent.

[0010] In still further embodiments of the system of these teachings, the system further comprises a soft material disposed between the second surface, the package surface and the one or more support members. The system further comprises a soft material disposed between the second surface, the package surface and the one or more second support members. The system further comprises a soft material disposed between the second surface, the package surface and the one or more first and one or more second support members. The one or more support members comprise at least two support members. A width of one support member is smaller than a width of other support members. A sealing material is applied between the package surface and at least one support member, the sealing material being configured to provide a hermetic seal. At least one support member is bonded to the package surface.

[0011] In one or more embodiments, the method of these teachings for fabricating a sensor system includes etching into a surface of a component of a sensor structure, the sensor structure having a first surface, in order to form a second surface of the sensor structure and one or more support members disposed on the second surface. The second surface is disposed away from the first surface. The second surface is also disposed away from a package surface and located between the first surface and the package surface. The one or more support members are configured to reduce stress produced by package-sensor interaction. A first support member from the one or more support members surrounds a central region of the second surface; and a second support member surrounds the first support member.

[0012] In yet further embodiments of the method of these teachings, the one or more support members are configured such that, in the sensor system, each support member from the one or more support members extends from the second surface to the package surface. The component is a silicon component. A first support member from the one or more support members surrounds a central region of the second surface and each subsequent support member surrounds prior support members. Each support member from the one or more support members comprises a

closed structure and/or a hollow cylindrical structure, wherein the closed curves in the cylindrical structure are not circles. Each one of the closed curves comprises a plurality of sections, each section from the plurality of sections being joined to another section from the plurality of sections at one or more points, a slope of each section not being equal to a slope of another section at at least one of the one or more points. Each support member from the one or more support members extends a distance away from the second surface, the distance being smaller than a distance between the second surface and the package surface.

[0013] In yet further embodiments of the method of these teachings, the method further comprises trimming each support member such that each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface, the cross-sectional area increasing with distance away from the second surface. In still another embodiment, the method further comprises trimming each support member such that each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface; the cross-sectional area decreasing with distance away from the second surface. In yet another embodiment, the method further comprises trimming each support member such that each support member from the one or more support members comprises two subcomponents, a first subcomponent extending from the second surface to a predetermined location between the second surface and the package surface and a second subcomponent extending from the predetermined location to the package surface, a cross-sectional area of the first subcomponent being smaller than a cross-sectional area of the second subcomponent.

[0014] A number of other embodiments of the system and method of these teachings are also disclosed.

[0015] For a better understanding of the present teachings, together with other and further objects thereof, reference is made to the accompanying drawings and detailed description and its scope will be pointed out in the appended claims.

CLAIMS

1. A system comprising:

a sensor having a first surface and a second surface, the second surface being disposed away from the first surface; the second surface also being disposed away from a package surface and located between the first surface and the package surface;

one or more support members;

each support member from the one or more support members extending from the second surface to the package surface;

the one or more support members being disposed on and operatively connected to only a portion of the second surface;

the one or more support members being configured to reduce stress produced by package-sensor interaction;

wherein a first support member from the one or more support members surrounds a central region of the second surface; and wherein a second support member from the one or more support members surrounds the first support member.

2. The system of claim 1 wherein each support member from the one or more support members comprises a closed structure.

3. The system of claim 2 wherein each support member from the one or more support members comprises a hollow cylindrical structure.

4. The system of claim 1 wherein each support member from the one or more support members is comprised of the same material as a section of the sensor proximate to the second surface.

5. The system of claim 1 further comprising a soft material disposed between the second surface, the package surface and the one or more support members.

6. The system of claim 1 wherein each support member from the one or more support members is comprised of the same material as the package surface.

7. The system of claim 1 wherein the one or more support members comprises:

one or more first support members extending away from the second surface; and

one or more second support members extending from the package surface to the second surface;

the one or more second support members configured to receive the one or more first support members.

8. The system of claim 7 wherein each support member from the one or more first support members extends a distance away from the second surface, said distance being smaller than a distance between the second surface and the package surface.

9. The system of claim 7 further comprising a soft material disposed between the second surface, the package surface and the one or more second support members.

10. The system of claim 7 further comprising a soft material disposed between the second surface, the package surface and the one or more first and one or more second support members.

11. The system of claim 1 wherein the one or more support members comprise at least two support members.

12. The system of claim 11 wherein a width of one support member is smaller than a width of other support members.

13. The system of claim 11 wherein a sealing material is applied between the package surface and at least one support member; the sealing material being configured to provide a hermetic seal.

14. The system of claim 11 wherein at least one support member is bonded to the package surface.

15. The system of claim 1 wherein each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface; the cross-sectional area increasing with distance away from the second surface.

16. The system of claim 1 wherein each support member from the one or more support members comprises two subcomponents: a first subcomponent extending from the second surface to a predetermined location between the second surface and the package surface and a second subcomponent extending from said predetermined location to the package surface; a cross-sectional area of the first subcomponent being smaller than a cross-sectional area of the second subcomponent.

17. The system of claim 3 wherein closed curves in the cylindrical structure are not circles.

18. The system of claim 17 wherein each one of the closed curves comprises a plurality of sections, each section from the plurality of sections being joined to another section from the plurality of sections at one or more points; a slope of said each section not being equal to a slope of said another section at at least one of said one or more points.

19. A method for fabricating a sensor system, comprising:

etching into a surface of a component of a sensor structure, the sensor structure having a first surface, in order to form a second surface of the sensor structure and one or more support members disposed on the second surface; the second surface being disposed away from the first surface; the second surface also being disposed away from a package surface and located between the first surface and the package surface; the one or more support members being configured to reduce stress produced by package-sensor interaction;

wherein a first support member from the one or more support members surrounds a central region of the second surface; and a second support member surrounds the first support member.

20. The method of claim 19 wherein the one or more support members is configured such that, in the sensor system, each support member from the one or more support members extends from the second surface to the package surface.

21. The method of claim 19 wherein the component is a silicon component.

22. The method of claim 19 wherein each support member from the one or more support members comprises a closed structure.

23. The method of claim 19 wherein each support member from the one or more support members comprises a hollow cylindrical structure.

24. The method of claim 23 wherein closed curves in the cylindrical structure are not circles.

25. The method of claim 24 wherein each one of the closed curves comprises a plurality of sections, each section from the plurality of sections being joined to another section from the plurality of sections at one or more points; a slope of said each section not being equal to a slope of said another section at at least one of said one or more points.

26. The method of claim 19 wherein each support member from the one or more support members extends a distance away from the second surface, said distance being smaller than a distance between the second surface and the package surface.

27. The method of claim 19 further comprising:

trimming each support member such that said each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface; the cross-sectional area increasing with distance away from the second surface.

28. The method of claim 19 further comprising:

trimming each support member such that said each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface; the cross-sectional area decreasing with distance away from the second surface.

29. The method of claim 19 further comprising:

trimming each support member such that said each support member from the one or more support members comprises two subcomponents; a first subcomponent extending from the second surface to a predetermined location between the second surface and the package surface and a second subcomponent extending from said predetermined location to the package surface; a cross-sectional area of the first subcomponent being smaller than a cross-sectional area of the second subcomponent.

30. The system of claim 1 wherein each support member from the one or more support members has a cross-sectional area that varies with distance away from the second surface; the cross-sectional area decreasing with distance away from the second surface.

31. The system of claim 1 wherein each support member from the one or more support members comprises two subcomponents; a first subcomponent extending from the second surface to a predetermined location between the second surface and the package surface and a second subcomponent extending from said predetermined location to the package surface; a cross-sectional area of the first subcomponent being larger than a cross-sectional area of the second subcomponent.