MIDDLE LAYER OF DIE STRUCTURE THAT COMPRISES A CAVITY THAT HOLDS AN ALKALI METAL

BACKGROUND

Alkali metals (i.e., cesium) are used by various systems and devices. In order to integrate cesium with elements of a system it may be necessary to encapsulate the cesium in a closed structure. A small system or device may require the closed structure encapsulating cesium to be small. To maintain the integrity of the cesium cell, the inner surfaces of the closed structure are constructed with a material that does not react to cesium or is passive with respect to cesium.

In one example, the closed structure encapsulating cesium comprises an ampoule of a borosilicate glass (i.e., Pyrex). Pyrex does not react to cesium. Glass blowing technology is often used to generate the ampoule. A plurality of ampoules may be attached to a manifold and therefore the plurality of ampoules may be filled with cesium simultaneously. To fill the ampoule or plurality of ampoules the ampoule or manifold connecting the plurality of ampoules is infused with cesium. For example, differential heating moves droplets of cesium through a glass tube into an opening in the ampoule. Once the ampoule is filled with cesium, then the opening of the ampoule is pinched or fused to seal the cesium within the ampoule.

As one shortcoming, the process of encapsulating cesium within the plurality of ampoules is not automated. Therefore, the process is not well suited for batch fabrication. As another shortcoming, using glass blowing technology to create a small closed structure encapsulating cesium and controlling the dimensions of the small closed structure encapsulating cesium is difficult. The lack of control over the dimensions of the small closed structure encapsulating cesium limits an endurance of the small closed structure encapsulating cesium to effects of shock and vibration. Therefore, the fabrication of the small closed structure encapsulating cesium is dependent on a highly skilled glass blowing technique. As yet another shortcoming, a large closed structure encapsulating cesium requires more power to maintain a temperature the large closed structure encapsulating cesium within a range than the small closed structure encapsulating cesium in environments where the ambient temperature is outside of the range. As yet another shortcoming, the small system or device may not be able to use the large closed structure encapsulating cesium. As yet another shortcoming, the closed structure encapsulating cesium created though glass blowing technology is restricted in functionality to the encapsulation of cesium, and not amenable to function as part of a system or device beyond such functionality.

Thus, a need exists for an enhanced closed structure encapsulating an alkali metal. A need also exists for an enhanced process of encapsulating an alkali metal within a closed structure.

SUMMARY

The invention in one implementation encompasses an apparatus. The apparatus comprises a die structure that comprises a middle layer, a first outside layer, and a second outside layer. The middle layer comprises a cavity that holds an alkali metal, wherein one of the first outside layer and the second outside layer comprises a channel that leads to the cavity. The middle layer, the first outside layer, and the second outside layer comprise dies from one or more wafer substrates.

Another implementation of the invention encompasses an apparatus. The apparatus comprises a chamber that accommodates an array of die structures that comprises one or more cavities. The chamber comprises an alkali metal source and an alkali metal source control component. The alkali metal source control component fills a portion of the chamber and the one or more cavities of the array of die structures with a portion of the alkali metal source.

Yet another implementation of the invention encompasses an apparatus. The apparatus comprises a first layer of a die structure package that comprises a die structure, a thermal isolator, and an electrical conductor and a second layer of the die structure package that comprises one or more electronic components that provide supplementary functionality to one or more of the die structure, the thermal isolator, and the electrical conductor. The die structure package comprises inorganic materials that serves to promote a reduction of gases released from the die structure package.

Still yet another implementation of the invention encompasses a method. A chamber is selected that accommodates an array of die structures that comprises one or more cavities. An inner chamber of the chamber is maintained at a first temperature. An alkali metal source of the chamber is maintained at a second temperature greater than the first temperature. An outer chamber of the chamber is maintained at a third temperature greater than the first temperature and the second temperature. The one or more cavities of the array of die structures is filled with a portion of the alkali metal source. The one or more cavities of the array of die structures is sealed to comprise the portion of the alkali metal source.

BRIEF DESCRIPTION OF THE DRAWINGS

Features of exemplary implementations of the invention will become apparent from the description, the claims, and the accompanying drawings in which:

FIG. **1** is a representation of one exemplary implementation of an apparatus that comprises a die structure with a reservoir for an alkali metal.

FIG. **2** is a sectional representation of the die structure directed along line **2-2** of FIG. **1**.

FIG. **3** is a representation of one exemplary implementation of a wafer structure that comprises an array of die structures analogous to the die structure of the apparatus of FIG. **1**.

FIG. **4** is a representation of one exemplary implementation of a chamber structure that serves to fill with cesium the die structure of the apparatus of FIG. **1**.

FIG. **5** a cross-section view of one exemplary implementation of a method of sealing the die structure of the apparatus of FIG. **1**.

FIG. **6** is a representation of one exemplary implementation of a photocell and the die structure of the apparatus of FIG. **1** fixedly mounted to a first beam structure.

FIG. **7** is a representation of another exemplary implementation of a photocell and the die structure of the apparatus of FIG. **1** fixedly mounted to a first beam structure.

FIG. **8** is one representation of one exemplary implementation of a system package that comprises a housing for the die structure of the apparatus of FIG. **1**.

FIG. **9** is another representation of one exemplary implementation of a system package that comprises a housing for the die structure of the apparatus of FIG. **1**.