SEMICONDUCTOR DEVICE AND METHOD OF FORMING SUPPORTING LAYER OVER SEMICONDUCTOR DIE IN THIN FAN-OUT WAFER LEVEL CHIP SCALE PACKAGE

Field of the Invention

The present invention relates in general to semiconductor devices and, more particularly, to a semiconductor device and method of forming a supporting layer over a semiconductor die in a thin fan-out wafer level chip scale package.

Background of the Invention

Semiconductor devices are commonly found in modern electronic products. Semiconductor devices vary in the number and density of electrical components. Discrete semiconductor devices generally contain one type of electrical component, e.g., light emitting diode (LED), small signal transistor, resistor, capacitor, inductor, and power metal oxide semiconductor field effect transistor (MOSFET). Integrated semiconductor devices typically contain hundreds to millions of electrical components. Examples of integrated semiconductor devices include microcontrollers, microprocessors, charged-coupled devices (CCDs), solar cells, and digital micro-mirror devices (DMDs).

Semiconductor devices perform a wide range of functions such as signal processing, high-speed calculations, transmitting and receiving electromagnetic signals, controlling electronic devices, transforming sunlight to electricity, and creating visual projections for television displays. Semiconductor devices are found in the fields of entertainment,

Claims

What is claimed:

1. A method of making a semiconductor device, comprising:

providing a semiconductor die;

forming a first supporting layer over the semiconductor die;

forming an encapsulant around the semiconductor die~~;~~

~~forming a build up interconnect structure over a first surface of the semiconductor die and encapsulant;~~

~~forming a first supporting layer over a second surface of the semiconductor die as a supporting substrate or silicon wafer disposed opposite the build-up interconnect structure; and~~

~~forming a second supporting layer over the first supporting layer~~ and over a side surface of the first supporting layer; and

forming an interconnect structure over the semiconductor die and encapsulant opposite the first supporting layer, wherein a surface of the encapsulant opposite the interconnect structure is devoid of the first supporting layer.

2. The method of claim 1, further including forming the ~~second supporting layer to comprise a fiber-enhanced polymer composite material including a footprint~~ first supporting layer including a footprint comprising an area ~~greater than~~ equal to an area of a footprint of the semiconductor die.

3. The method of claim 1, further including forming the first supporting layer including a footprint comprising an area greater than an area of a footprint of the semiconductor die.

~~3~~4. The method of claim 1, further including forming the first supporting layer ~~to comprise a footprint including an area equal to an area of a footprint of the semiconductor die and further include~~ as a warpage balance layer comprising a coefficient of thermal expansion less than 10-300 ppm/K.

5. A method of making a semiconductor device, comprising:

providing a semiconductor die;

forming an interconnect structure over the semiconductor die;

forming a first supporting layer over the semiconductor die opposite the interconnect structure, the first supporting layer including a footprint comprising an area less than an area of a footprint of the interconnect structure; and

forming a second supporting layer in a peripheral area around the semiconductor die extending a distance of at least 50 micrometers.

~~4~~6. The method of claim ~~1~~5, ~~further including forming the first supporting layer to comprise a~~ wherein the area of the footprint of the first supporting layer is ~~footprint including an area~~ greater than an area of a footprint of the semiconductor die.

7. The method of claim 6, further including forming an opening through the first supporting layer outside the footprint of the semiconductor die.

8. The method of claim 5, further including forming a marking layer over the first supporting layer.

~~5. The method of claim 1, further including:~~

~~removing material from the second surface of the semiconductor die such that the semiconductor die comprises a thickness less than 450 micrometers (μm); and~~

~~forming the semiconductor device such that the thickness of the semiconductor die is at least 1 μm less than a difference between a total thickness of the semiconductor device and a~~

thicknesses of the build-up interconnect structure and the second supporting layer.

6. A method of making a semiconductor device, comprising:
providing a semiconductor die;
forming an encapsulant around the semiconductor die;
forming an interconnect structure over the semiconductor die and encapsulant;
forming a first supporting layer over the semiconductor die disposed opposite the interconnect structure; and
forming a second supporting layer over the first supporting layer.

7. The method of claim 6, further including forming the first supporting layer on a surface of the semiconductor die as a glass substrate or silicon wafer.

8. The method of claim 6, further including forming the second supporting layer to comprise a fiber enhanced polymer composite material including a footprint comprising an area greater than an area of a footprint of the semiconductor die.

~~9. The method of claim 6, further including:~~

~~forming the first supporting layer as a warpage balance layer comprising a coefficient of thermal expansion in a range of 10-300 ppm/K; and~~

~~forming the second supporting layer as a polymer matrix composite material.~~

~~10. The method of claim 6, further including removing a portion of the encapsulant to expose a surface of the semiconductor die or a surface of the first supporting layer.~~

~~11~~9. A semiconductor device, comprising:

a semiconductor die;

an encapsulant formed around the semiconductor die;

an interconnect structure formed over the semiconductor die and encapsulant; ~~and~~

a first supporting layer including a footprint comprising an area greater than or equal to an area of a footprint of the semiconductor die formed over the semiconductor die opposite the interconnect structure and

a second supporting layer including a fiber material formed over the first supporting layer.

~~12. The semiconductor device of claim 11, further including a second supporting layer embedded within the semiconductor device at a peripheral area around the semiconductor die that extends within the semiconductor device a distance of at least 50 micrometers.~~

1~~3~~0. The semiconductor device of claim ~~11~~9, wherein the first supporting layer includes a core material formed of epoxy and

glass fibers comprising a coefficient of thermal expansion in a range of 4-150 ppm/K ~~and further includes a footprint comprising an area greater than an area of a footprint of the semiconductor die~~.

141. The semiconductor device of claim 110, wherein the first supporting layer includes openings formed through the first supporting layer outside athe footprint of the semiconductor die.

152. The semiconductor device of claim 119, further including a marking layer formed over the first supporting layer.

13. A semiconductor device comprising:

a semiconductor die;

an encapsulant formed around the semiconductor die;

an interconnect structure formed over the semiconductor die and encapsulant;

a first supporting layer including a footprint comprising an area greater than or equal to an area of a footprint of the semiconductor die formed over the semiconductor die opposite the interconnect structure; and

a second supporting layer embedded within the semiconductor device at a peripheral area around the semiconductor die that extends within the semiconductor device a distance of at least 50 micrometers.

14. The semiconductor device of claim 13, wherein the area of the footprint of the first supporting layer is equal to the area of the footprint of the semiconductor die.

15. A semiconductor device, comprising:

a semiconductor die;

an interconnect structure formed over the semiconductor die;

a first supporting layer formed over the semiconductor die opposite the interconnect structure; and

an encapsulant formed around the semiconductor die and over a side surface of the first supporting layer, wherein a surface of the encapsulant opposite the interconnect structure is devoid of the first supporting layer.

16. The semiconductor device of claim 15, further including a second supporting layer embedded within the encapsulant at a peripheral area around the semiconductor die that extends within the semiconductor device a distance of at least 50 micrometers.

17. The semiconductor device of claim 15, wherein the first supporting layer includes a footprint comprising an area equal to an area of a footprint of the semiconductor die.

18. The semiconductor device of claim 15, wherein the first supporting layer includes a footprint comprising an area greater than an area of a footprint of the semiconductor die.

19. The semiconductor device of claim 18, wherein the first supporting layer includes openings formed through the first supporting layer outside the footprint of the semiconductor die.

20. The semiconductor device of claim 18, wherein the first supporting layer includes properties selected to control warpage of the semiconductor device.

21. The semiconductor device of claim 18, further including a marking layer formed over the first supporting layer.

22. A semiconductor device, comprising:

a semiconductor die;

an interconnect structure formed over the semiconductor die;

a first supporting layer formed over the semiconductor die opposite the interconnect structure, the first supporting layer including a footprint comprising an area less than an area of a footprint of the interconnect structure; and

a second supporting layer embedded within the semiconductor device at a peripheral area around the semiconductor die that extends within the semiconductor device a distance of at least 50 micrometers.

23. The semiconductor device of claim 22, wherein the area of the footprint of the first supporting layer is equal to an area of a footprint of the semiconductor die.

24. The semiconductor device of claim 22, wherein the area of the footprint of the first supporting layer is greater than an area of a footprint of the semiconductor die.

25. The semiconductor device of claim 24, wherein the first supporting layer includes openings formed through the first supporting layer outside the footprint of the semiconductor die.

26. The semiconductor device of claim 24, wherein the first supporting layer includes properties selected to control warpage of the semiconductor device.

27. The semiconductor device of claim 24, further including a marking layer formed over the first supporting layer.