contains powdered or flaked silver or carbon conductive materials applied as a thin layer in patterned trench 150. A conductive ink distribution tool or squeegee 156 distributes conductive ink 154 across stencil 152 and into patterned trench 150. During the printing operation, conductive ink distribution tool 156 moves left to right across stencil 152 as shown by arrow 158 to press conductive ink 154 through the openings in the stencil into patterned trench 150 in insulating layer 146.

In another embodiment, a volume of conductive ink 154 is deposited directly into patterned trench 150 in insulating layer 146 using dispensing nozzle or jet 160, as shown in FIG. 6e. During the jetting operation, conductive ink 154 flows from dispensing nozzle 160 as droplets or steady stream in the proper volume to fill patterned trench 150. The volume of conductive ink 154 is measured according to the space requirements of patterned trench 150.

FIG. 6f shows conductive ink 154 deposited into patterned trench 150 in insulating layer 146 by operation of conductive ink distribution tool 156, dispensing nozzle 160, or other suitable applicator for dispensing or distributing the conductive ink. Conductive ink 154 is evenly dispensed and uniformly distributed within patterned trench 150 in insulating layer 146. Excess conductive ink 154 can be removed by a planarizing operation on insulating layer 146 to make the conductive ink planar with the insulating layer.

An ultraviolet (UV) light source 162 radiates UV light 164 onto conductive ink 154 at room temperature (15-25°C) causing a chemical crosslinking reaction to cure the conductive ink. An elevated temperature is not required for the UV cure of conductive ~~i~~ink 154.

Claims

What is claimed:

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

~~providing a semiconductor die;~~

~~forming a first insulating layer over the semiconductor die;~~

~~forming a patterned trench in the first insulating layer;~~

~~depositing a conductive ink in the patterned trench; and~~

~~curing the conductive ink by ultraviolet light.~~

~~2. The method of claim 1, further including curing the conductive ink at room temperature.~~

~~3~~4. The method of claim 1, further including:

forming a second insulating layer over the first insulating layer and conductive ink; and

forming an interconnect structure over the conductive ink.

~~4~~2. The method of claim 1, wherein depositing the conductive ink includes ~~further including~~:

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

~~forming the patterned trench in the encapsulant; and~~

~~depositing the conductive ink in the patterned trench in the encapsulant.~~

disposing a stencil over the first insulating layer with an opening in the stencil aligned with the patterned trench; and

depositing the conductive ink through the opening in the stencil into the patterned trench.

3. The method of claim 1, wherein depositing the conductive ink includes dispensing the conductive ink through a nozzle into the patterned trench.

~~5~~1. A method of making a semiconductor device, comprising:

providing a ~~substrate~~ semiconductor die;

depositing an encapsulant around the semiconductor die;

forming a first insulating layer over the ~~substrate~~ semiconductor die;

forming a patterned trench in the first insulating layer and encapsulant;

depositing a conductive ink in the patterned trench in the first insulating layer and encapsulant;

planarizing the conductive ink with the first insulating layer and the encapsulant; and

~~in the trench; and~~

curing the conductive ink by ultraviolet light at room temperature to form a redistribution layer in the patterned trench.

~~6. The method of claim 5, further including curing the conductive ink by ultraviolet light.~~

~~7~~6. The method of claim 5, further including curing the conductive ink at room temperature.

~~8~~7. The method of claim 5, wherein depositing the conductive ink includes~~further including~~:

~~forming a second insulating layer over the first insulating layer and conductive ink; and~~

~~forming an interconnect structure over the conductive ink.~~

disposing a stencil over the first insulating layer; and

depositing the conductive ink through the stencil into the trench.

~~9~~8. The method of claim 5, wherein depositing the conductive ink includes ~~further including:~~

~~depositing an encapsulant around the substrate;~~

~~forming the trench in the encapsulant; and~~

~~depositing~~ dispensing the conductive ink through a nozzle into~~in~~ the trench ~~in the encapsulant~~.

~~10~~5. A method of making a semiconductor device, comprising:

providing a substrate;

forming a first insulating layer ~~formed~~ over the substrate;

~~a trench formed in the first insulating layer; and~~

~~a conductive ink deposited in the trench, wherein the conductive ink is cured~~

depositing an encapsulant around the substrate;

forming a trench in the encapsulant and in the first insulating layer;

depositing a conductive ink in the trench in the encapsulant;

curing the conductive ink by ultraviolet light to form a redistribution layer in the trench;

forming a second insulating layer over the first insulating layer and ~~conductive ink~~ redistribution layer; and

forming an interconnect structure over the redistribution layer.

9. The method of claim 5, further including measuring a volume of the conductive ink according to a size of the trench, wherein depositing the conductive ink includes dispensing the volume of the conductive ink measured according to the size of the trench.

10. The method of claim 5, further including planarizing the conductive ink with the first insulating layer and the encapsulant.

~~11. The semiconductor device of claim 10, wherein the conductive ink is cured by ultraviolet light.~~

11. A semiconductor device, comprising:

a semiconductor die;

an encapsulant deposited around the semiconductor die;

a first insulating layer formed over the semiconductor die;

a patterned trench formed in the first insulating layer and encapsulant; and

a conductive ink deposited in the patterned trench and planarized with the first insulating layer and encapsulant, wherein the conductive ink is cured by ultraviolet light.

1~~2~~4. The semiconductor device of claim 1~~0~~1, wherein the conductive ink is cured at room temperature.

12. The semiconductor device of claim 11, further including a stencil disposed over the first insulating layer, wherein the conductive ink is deposited through the stencil into the patterned trench.

13. The semiconductor device of claim 11, further including a nozzle disposed over the patterned trench, wherein the conductive ink is dispensed through the nozzle into the patterned trench.

15. The semiconductor device of claim 11, further including:

a second insulating layer formed over the first insulating layer and conductive ink; and

an interconnect structure formed over the conductive ink.

~~15. The semiconductor device of claim 10, further including an encapsulant deposited around the substrate, wherein the trench is formed in the encapsulant and the conductive ink is deposited in the trench in the encapsulant.~~

16. A semiconductor device, comprising:

a substrate;

a first insulating layer formed over the substrate;

an encapsulant deposited around the substrate;

a trench formed in the first insulating layer and in the encapsulant;

an ultraviolet (UV) curable conductive ink deposited in the trench in the first insulating layer and the encapsulant as a redistribution layer formed in the trench;

a second insulating layer formed over the first insulating layer and redistribution layer; and

an interconnect structure formed over the redistribution layer.

17. The semiconductor device of claim 16, wherein the UV curable conductive ink is cured by ultraviolet light.

18. The semiconductor device of claim 16, wherein the UV curable conductive ink is cured at room temperature.

19. The semiconductor device of claim 16, wherein the UV curable conductive ink includes flaked silver or carbon conductive materials.

20. The semiconductor device of claim 16, further including the UV curable conductive ink planarized with the first insulating layer and the encapsulant.

21. A method of making a semiconductor device, comprising:
providing a substrate;
forming a first insulating layer over the substrate;
forming a trench in the first insulating layer;
depositing a conductive ink in the trench in the first insulating layer; and
curing the conductive ink by ultraviolet light to form a redistribution layer in the trench.

22. The method of claim 21, further including measuring a volume of the conductive ink according to a size of the trench, wherein depositing the conductive ink includes dispensing the volume of the conductive ink measured according to the size of the trench.

23. The method of claim 21, wherein depositing the conductive ink includes:

disposing a stencil over the first insulating layer; and

depositing the conductive ink through the stencil into the trench.

24. The method of claim 21, wherein depositing the conductive ink includes dispensing the conductive ink through a nozzle into the trench.

25. The method of claim 21, further including curing the conductive ink at room temperature.

26. The method of claim 21, further including planarizing the conductive ink with the first insulating layer.