

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device, the method comprising:

providing a base structure including a semiconductor substrate having a top surface and a bottom surface opposite to the top surface, and a color filter and a micro-lens on the top surface of the semiconductor substrate;

forming a redistribution line on the bottom surface of the semiconductor substrate;

forming a passivation layer covering the redistribution line on the bottom surface of the semiconductor substrate; and

spontaneously forming an oxide layer on the redistribution line and growing the oxide layer between the redistribution line and the passivation layer at a temperature regime specified to avoid thermal damage to the color filter and the micro-lens;

wherein the oxide layer is formed to a thickness in a range of from 50 nm to 200 nm.

2. The method of claim 1, wherein the passivation layer is formed of material comprising oxygen, and the oxygen in the passivation layer and a constituent of material of the redistribution line react to form the oxide layer.

3. The method of claim 1 or claim 2, wherein the growing of the oxide layer automatically occurs during processes carried out subsequent to the

forming of the passivation layer.

4. The method of any one of the previous claims, wherein the oxide layer is automatically grown to have a thickness of about 100 nm at a time at which the manufacturing of the semiconductor device has been completed.

5. The method of any one of the previous claims, wherein the temperature regime has a maximum temperature of 250°C.

6. The method of any one of the previous claims, wherein forming the redistribution line comprises:

forming a mask pattern on the bottom surface of the semiconductor substrate;

sequentially forming a barrier layer and a seed layer on a surface of the semiconductor substrate exposed by the mask pattern; and

forming a metal layer by a plating process using the seed layer.

7. The method of claim 6, wherein the base structure comprises a through electrode that penetrates the semiconductor substrate and is exposed at the bottom surface of the semiconductor substrate, and

the barrier layer is formed as coupled to the through electrode.

8. The method of claim 6 or claim 7, wherein the redistribution line has a top surface facing the bottom surface of the semiconductor substrate, a

bottom surface facing away from the semiconductor substrate, and a side surface, the side surface connecting the top surface and the bottom surface of the redistribution line to each other,

the barrier layer is formed to cover the top surface of the redistribution line, and

the oxide layer covers the bottom surface and the side surface of the redistribution line.

9. The method of any one of the previous claims, wherein the forming of the passivation layer comprises forming a layer of polybenzoxazole (PBO) on the redistribution line and along the bottom surface of the semiconductor substrate not covered by the redistribution line.

10. A method of manufacturing a semiconductor device, the method comprising:

providing a base structure including semiconductor substrate having an active surface and an inactive surface opposite to the active surface, and a color filter and a micro-lens on the active surface;

forming a redistribution metal layer on the inactive surface of the semiconductor substrate;

forming on the inactive surface of the semiconductor substrate an organic insulation layer covering the redistribution metal layer; and

growing a metal oxide layer to a predetermined thickness in a range of from 50 nm to 200 nm between the redistribution metal layer and the organic

insulation layer,

wherein the metal oxide layer is grown to said predetermined thickness during processing carried out subsequent to the forming of the organic insulation layer within a temperature regime specified to avoid thermal damage to the color filter and the micro-lens.

11. The method of claim 10, wherein the metal oxide layer is formed by a spontaneous reaction between the redistribution metal layer and the organic insulation layer.

12. The method of claim 10 or claim 11, wherein temperature regime has a maximum temperature of 250°C.

13. The method of any one of claims 10 to 12, wherein the providing of the base structure comprises:

forming a through electrode through the semiconductor substrate; and

thinning the semiconductor substrate to reveal the inactive surface,

wherein the through electrode is exposed at the inactive surface of the semiconductor substrate.

14. The method of claim 13, wherein the forming of the redistribution metal layer comprises:

forming on the inactive surface of the semiconductor substrate a mask having a groove that exposes the through electrode;

forming on the inactive surface of the semiconductor substrate a barrier layer coupled to the through electrode;

forming a seed layer on the barrier layer; and

performing a plating process using the seed layer to form in the groove a metal layer comprising copper (Cu).

15. The method of claim 14, wherein the forming of the organic insulation layer comprises:

providing polybenzoxazole (PBO) on the copper (Cu); and

curing the polybenzoxazole (PBO).

16. The method of any one of the previous claims 10 to 15, wherein the providing of the base structure comprises forming a metal line structure on the active surface of the semiconductor substrate, wherein the color filter and the micro-lens are stacked on the metal line structure; and

further comprising forming an outer terminal that extends through the organic insulation layer to the redistribution metal layer.

17. A method of forming a redistribution line, the method comprising:

providing a base structure including a semiconductor substrate having an active surface and an inactive surface, and a through electrode that does not reach the inactive surface;

recessing the inactive surface of the semiconductor substrate to expose the through electrode;

subsequently forming the redistribution line on the inactive surface of the semiconductor substrate, the redistribution line electrically connected to the through electrode; and

forming an organic passivation layer covering the redistribution line;
and

growing, at a temperature equal to or less than 250°C, a native metal oxide layer between the redistribution line and the organic passivation layer to a thickness in a range of from 50 nm to 200 nm.

18. The method of claim 17, wherein the recessing of the inactive surface of the semiconductor substrate comprises:

adhering a carrier to the active surface of the semiconductor substrate;
and

grinding the semiconductor substrate having the carrier adhered thereto.

19. The method of claim 17 or claim 18, further comprising forming on the inactive surface of the semiconductor substrate, after the inactive surface has been recessed, an insulation layer covering the through electrode, and

planarizing the insulation layer to form a planarized structure in which the through electrode appears at a surface of the insulation layer,

wherein the redistribution line is formed as electrically connected to the through electrode of the planarized structure.