CLAIMS

WHAT IS CLAIMED IS:

1. A semiconductor device, comprising:

a first layer, a second layer, a first die between the first layer and the second layer, a second die, and a base die, the base die, the first layer, the first die, the second layer, and the second die are stacked together along a first direction, wherein:

each of the first die and the second die has a conductive layer;

the first die and the second die are bonded through the second layer; and

the base die and the first die are bonded through the first layer;

a first contact structure coupled to the conductive layer of the first die, wherein the first contact structure extends along the first direction and contacts the conductive layer of the first die without extending through the second layer; and

a second contact structure coupled to the conductive layer of the second die, wherein:

the second contact structure extends through the second layer along the first direction without extending through the second die; and

the second contact structure contacts the conductive layer of the second die without extending through the conductive layer of the first die;

wherein:

the second layer comprises a top bonding layer and a bottom bonding layer each comprising a dielectric material and excluding a conductive bonding contact;

the dielectric material of the top bonding layer of the second layer is bonded to the dielectric material of the bottom bonding layer of the second layer;

the first layer comprises a top bonding layer and a bottom bonding layer each comprising conductive bonding contacts and a dielectric material isolating the conductive bonding contacts;

the dielectric material of the top bonding layer of the first layer is bonded to the dielectric material of the bottom bonding layer of the first layer; and

the conductive bonding contacts of the top bonding layer of the first layer are bonded to the conductive bonding contacts of the bottom bonding layer of the first layer.

2. The semiconductor device of claim 1, wherein:

a first end of the conductive layer of the first die and a first end of the conductive layer of the second die are offset along a second direction perpendicular to the first direction.

3. The semiconductor device of claim 2, wherein:

the second contact structure is between the first end of the conductive layer of the first die and the first end of the conductive layer of the second die along the second direction.

4. The semiconductor device of claim 1, wherein each of the first contact structure and the second contact structure is a continuous structure.

5. The semiconductor device of claim 1, wherein:

the base die comprises first vias extending along the first direction and being coupled to the conductive bonding contacts of the first layer; and

each of the first contact structure and the second contact structure is coupled to one of the first vias through one of the conductive bonding contacts of the first layer.

6. The semiconductor device of claim 5, further comprising:

a computing die and an interposer, wherein:

the base die and the computing die are integrated on different positions of the interposer along a second direction perpendicular to the first direction.

7. The semiconductor device of claim 6, wherein:

the base die comprises first vias coupled to the computing die through the interposer;

the first vias are coupled to the first conductive terminals on a surface of the interposer;

the computing die is coupled to second conductive terminals on the surface of the interposer; and

the first conductive terminals and the second conductive terminals are coupled through conductive lines in the interposer.

8. The semiconductor device of claim 1, further comprising:

a computing die and a third layer between the computing die and the base die, wherein:

the computing die, the third layer, the base die, the first layer, the first die, the second layer, and the second die are stacked along the first direction; and

the base die and the computing die are bonded through the third layer.

9. The semiconductor device of claim 8, wherein:

the third layer comprises conductive bonding contacts and at least one dielectric material isolating the conductive bonding contacts.

10. The semiconductor device of claim 9, wherein:

the third layer comprises a top bonding layer and a bottom bonding layer, each comprising conductive bonding contacts and a dielectric material isolating the conductive bonding contacts;

the dielectric material of the top bonding layer of the third layer is bonded to the dielectric material of the bottom bonding layer of the third layer; and

the conductive bonding contacts of the top bonding layer of the third layer are bonded to the conductive bonding contacts of the bottom bonding layer of the third layer.

11. The semiconductor device of claim 10, wherein:

the base die comprises first vias coupled to the computing die;

the computing die comprises second vias extending along the first direction and being coupled to the conductive bonding contacts of the third layer; and

the first vias are coupled to the second vias through the conductive bonding contacts of the third layer.

12. The semiconductor device of claim 11, further comprising an interposer, wherein the interposer, the computing die, the third layer, the base die, the first layer, the first die, the second layer, and the second die are stacked along the first direction.

13. A semiconductor device, comprising:

a base die, a first layer, a second layer, a first die between the first layer and the second layer, and a second die stacked together along a first direction, wherein:

each of the base die, the first die, and the second die has a conductive layer;

the first die and the second die are bonded through the second layer; and

the base die and the first die are bonded through the first layer;

a first contact structure coupled to the conductive layer of the base die, wherein the first contact structure extends along the first direction and contacts the conductive layer of the base die without extending through the first layer;

a second contact structure coupled to the conductive layer of the first die, wherein:

the second contact structure extends through the first layer along the first direction without extending through the second layer; and

the second contact structure contacts the conductive layer of the first die without extending through the conductive layer of the base die; and

a third contact structure coupled to the conductive layer of the second die, wherein:

the third contact structure extends through the first layer and the second layer along the first direction without extending through the second die; and

the third contact structure contacts the conductive layer of the second die without extending through the conductive layer of the first die;

wherein:

the second layer comprises a top bonding layer and a bottom bonding layer each comprising a dielectric material and excluding a conductive bonding contact;

the dielectric material of the top bonding layer of the second layer is bonded to the dielectric material of the bottom bonding layer of the second layer;

the first layer comprises a top bonding layer and a bottom bonding layer each comprising a dielectric material and excluding a conductive bonding contact; and

the dielectric material of the top bonding layer of the first layer is bonded to the dielectric material of the bottom bonding layer of the first layer.

14. The semiconductor device of claim 13, wherein:

a first end of the conductive layer of the first die and a first end of the conductive layer of the second die are offset along a second direction perpendicular to the first direction.

15. The semiconductor device of claim 14, wherein:

the third contact structure is between the first end of the conductive layer of the first die and the first end of the conductive layer of the second die along the second direction.

16. The semiconductor device of claim 13, wherein:

the base die comprises an interconnect layer extending along a second direction perpendicular to the first direction; and

each of the first contact structure, the second contact structure, and the third contact structure is coupled to the interconnect layer.

17. A method, comprising:

providing a first die and a second die, wherein the first die comprises a conductive layer and at least a first bonding layer, and the second die comprises a conductive layer and at least a second bonding layer;

stacking the second die on the first die along a first direction;

bonding the second bonding layer of the second die to the first bonding layer of the first die, wherein the first bonding layer of the first die and the second bonding layer of the second die each include a dielectric material and exclude a conductive bonding contact;

forming a first contact structure and a second contact structure that extend along the first direction, wherein:

the first contact structure contacts the conductive layer of the first die;

the second contact structure extends through the first bonding layer of the first die and the second bonding layer of the second die; and

the second contact structure contacts the conductive layer of the second die without contacting the conductive layer of the first die;

forming a third bonding layer on top of the first die, wherein the third bonding layer comprises conductive bonding contacts and a dielectric material isolating the conductive bonding contacts;

providing a base die, wherein the base die comprises a bottom bonding layer comprising conductive bonding contacts and a dielectric material isolating the conductive bonding contacts; and

stacking the base die on the first die by bonding the dielectric material of the bottom bonding layer of the base die to the dielectric material of the third bonding layer of the first die and bonding the conductive bonding contacts of the bottom bonding layer of the base die to the conductive bonding contacts of the third bonding layer of the first die.

18. The method of claim 17, wherein stacking the second die on the first die along the first direction comprises:

aligning the second die with the first die to offset a first end of the conductive layer of the first die and a first end of the conductive layer of the second die along a second direction perpendicular to the first direction.

19. The method of claim 17, wherein providing the first die comprises:

thinning the first die by thinning a substrate comprised in the first die.

20. The method of claim 17, wherein the first contact structure and the second contact structure are formed by a same process comprising:

forming a first contact hole and a second contact hole;

forming an insulating layer in each of the first contact hole and the second contact hole; and

forming the first contact structure and the second contact structure by forming a conductive structure in the insulating layer of each of the first contact hole and the second contact hole, wherein the first contact structure comprises the insulating layer and the conductive structure in the first contact hole, and the second contact structure comprises the insulating layer and the conductive structure in the second contact hole.