

Claims

What is claimed is:

1. An interconnect assembly comprising:
a flexible substrate defining a plane; and
5 a wavy interconnect disposed on the flexible substrate and configured to route electrical signals of an integrated circuit (IC) device in a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile from a second direction that is perpendicular to the first direction and coplanar with the plane.
- 10 2. The interconnect assembly of claim 1, wherein the wavy interconnect has a straight line profile from a third direction that is perpendicular to the first direction and the second direction.
3. The interconnect assembly of claim 1, wherein the flexible substrate and the wavy interconnect are configured to stretch in the first direction and/or
15 bend in a third direction that is perpendicular to the first direction and the second direction.
4. The interconnect assembly of claim 1, wherein:
the wavy interconnect has a width in the second direction;
the wavy profile has a semi-amplitude; and
20 a ratio of the width to the semi-amplitude (width/semi-amplitude) is greater than or equal to $\frac{1}{2}$.
5. The interconnect assembly of claim 4, wherein:
the wavy interconnect has a thickness in a third direction that is perpendicular to the first direction and the second direction; and
25 a ratio of the semi-amplitude to the thickness (semi-amplitude/thickness) is greater than or equal to 10.
6. The interconnect assembly of any of claims 1-5, wherein the wavy profile is a curved profile.
7. The interconnect assembly of any of claims 1-5, wherein the wavy
30 interconnect is one of multiple wavy interconnects that run parallel with the wavy interconnect in the first direction.
8. The interconnect assembly of any of claims 1-5, wherein:
the wavy interconnect comprises a metal; and
the flexible substrate comprises a polymer.

9. A method of fabricating an integrated circuit (IC) assembly, the method comprising:

providing a flexible substrate, the flexible substrate defining a plane;

and

5 forming a wavy interconnect on the flexible substrate, the wavy interconnect being configured to route electrical signals of an integrated circuit (IC) device in a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile from a second direction that is perpendicular to the first direction and coplanar with the plane.

10 10. The method of claim 9, wherein forming the wavy interconnect comprises:

forming a wavy profile in a surface of the flexible substrate; and
depositing a metal on the wavy profile.

15 11. The method of claim 10, wherein forming the wavy profile comprises using a printing, molding or lithography process.

12. The method of claim 9, further comprising:

depositing a passivation layer on the flexible substrate to cover the wavy interconnect.

13. The method of claim 12, further comprising:

20 electrically coupling the IC device with the wavy interconnect prior to depositing the passivation layer, wherein depositing the passivation layer comprises depositing the passivation layer on the IC device.

14. The method of claim 9, wherein forming the wavy interconnect comprises:

25 depositing a metal on a substantially flat surface of the flexible substrate; and

shaping the metal and the flexible substrate to create the wavy profile.

30 15. The method of claim 14, wherein the metal is deposited on a first side of the flexible substrate that is disposed opposite to a second side of the flexible substrate, the method further comprising:

mounting the IC device on the flexible substrate; and

depositing a flexible passivation layer on the first side and the second side of the flexible substrate to lock in the wavy profile.

16. The method of claim 9, wherein the flexible substrate is a first flexible substrate, the method further comprising:
embedding the IC device in a second flexible substrate;
coupling the first substrate with the second substrate; and
5 forming an electrical connection between the wavy interconnect and the IC device.

17. The method of claim 16, wherein forming the electrical connection comprises forming a through-substrate interconnect.

18. A stretchable or bendable integrated circuit (IC) assembly, the IC
10 assembly comprising:
an integrated circuit (IC) device;
a flexible substrate defining a plane; and
a wavy interconnect disposed on the flexible substrate and
electrically coupled with the IC device to route electrical signals of the IC device in
15 a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile from a second direction that is perpendicular to the first direction and coplanar with the plane.

19. The IC assembly of claim 18, wherein the wavy interconnect has a straight line profile from a third direction that is perpendicular to the first direction
20 and the second direction.

20. The IC assembly of claim 18, wherein the IC device is a first IC device, the IC assembly further comprising:
a second IC device electrically coupled with the wavy interconnect,
wherein the wavy interconnect is configured to route electrical signals between the
25 first IC device and the second IC device.

21. The IC assembly of claim 20, wherein the first IC device is a die and the second IC device is a sensor.

22. The IC assembly of claim 18, wherein the IC device is directly coupled with the flexible substrate, the IC assembly further comprising:
30 a flexible passivation layer disposed on the wavy interconnect and the IC device.

23. The IC assembly of claim 22, wherein:
the wavy interconnect is disposed on a first side of the flexible substrate;

a second side of the flexible substrate has a wavy profile corresponding with the wavy profile of the wavy interconnect; and the second side is disposed opposite to the first side.

24. The IC assembly of claim 18, wherein:
- 5 the flexible substrate is a first flexible substrate;
- the IC device is embedded in a second flexible substrate that is coupled with the first flexible substrate; and
- the IC device is electrically coupled with the wavy interconnect using a through-substrate interconnect that extends through at least a portion of the first
- 10 flexible substrate and the second flexible substrate.
25. The IC assembly of any of claims 18-24, wherein the IC assembly is wearable by a person.

Claims

What is claimed is:

1. An interconnect assembly comprising:
a flexible substrate defining a plane; and
a wavy interconnect disposed on the flexible substrate and configured to route electrical signals of an integrated circuit (IC) device in a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile when viewed from a second direction that is perpendicular to the first direction and coplanar with the plane.
2. The interconnect assembly of claim 1, wherein the wavy interconnect has a straight line profile when viewed from a third direction that is perpendicular to the first direction and the second direction.
3. The interconnect assembly of claim 1, wherein the flexible substrate and the wavy interconnect are configured to stretch in the first direction, bend around an axis of the second direction and/or twist out of a plane defined by the first direction and the second direction.
4. The interconnect assembly of claim 1, wherein:
the wavy profile has a semi-amplitude;
the wavy interconnect has a thickness in a third direction that is perpendicular to the first direction and the second direction; and
a ratio of the semi-amplitude to the thickness (semi-amplitude/thickness) is greater than or equal to 10.
5. The interconnect assembly of claim 1, wherein:
the wavy interconnect has a width in the second direction;
the wavy interconnect is one of a plurality of wavy interconnects having a pitch between adjacent wavy interconnects in the second direction; and
a ratio of the width to the pitch (width/pitch) is greater than or equal to $\frac{1}{2}$.

6. The interconnect assembly of claim 1, wherein the wavy profile is a curved profile.
7. The interconnect assembly of any of claim 1, wherein the wavy interconnect is one of multiple wavy interconnects that run parallel with the wavy interconnect in the first direction.
8. The interconnect assembly of any of claim 1, wherein:
the wavy interconnect comprises a metal; and
the flexible substrate comprises a polymer.
9. A method of fabricating an integrated circuit (IC) assembly, the method comprising:
providing a flexible substrate, the flexible substrate defining a plane; and
forming a wavy interconnect on the flexible substrate, the wavy interconnect being configured to route electrical signals of an integrated circuit (IC) device in a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile when viewed from a second direction that is perpendicular to the first direction and coplanar with the plane.
10. The method of claim 9, wherein forming the wavy interconnect comprises:
forming a wavy profile in a surface of the flexible substrate; and
depositing a metal on the wavy profile.
11. The method of claim 10, wherein forming the wavy profile comprises using a printing, molding or lithography process.
12. The method of claim 9, further comprising:
depositing a passivation layer on the flexible substrate to cover the wavy interconnect.

13. The method of claim 12, further comprising:
 - electrically coupling the IC device with the wavy interconnect prior to depositing the passivation layer, wherein depositing the passivation layer comprises depositing the passivation layer on the IC device.
14. The method of claim 9, wherein forming the wavy interconnect comprises:
 - depositing a metal on a substantially flat surface of the flexible substrate; and
 - shaping the metal and the flexible substrate to create the wavy profile.
15. The method of claim 14, wherein the metal is deposited on a first side of the flexible substrate that is disposed opposite to a second side of the flexible substrate, the method further comprising:
 - mounting the IC device on the flexible substrate; and
 - depositing a flexible passivation layer on the first side and the second side of the flexible substrate to lock in the wavy profile.
16. The method of claim 9, wherein the flexible substrate is a first flexible substrate, the method further comprising:
 - embedding the IC device in a second flexible substrate;
 - coupling the first substrate with the second substrate; and
 - forming an electrical connection between the wavy interconnect and the IC device.
17. The method of claim 16, wherein forming the electrical connection comprises forming a through-substrate interconnect.
18. A stretchable or bendable integrated circuit (IC) assembly, the IC assembly comprising:
 - an integrated circuit (IC) device;
 - a flexible substrate defining a plane; and

a wavy interconnect disposed on the flexible substrate and electrically coupled with the IC device to route electrical signals of the IC device in a first direction that is coplanar with the plane, the wavy interconnect having a wavy profile when viewed from a second direction that is perpendicular to the first direction and coplanar with the plane.

19. The IC assembly of claim 18, wherein the wavy interconnect has a straight line profile when viewed from a third direction that is perpendicular to the first direction and the second direction.

20. The IC assembly of claim 18, wherein the IC device is a first IC device, the IC assembly further comprising:

a second IC device electrically coupled with the wavy interconnect, wherein the wavy interconnect is configured to route electrical signals between the first IC device and the second IC device.

21. The IC assembly of claim 20, wherein the first IC device is a die and the second IC device is a sensor.

22. The IC assembly of claim 18, wherein the IC device is directly coupled with the flexible substrate, the IC assembly further comprising:

a flexible passivation layer disposed on the wavy interconnect and the IC device.

23. The IC assembly of claim 22, wherein:

the wavy interconnect is disposed on a first side of the flexible substrate;

a second side of the flexible substrate has a wavy profile corresponding with the wavy profile of the wavy interconnect; and

the second side is disposed opposite to the first side.

24. The IC assembly of claim 18, wherein:

the flexible substrate is a first flexible substrate;

the IC device is embedded in a second flexible substrate that is coupled with the first flexible substrate; and

the IC device is electrically coupled with the wavy interconnect using a through-substrate interconnect that extends through at least a portion of the first flexible substrate and the second flexible substrate.

25. The IC assembly of claim 18, wherein the IC assembly is wearable by a person.