CLAIMS

What is claimed is:

1. An optoelectrical system, comprising:

a first photonics structure having a first photonics dielectric stack;

a second photonics structure having a second photonics dielectric stack;

a bond layer that fusion bonds the first photonics structure to the second photonics structure;

one or more metallization layer integrally formed in the first photonics dielectric stack;

at least one metallization layer integrally formed in the second photonics dielectric stack;

one or more photonics device integrally formed in the first photonics dielectric stack;

at least one photonics device integrally formed in the second photonics dielectric stack;

one or more laser stack structure active region integrally formed in the second photonics dielectric stack, each laser stack structure active region including a laser stack structure associated therewith, the laser stack structure having a bottom contact structure thereof; and

an extended dielectric stack region of the second photonics dielectric stack including a contact extending therethrough to contact at least one bottom contact structure of a laser stack structure, and the extended dielectric stack region further including a termination in electrical communication with the contact.

2. The optoelectrical system of claim 1, wherein the one or more photonics device includes at least one waveguide, and wherein the at least one photonics device includes at least one waveguide.

3. The optoelectrical system of claim 1, wherein the bond layer fusion bonds the first photonics dielectric stack to the second photonics dielectric stack.

4. The optoelectrical system of claim 1, further including a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to a laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack.

5. The optoelectrical system of claim 1, further including a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to a laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack, the waveguide having a longitudinal axis configured to coincide with a longitudinal axis of the laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack.

6. The optoelectrical system of claim 1, wherein the one or more photonics device includes a photodetector.

7. The optoelectrical system of claim 1, wherein the at least one photonics device includes a first waveguide formed at a first elevation, a second waveguide formed at a second elevation.

8. The optoelectrical system of claim 1, further including:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure;

a through via that connects a metallization layer of a third photonics structure to a metallization layer of the second photonics structure, the through via extending entirely through the bond layer that fusion bonds the interposer base structure to the first photonics structure; and

a second through via that connects a metallization layer of the second photonics structure to a metallization layer of the first photonics structure, the second through via extending entirely through the bond layer that fusion bonds the first photonics structure to the first photonics structure.

9. An optoelectrical system, comprising:

a first photonics structure having a first photonics dielectric stack;

a second photonics structure having a second photonics dielectric stack;

a bond layer that fusion bonds the first photonics structure to the second photonics structure;

one or more metallization layer integrally formed in the first photonics dielectric stack;

at least one metallization layer integrally formed in the second photonics dielectric stack;

one or more photonics device integrally formed in the first photonics dielectric stack;

at least one photonics device integrally formed in the second photonics dielectric stack;

one or more laser stack structure active region integrally formed in the second photonics dielectric stack, each laser stack structure active region including a laser stack structure associated therewith, the laser stack structure having a bottom contact structure thereof;

an extended dielectric stack region of the second photonics dielectric stack including a contact extending therethrough to contact at least one bottom contact structure of a laser stack structure, and the extended dielectric stack region further including a termination in electrical communication with the contact;

a first waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to a laser stack structure of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack;

a monocrystalline waveguide integrally fabricated within the first photonics dielectric stack; and

a plurality of intermediary waveguides configured to evanescently couple light from the first waveguide, through the bond layer, to the monocrystalline waveguide.

10. The optoelectrical system of claim 9,

wherein the monocrystalline waveguide is defined by a monocrystalline layer of an SOI wafer, wherein a dielectric layer of the first photonics structure dielectric stack is defined by an insulator layer of the SOI wafer.

11. The optoelectrical system of claim 9, wherein the first waveguide is formed of a first material and each of the plurality of intermediary waveguides formed of a second material.

12. The optoelectrical system of claim 9, wherein the optoelectrical system further includes:

an interposer base structure, the interposer base structure including a redistribution layer, and through silicon vias electrically connected to the redistribution layer; and

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure.

13. The optoelectrical system of claim 9, wherein the optoelectrical system further includes:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure; and

a through via that connects a metallization layer of the first photonics structure to the metallization layer of the interposer base structure.

14. The optoelectrical system of claim 9, wherein the optoelectrical system further includes:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure; and

a through via that connects a metallization layer of the second photonics structure to a metallization layer of the first photonics structure.

15. An optoelectrical system, comprising:

a first photonics structure having a first photonics dielectric stack;

a second photonics structure having a second photonics dielectric stack;

a bond layer that fusion bonds the first photonics structure to the second photonics structure;

one or more metallization layer integrally formed in the first photonics dielectric stack;

at least one metallization layer integrally formed in the second photonics dielectric stack;

one or more photonics device integrally formed in the first photonics dielectric stack;

at least one photonics device integrally formed in the second photonics dielectric stack;

one or more laser stack structure active region integrally formed in the second photonics dielectric stack, each laser stack structure active region including a laser stack structure associated therewith, the laser stack structure having a bottom contact structure thereof;

an extended dielectric stack region of the second photonics dielectric stack including a contact extending therethrough to contact at least one bottom contact structure of a laser stack structure, and the extended dielectric stack region further including a termination in electrical communication with the contact;

a first waveguide formed in the second photonics dielectric stack, at least a portion of the first waveguide horizontally aligned with at least one of the one or more laser stack structure active region of the second photonics dielectric stack; and

a ridge waveguide formed in the first photonics dielectric stack, at least a portion of the ridge waveguide vertically aligned with the first waveguide, wherein the first waveguide formed in the second photonics dielectric stack is evanescently coupled to the ridge waveguide formed in the first photonics dielectric stack.

16. The optoelectrical system of claim 15, further including at least one intermediary waveguide formed in the first photonics dielectric stack, the at least one intermediary waveguide position

vertically between the first waveguide and the ridge waveguide, wherein at least a portion of the at least one intermediary waveguide is vertically aligned with at least one of the first waveguide or the ridge waveguide.

17. The optoelectrical system of claim 16, wherein the at least one intermediary waveguide includes:

a first intermediary waveguide formed in the first photonics dielectric stack adjacent the bond layer, at least a portion of the first intermediary waveguide vertically aligned with the first waveguide, wherein the first intermediary waveguide is evanescently coupled to the first waveguide;

a second intermediary waveguide formed in the first photonics dielectric stack, between the first intermediary waveguide and the ridge waveguide, at least a portion of the second intermediary waveguide vertically aligned with the first intermediary waveguide, wherein the second intermediary waveguide is evanescently coupled to the first intermediary waveguide; and

a third intermediary waveguide formed in the first photonics dielectric stack, between the second intermediary waveguide and the ridge waveguide, at least a portion of the second intermediary waveguide vertically aligned with:

the first intermediary waveguide, and

the ridge waveguide,

wherein the third intermediary waveguide is evanescently coupled to the second intermediary waveguide and the ridge waveguide.

18. The optoelectrical system of claim 17, further including a photodetector formed in the first photonics dielectric stack, wherein the second intermediary waveguide and the third intermediary waveguide are positioned adjacent to and at least partially horizontally aligned with the photodetector.

19. The optoelectrical system of claim 15, wherein the ridge waveguide is formed adjacent to and at least partially horizontally aligned with a waveguiding material formation.

20. The optoelectrical system of claim 15, wherein the one or more photonics device includes a photodetector.

CLAIMS

What is claimed is:

1. A method comprising:

building a first photonics structure using a first wafer having a first substrate, wherein the building the first photonics structure includes integrally fabricating within a first photonics dielectric stack one or more photonics device, the one or more photonics device formed on the first substrate;

building a second photonics structure using a second wafer having a second substrate, wherein the building the second photonics structure includes integrally fabricating within a second photonics dielectric stack a laser stack structure active region and one or more photonics device, the second photonics dielectric stack formed on the second substrate; and

bonding the first photonics structure and the second photonics structure to define an optoelectrical system having the first photonics structure bonded the second photonics structure.

2. The method of claim 1, wherein the bonding includes using a low temperature oxide fusion wafer scale bonding process.

3. The method of claim 1, wherein the bonding includes using a low temperature oxide fusion bond process that includes a polishing stage, an activation stage and an anneal stage.

4. The method of claim 1, wherein the first wafer is a silicon on insulator (SOI) wafer.

5. The method of claim 1, wherein the second wafer is a silicon on insulator (SOI) wafer.

6. The method of claim 1, wherein the first wafer is an SOI wafer and wherein the second wafer is a SOI wafer.

7. The method of claim 1, wherein the second wafer is an SOI wafer having an insulator layer and a silicon layer, wherein the method includes, subsequent to the bonding the first photonics structure and the second photonics structure, removing from the second photonics structure the second substrate of the second wafer to reveal the second dielectric stack, and subsequently building an extended dielectric stack region to extend the second dielectric stack, wherein the method includes fabricating a contact extending through the extended dielectric stack region to contact a bottom contact layer of a laser stack structure associated to the laser stack active region,

and fabricating a termination in the extended dielectric stack region, the termination in electrical communication with the contact.

8. The method of claim 1, wherein the second wafer is an SOI wafer having an insulator layer and a silicon layer, wherein the method includes, subsequent to the bonding the first photonics structure and the second photonics structure, removing from the second photonics structure the second substrate of the second wafer and a portion of the second dielectric stack as well as a buffer structure of a laser stack structure associated to the laser stack active region, and subsequently building an extended dielectric stack region to extend the second dielectric stack, wherein the method includes fabricating a contact extending through the extended dielectric stack region to contact a bottom contact structure of a laser stack structure associated to the laser stack active region, and fabricating a termination in the extended dielectric stack region, the termination in electrical communication with the contact.

9. The method of claim 1, wherein the building the first photonics structure using the first wafer includes integrally fabricating within the first photonics dielectric stack one or more photonics device selected from the group consisting of a waveguide and a photodetector.

10. The method of claim 1, wherein the building the second photonics structure using the second wafer includes integrally fabricating within the second wafer photonics dielectric stack one or more photonics device selected from the group consisting of a waveguide and a photodetector.

11. The method of claim 1, wherein the first wafer is provided by an SOI wafer having a monocrystalline silicon layer, wherein the method includes integrally fabricating in the first photonics structure a monocrystalline waveguide, the integrally fabricating including patterning the monocrystalline silicon layer of the SOI wafer.

12. The method of claim 1, wherein a second photonics dielectric stack includes a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to the laser stack structure active region.

13. The method of claim 1, wherein a second photonics dielectric stack includes a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to the laser stack structure active region, the waveguide having a longitudinal axis configured to coincide with a longitudinal axis of the laser stack structure active region.

14. The method of claim 1, wherein method includes fabricating a plurality of waveguides configured to evanescently couple light emitted from the laser stack active region through a bond layer defined between the first structure to the second structure to a monocrystalline waveguide, wherein the first wafer is provided by an SOI wafer having a monocrystalline silicon layer,

wherein the method includes fabricating in the first photonics structure the monocrystalline waveguide, the fabricating including patterning the monocrystalline silicon layer of the SOI wafer.

15. The method of claim 1, wherein the first wafer is an SOI wafer having a monocrystalline silicon layer, and wherein the method is performed so the second photonics structure and the first photonics structure are configured so that light emitted by the active region is coupled into the monocrystalline silicon layer.

16. An optoelectrical system comprising:

a first photonics structure having a first photonics dielectric stack;

a second photonics structure having a second photonics dielectric stack;

a bond layer that fusion bonds the first photonics structure to the second photonics structure;

one or more metallization layer integrally formed in the first dielectric stack;

at least one metallization layer integrally formed in the second photonics dielectric stack;

one or more photonics device integrally formed in the first photonics dielectric stack;

at least one photonics device integrally formed in the second photonics dielectric stack; and

one or more laser stack structure active region integrally formed in the second photonics dielectric stack.

17. The optoelectrical system of claim 16, wherein the one or more photonics device includes a waveguide.

18. The optoelectrical system of claim 16, wherein the bond layer fusion bonds the first photonics dielectric stack to the second photonics dielectric stack.

19. The optoelectrical system of claim 16, wherein the optoelectrical system includes a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge coupled to a laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack.

20. The optoelectrical system of claim 16, wherein the optoelectrical system includes a waveguide integrally formed in the second photonics dielectric stack, the waveguide being edge

coupled to a laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack, the waveguide having a longitudinal axis configured to coincide with a longitudinal axis of the laser stack structure active region of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack.

21. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

a first waveguide integrally formed in the second photonics structure dielectric stack, the waveguide being edge coupled to a laser stack structure of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack;

a monocrystalline waveguide integrally fabricated within the first photonics dielectric stack;

a plurality of intermediary waveguides configured to evanescently couple light from the first waveguide, through the bond layer, to the monocrystalline waveguide.

22. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

a first waveguide integrally formed in the second photonics structure dielectric stack, the waveguide being edge coupled to a laser stack structure of the one or more laser stack structure active region integrally formed in the second photonics dielectric stack;

a monocrystalline waveguide integrally fabricated within the first photonics dielectric stack;

a plurality of intermediary waveguides configured to evanescently couple light from the first waveguide, through the bond layer, to the monocrystalline waveguide, wherein the monocrystalline waveguide is defined by a monocrystalline layer of an SOI wafer, wherein a dielectric layer of the photonics structure dielectric stack is defined by an insulator layer of the SOI wafer.

23. The optoelectrical system of claim 16, wherein the at least one photonics device includes a waveguide.

24. The optoelectrical system of claim 16, wherein the one or more photonics device includes a photodetector.

25. The optoelectrical system of claim 16, wherein the at least one photonics device includes a photodetector.

26. The optoelectrical system of claim 16, wherein the at least one photonics device includes first waveguide formed of a first material and a second waveguide formed of a second material.

27. The optoelectrical system of claim 16, wherein the at least one photonics device includes a first waveguide formed at a first elevation, a second waveguide formed at a second elevation.

28. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

an interposer base structure, the interposer base structure including a redistribution layer, and through silicon vias electrically connected to the redistribution layer; and

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure.

29. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure; and

a through via that connects a metallization layer of the first photonics structure to the metallization layer of the interposer base structure.

30. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure; and

a through via that connects a metallization layer of the second photonics structure to a metallization layer of the first photonics structure.

31. The optoelectrical system of claim 16, wherein the optoelectrical system includes:

an interposer base structure, the interposer base structure including a metallization layer, a redistribution layer, and through silicon vias electrically connected to the redistribution layer;

a bond layer that fusion bonds the first photonics dielectric stack to the interposer base structure;

a through via that connects a metallization layer of the second photonics structure to a metallization layer of the second photonics structure, the through via extending entirely through the bond layer that fusion bonds the interposer base structure to the first photonics structure; and

a second through via that connects a metallization layer of the second photonics structure to a metallization layer of the first photonics structure, the second through via extending entirely through the bond layer that fusion bonds the first photonics structure to the first photonics structure.

32. A method comprising:

building an interposer base structure using a base structure wafer having a base substrate, wherein the building the interposer base structure includes fabricating a redistribution layer, and through silicon vias that extend through the base substrate;

building a first photonics structure using a first wafer having a first substrate, wherein the building the first photonics structure includes integrally fabricating within a photonics dielectric stack formed on the first substrate one or more photonics device;

bonding the first photonics structure to the interposer base structure to define a bonded structure having the interposer base structure and the first photonics structure;

building a second photonics structure using a second wafer having a second substrate, wherein the building the second photonics structure includes integrally fabricating within a second photonics dielectric stack formed on the second substrate a laser stack structure active region and one or more photonics device; and

bonding the second photonics structure and the bonded structure to define an interposer optoelectrical system having the second photonics structure bonded to the first photonics structure, and the first photonics structure bonded to the interposer base structure.

33. The method of claim 32, wherein the method includes, subsequent to the bonding the first photonics structure to the interposer base structure, removing, from the first photonics structure the first substrate of the first wafer.

34. The method of claim 32, wherein the first wafer is an SOI wafer having an insulator layer and a silicon layer, wherein the method includes, subsequent to the bonding the first photonics structure to the interposer base structure, removing from the first photonics structure the first

~~substrate of the first wafer to reveal the insulator layer, depositing a layer of waveguiding material on the insulator layer, and patterning the waveguiding layer to define a waveguide.~~

~~35. The method of claim 32, wherein the method includes, prior to the bonding the second photonics structure and the bonded structure, fabricating a through via that extends entirely through a bond layer that fusion bonds the interposer base structure to the first photonics structure, and which connects a metallization layer of the interposer base structure to a metallization layer of the first photonics structure.~~

~~36. The method of claim 32, wherein the method includes, subsequent to the bonding the second photonics structure and the bonded structure, fabricating a through via that extends entirely through a bond layer that fusion bonds the first photonics structure and the second photonics structure, and which connects a metallization layer of the first photonics structure to a metallization layer of the second photonics structure.~~