What is claimed is:

1. A method of fabricating a photodetector structure comprising:

forming dielectric material over silicon;

etching a trench in the dielectric material extending to the silicon;

epitaxially growing germanium within the trench;

annealing germanium formed by the epitaxially growing;

repeating the epitaxially growing and the annealing until the germanium overfills the trench;

planarizing an overfill portion of the germanium; and

creating top and bottom contacts using doping and metallization.

2. The method of claim 1, wherein the epitaxially growing is performed so that germanium is formed on the silicon.

3. The method of claim 1, wherein the epitaxially growing is performed so that the photodetector structure is absent a low-temperature SiGe or Ge buffer structure adjacent to the silicon.

4. The method of claim 1, wherein the epitaxially growing of germanium is performed without use of a doping gas so that intrinsic germanium is formed by the epitaxially growing.

5. The method of claim 1, wherein the epitaxially growing of germanium is performed using a dopant precursor so that in-situ doped germanium is formed by the epitaxially growing.

6. The method of claim 1, wherein the epitaxially growing includes performing epitaxial growing at a temperature in the range of from about 550 to about 850 degree Celsius.

7. The method of claim 1, wherein the epitaxially growing includes performing epitaxial growing at a temperature in the range of from about 550 to about 850 degree Celsius and wherein the annealing includes annealing at a temperature of between about 650 degrees Celsius to about 850 degrees Celsius.

8. The method of claim 1, wherein the epitaxially growing includes performing epitaxial growing at a temperature in the range of from about 550 to about 850 degree Celsius at a pressure in the range of from about 10 Torr to about 300 Torr using germane (GeH_4) and H_2 as a precursor and carrier gas, and wherein

the annealing includes annealing at a temperature of between about 650 degrees Celsius to about 850 degrees Celsius at a pressure of between about 100 Torr to about 600 Torr.

9. The method of claim 1, wherein the growing is preceded by an ex-situ wet-chemical and an in-situ dry cleaning process for removal of organic and metallic contamination and native oxide.

10. The method of claim 1, wherein the growing is further preceded by an in-situ thermal treatment in a reducing H_2-environment for removal of sub-stoichiometric surface silicon oxide.

11. The method of claim 1, wherein the method includes performing a shallow top contact doping region and depositing a capping oxide.

12. The method of claim 1, wherein the method includes forming a reduced area doping region spaced apart from an oxide trench.

13. The method of claim 1, wherein the method includes forming a reduced area shallow top doping region spaced apart from an oxide trench so that there is defined spacing distance between a perimeter of the germanium and a perimeter of a doping region.

14. The method of claim 1, wherein the method includes forming a reduced area shallow top doping region spaced apart from an oxide trench by a spacing distance equal to or greater than a threshold distance.

15. The method of claim 1, wherein the method includes forming a reduced area top metal contact that is fully contained in a top doping region.

16. The method of claim 1, wherein the photonic structure is absent of a low-temperature SiGe or Ge buffer between the silicon and the germanium formation.

17. A photonic structure comprising:

dielectric material formed over silicon;

a trench formed in the dielectric material extending to the silicon;

a germanium formation formed in the trench; and

a doping region formed in an area of the germanium formation so that the doping region is spaced from the trench by a spacing distance equal to or greater than a threshold distance.

18. The photonic structure of claim 17, wherein an entire perimeter of the doping region is spaced from the trench by a spacing distance equal to or greater than a threshold distance.

19. The photonic structure of claim 17, wherein the threshold distance is selected from the group consisting of (a) 200nm to 1000nm and (b) 750nm.

20. The photonic structure of claim 17, wherein the threshold distance is 750 nm.

21. The photonic structure of claim 17, further comprising a contact formed on the doping region in an area of the doping region so that the contact is spaced from a perimeter of the doping region by a spacing distance that is equal to or greater than a threshold distance.

22. The photonic structure of claim 17, further comprising a contact formed on the doping region in an area of the doping region so that an entire perimeter of the contact is spaced from a perimeter of the doping region by a spacing distance that is equal to or greater than a threshold distance.

23. A method of fabricating a photonic structure comprising:

depositing a layer formed of silicon nitride or silicon oxynitride waveguiding material;

patterning the layer formed of silicon nitride or silicon oxynitride waveguiding material to define photonic features, wherein the depositing includes using plasma-enhanced chemical vapor deposition; and

depositing a non-conformal high-aspect-ratio gap-filling dielectric material over the photonic features.

24. A method comprising:

depositing a metal within a trench, the trench having a bottom formed of silicon and sidewalls formed of dielectric material;

performing silicide formation annealing so that metal reacts with the silicon to form a silicide formation at the bottom of the trench;

performing transformation stage annealing so that the silicide formation is transformed into a low resistivity phase.

25. The method of claim 24, wherein the depositing a metal results in unreacted metal being formed on the sidewalls, and wherein the method includes forming a capping layer over the unreacted metal prior to the performing silicide formation annealing.

26. The method of claim 24, wherein the depositing a metal results in unreacted metal being formed on the sidewalls, wherein the method includes forming a capping layer over the unreacted metal prior to the performing silicide formation annealing, and wherein the method includes removing the capping layer and the unreacted metal prior to the performing transformation stage annealing.

27. The method of claim 24, wherein the transformation stage annealing is performed at a higher annealing temperature than the silicide formation annealing.

28. The method of claim 24, wherein the metal is selected from the group consisting of nickel and nickel platinum.

29. The method of claim 24, wherein the depositing, annealing, and removal of the first metal is followed by a second metal deposition overfilling the trench so that the second metal has a thickness at a top of the trench that is multiple times a desired thickness at a bottom of the trench.

30. The method of claim 24, wherein the depositing, annealing, and removal of the first metal is followed by a second metal deposition overfilling the trench so that the second metal has a thickness at a top of the trench that is more than three times a desired thickness at a bottom of the trench.

31. The method of claim 24, wherein the method of depositing, annealing, and removal of the first second metal includes forming copper within the trench subsequent to formation of the silicide formation (first metal).

32. A method of forming a photonic structure comprising:

forming a photodetector having a bottom and top contact;

forming a dielectric layer defining a trench over the top contact;

forming an aluminum metallization layer within the trench, the aluminum metallization layer being in communication with the top contact.

33. The method of claim 32, wherein the method includes subjecting the aluminum metallization layer to processing so that the aluminum metallization layer defines a termination layer.

34. The method of claim 32, wherein the method includes using a damascene process to form the aluminum metallization layer, and wherein the method is performed so that the aluminum metallization layer defines an aluminum termination over a copper conductive material formation.

35. The method of claim 32, wherein the forming an aluminum metallization layer includes depositing aluminum using a process selected from the group consisting of physical vapor deposition (PVD), chemical vapor deposition (CVD) and evaporation.

36. The method of claim 32, wherein the method includes performing a low temperature anneal to densify, reflow, or recrystallize the aluminum metallization layer.

37. The method of claim 32, wherein the method includes performing a moderate temperature aluminum metallization compatible with existing (Cu) metallization formations.

38. The method of claim 32, wherein the method includes subjecting the aluminum metallization layer to processing to define a contact pad.

39. The method of claim 32, wherein the method includes planarizing the aluminum metallization layer so that the aluminum metallization layer defines a flat wiring assembly.

40. The method of claim 32, wherein the method includes performing a dual-patterning and single fill/planarization process where the aluminum metallization layer simultaneously fills the trench and a via below the trench, and wherein the method includes planarizing the aluminum metallization layer.

41. A method of fabricating a photonic structure comprising:

forming a stack of hardmask material over a layer of waveguiding material;

depositing a stack of organic lithography material over the stack of hardmask materials; and

patterning the stack of organic lithography material, wherein the patterning includes stopping at the stack of hardmask material.

42. The method of claim 41, wherein the stack of hardmask material includes silicon dioxide.

43. The method of claim 41, wherein the method includes patterning photonic features in the layer of waveguiding material using the stack of organic lithography material.

44. The method of claim 41, wherein the patterning includes using reactive ion etching and wherein the method includes cleaning residue formed by the reactive ion etching.

45. The method of claim 41, wherein the patterning includes using reactive ion etching, wherein the method includes cleaning residue formed by the reactive ion etching, wherein the method includes patterning photonic features in the layer of waveguiding material using the stack of organic lithography material, and wherein the cleaning is performed subsequent to the patterning.

46. A method of fabricating a photonic structure comprising:

patterning a first set of photonic features in a first photonic layer, the first photonic layer formed of a first waveguiding material; and

forming a dielectric layer about the first set of photonic features, wherein dielectric material of the dielectric layer includes a plasma-enhanced oxide, wherein the forming includes using plasma enhanced chemical vapor deposition (PECVD), and wherein the method includes forming a second dielectric layer above the dielectric layer to provide corrected dielectric separation distance to one or more additional waveguiding layer.

47. The method of claim 46, wherein the forming includes forming plasma-enhanced oxide material over the first photonic layer so that the plasma-enhanced oxide material preferentially deposits on horizontal surfaces with suppressed deposition rates on vertical surface proximate feature edges, resulting in an overall non-conformal film topography.

48. The method of claim 46, wherein the forming includes applying process conditions for deposition of non-conformal oxide material deposition in a manner to provide void-minimized filling of minimum feature size gaps.

49. The method of claim 46, wherein the method includes forming a second dielectric layer above the dielectric layer to provide corrected dielectric separation distance to one or more additional waveguiding layer.

50. A photonic structure comprising:

a wiring level having a conductive material formation that defines a wiring assembly, wherein the conductive material formation is formed of a metallization material; and

a waveguiding layer patterned to define photonic features;

wherein the waveguiding layer is formed at an elevation of the photonic structure that is in common with or higher than an elevation of the wiring level.

51. The photonic structure of claim 50, wherein the conductive material formation is formed of a metallization material that is adapted to reflect light at wavelengths within a communication band of wavelengths of from about 1.3 μm to about 1.55 μm.

52. The photonic structure of claim 50, wherein the conductive material formation is formed of a metallization material that is adapted to reflect light at wavelengths within a band of wavelengths of from about 900 nm to about 1600 nm.

53. The photonic structure of claim 50, wherein the waveguiding layer is formed of silicon nitride or silicon oxynitride.

54. The photonic structure of claim 50, wherein the waveguiding layer is formed of a material selected from the group consisting of amorphous silicon and polysilicon.

55. The photonic structure of claim 50, wherein the waveguiding layer is formed of silicon nitride or silicon oxynitride deposited using plasma enhanced chemical vapor deposition.

56. The photonic structure of claim 50, wherein the waveguiding layer is formed at an elevation higher than an elevation of the wiring level.

57. The photonic structure of claim 50, wherein the waveguiding layer is formed at an elevation higher than an elevation of the wiring level and includes a first patterned section patterned to define one or more set of photonic features and a second section aligned to the conductive material formation.

58. The photonic structure of claim 50, wherein the waveguiding layer is formed at an elevation higher than an elevation of the wiring level and includes a first patterned section patterned to define one or more set of photonic features and a second section aligned to the conductive material formation so that the second section functions as a protect layer for the conductive material formation.