CLAIMS

I/We claim:

1. A method of making an SSL device substrate, comprising:

growing an intermediate structure on a support substrate;

disposing a seed material on the intermediate structure;

forming a region of silicon on the seed material, the region having a population of crystals with a (111) orientation;

annealing the region of silicon to increase the population of crystals having the (111) orientation;

etching the silicon region to remove crystals having an orientation other than (111);

growing the crystals having the (111) orientation; and

disposing gallium nitride over the crystals having the (111) orientation.

2. The method of claim 1, further comprising selecting a material composition of the support substrate based at least in part on a correlation between a thermal expansion coefficient of the support substrate and a thermal expansion coefficient of the gallium nitride.

3. The method of claim 2 wherein selecting the material composition of the support substrate includes selecting the material composition to include polycrystalline aluminum nitride.

4. The method of claim 1 wherein annealing includes annealing via a zone melt recrystalization process.

5. The method of claim 1 wherein growing the intermediate structure includes forming a layer having at least one of silicon dioxide, silicon carbide and silicon nitride.

6. The method of claim 1 wherein disposing a seed material includes disposing a seed material comprising aluminum nitride.

7. The method of claim 1 wherein disposing a seed material includes disposing a seed material comprising titanium and nickel.

8. The method of claim 1, further comprising:
removing the gallium nitride from the silicon crystals; and
forming an SSL device from the gallium nitride.

9. The method of claim 1 wherein the region of silicon is positioned between the seed material and the gallium nitride, and wherein the region includes a layer containing only silicon.

10. The method of claim 1, further comprising disposing buffer material on the crystals having the (111) orientation, and wherein disposing gallium nitride includes disposing the gallium nitride on the buffer material.

11. The method of claim 10 wherein disposing the buffer material includes disposing aluminum gallium nitride.

12. The method of claim 1 wherein the gallium nitride is disposed using an MOCVD process.

13. A method for making an SSL device substrate, comprising:
forming multiple crystals carried by a support member, the crystals having an orientation selected to facilitate formation of gallium nitride; and
forming a volume of gallium nitride carried by the crystals, with the orientation of the crystals at least partially controlling a crystal orientation of the gallium nitride, and without bonding the gallium nitride, as a unit, to the support member.

14. The method of claim 13 wherein forming multiple crystals includes forming multiple silicon crystals with a predominantly (111) orientation, and wherein forming a volume of gallium nitride includes forming gallium nitride with a predominantly (0001) crystal orientation.

15. The method of claim 13 wherein the support member includes a polycrystalline aluminum nitride support substrate, and wherein the method further comprises:

forming an interlayer structure on the polycrystalline aluminum nitride substrate, the interlayer structure including at least one layer having at least one of silicon dioxide, silicon carbide and silicon nitride; and

disposing a seed material on the interlayer structure, wherein the seed material includes at least one of aluminum nitride, titanium and nickel, and wherein

forming crystals on the support member includes:

forming a region of silicon on the seed material, the region having a population of crystals with a (111) orientation;

annealing the region of silicon to a increase the population of crystals having the (111) orientation;

etching the silicon region to remove crystals having an orientation other than (111); and

growing the crystals having the (111) orientation; and wherein the method further comprises:

forming gallium nitride on the crystals having the (111) orientation;

removing the gallium nitride from the silicon crystals; and

forming an SSL device from the gallium nitride layer.

16. The method of claim 13 wherein forming multiple crystals includes:

forming a region of silicon having a number of crystals with a (111) orientation;

annealing the region of silicon to increase the number of crystals with the (111) orientation;

etching the silicon region to remove crystals having an orientation other than (111);

growing the crystals having the (111) orientation; and wherein the method further comprises:

forming an SSL device from the gallium nitride.

17. The method of claim 13 wherein forming crystals includes forming silicon crystals.

18. The method of claim 13, further comprising:

forming an interlayer structure on the support member; and

disposing a seed material on the interlayer structure, and wherein forming multiple crystals includes forming multiple crystals on the seed material.

19. The method of claim 13, further comprising disposing a buffer material on the crystals, and wherein growing a volume of gallium nitride includes growing a volume of gallium nitride on the buffer material.

20. The method of claim 13 wherein forming the gallium nitride includes forming the gallium nitride with a dislocation density of $10^9/cm^2$ or less.

21. A method for making an SSL device substrate, comprising:

forming a number of crystals on a support member, with individual crystals having an orientation selected to facilitate formation of gallium nitride;

increasing the number of crystals on the support member having the selected orientation; and

forming gallium nitride carried by the crystals having the selected orientation, with the selected orientation of the crystals controlling, at least in part, the crystal orientation of the gallium nitride.

22. The method of claim 21 wherein forming a number of crystals includes preferentially forming a number of (111) silicon crystals, and wherein forming gallium nitride includes preferentially forming gallium nitride having a (0001) crystal orientation.

23. The method of claim 21 wherein increasing the number of crystals includes:

annealing a silicon region in which the crystals are located to increase a number of crystals having a (111) orientation;

etching the silicon region to remove crystals having an orientation other than (111); and

growing the crystals having the (111) orientation.

24. The method of claim 21, further comprising:

removing the gallium nitride from the support member; and

forming an SSL device from the gallium nitride.

25. The method of claim 21, further comprising disposing a buffer material on the crystals having the selected orientation, and wherein disposing gallium nitride includes disposing the gallium nitride on the buffer material.

26. An SSL device substrate, comprising:

a support substrate having widthwise dimension of at least six inches and a coefficient of thermal expansion at least approximately the same as that of gallium nitride; and

a volume of gallium nitride carried by the support substrate and having a thickness of at least 10 microns.

27. The device substrate of claim 26 wherein the gallium nitride does not include light-emitting structures.

28. The device substrate of claim 26 wherein the volume of gallium nitride has a thickness of at least 50 microns.

29. The device substrate of claim 26 wherein the volume of gallium nitride has a thickness of at least 300 microns and includes an HVPE film.

30. The device substrate of claim 26 wherein the support substrate has a widthwise dimension of about eight inches.

31. The device substrate of claim 26 wherein the support substrate has a widthwise dimension of about twelve inches.

32. The device substrate of claim 26 wherein the support substrate includes polycrystalline aluminum nitride.

33. An SSL device, comprising:

a volume of gallium nitride having a light-emitting region;

a P-contact connected to the gallium nitride;

an N-contact connected to the gallium nitride, with the light-emitting region between the P-contact and the N-contact; and

a support member connected to the gallium nitride, the support member including a support substrate and an at least partially crystal-oriented material carried by the support substrate.

34. The SSL device of claim 33 wherein the N-contact and the P-contact have a lateral arrangement and face in the same direction.

35. The SSL device of claim 33 wherein the at least partially crystal-oriented material includes (111) silicon and wherein the gallium nitride has a dislocation density of $10^9/cm^2$ or less.

36. The SSL device of claim 33 wherein the P-contact and N-contact are positioned to mount in an inverted flip chip position.

CLAIMS

I/We claim:

1. A method of making a solid state lighting ("SSL") device substrate, the method comprising:

forming a region of silicon over a support substrate, the region of silicon including first crystals having a (111) crystal orientation and second crystals not having the (111) crystal orientation;

etching the region of silicon to preferentially remove material from the second crystals relative to material from the first crystals;

forming additional silicon over the region of silicon after etching the region of silicon; and

forming gallium nitride over the region of silicon after forming the additional silicon, the gallium nitride forming with a (0001) crystal orientation.

2. The method of claim 1, wherein forming the region of silicon over the support substrate includes forming the region of silicon over a support substrate that includes polycrystalline aluminum nitride.

3. The method of claim 1, further comprising removing the gallium nitride from the region of silicon.

4. The method of claim 1, further comprising forming a buffer material over the region of silicon, wherein forming the gallium nitride includes forming the gallium nitride over the buffer material.

5. The method of claim 4 wherein forming the buffer material includes forming a buffer material that includes aluminum gallium nitride.

6. The method of claim 1 wherein forming the gallium nitride includes forming gallium nitride using a metal organic chemical vapor deposition ("MOCVD") process.

7. The method of claim 1 wherein forming gallium nitride includes forming gallium nitride having a dislocation density of $10^9/cm^2$ or less.

8. The method of claim 1 wherein:

the method further comprises—

growing an intermediate structure over the support substrate, and

disposing a seed material over the intermediate structure; and

forming the region of silicon over the support substrate includes forming the region of silicon over the intermediate structure.

9. The method of claim 8, further comprising annealing the region of silicon by zone melt recrystallization.

10. The method of claim 8 wherein growing the intermediate structure includes forming a layer having at least one of silicon dioxide, silicon carbide and silicon nitride.

11. The method of claim 8 wherein disposing a seed material includes disposing the seed material comprising aluminum nitride.

12. The method of claim 8 wherein disposing a seed material includes disposing the seed material comprising titanium and nickel.

13. The method of claim 3, further comprising forming an SSL device from the removed gallium nitride.

14. The method of claim 1 wherein the region of silicon includes a layer containing only silicon.