WHAT IS CLAIMED IS:

1. A method for the preparation of a multi-layered crystalline structure, the method comprising:

implanting ions selected from the group consisting of hydrogen, helium and combinations thereof into a silicon-on-insulator structure, wherein the silicon-on-insulator structure comprises a central axis, a device layer having an implantation surface and device surface which are generally perpendicular to the central axis and an average thickness, t, extending in the axial direction from the implantation surface to the device surface of the device layer, a handle layer, and an intervening layer which is positioned along the central axis of the silicon-on-insulator structure between the device surface and the handle layer, wherein the ions are implanted into the silicon-on-insulator structure through the implantation surface to an implantation depth D1 which is greater than the thickness, t, of the device layer to form in the implanted silicon-on-insulator structure a damage layer which is generally perpendicular to the axis and located in the intervening layer and/or in the handle layer;

bonding the implanted silicon-on-insulator structure to a second structure to form a bonded structure;

cleaving the silicon-on-insulator structure along the damaged layer to form a multi-layered crystalline structure comprising the second structure, the device layer and residual material, the residual material comprising at least a portion of the intervening layer and optionally a portion of the handle layer; and,

removing the residual material from the multi-layered crystalline structure.

2. The method of claim 1 wherein the ions are implanted using an implant energy of at least about 10 keV.

3. The method of claim 1 wherein the ions are implanted using an implant energy of at least about 80 keV.

4. The method of claim 1 wherein the ions are implanted using an implant energy of up to 120 keV.

5. The method of claim 1 wherein at least about $1x10^{16}$ ions/cm^2 are implanted into the silicon-on-insulator structure.

6. The method of claim 1 wherein at least about $2x10^{16}$ ions/cm^2 are implanted into the silicon-on-insulator structure.

7. The method of claim 1 wherein at least about $1x10^{17}$ ions/cm^2 are implanted into the silicon-on-insulator structure.

8. The method of claim 1 wherein at least about $2x10^{17}$ ions/cm^2 are implanted into the silicon-on-insulator structure.

9. The method of claim 1 further comprising thermally treating the implanted silicon-on-insulator structure to begin the formation of a cleave plane.

10. The method of claim 9 wherein thermally treating the implanted silicon-on-insulator structure comprises heating the implanted silicon-on-insulator structure to a temperature of from about 150°C to about 300°C for a period of from about 1 hour to about 100 hours.

11. The method of claim 1 wherein bonding the implanted silicon-on-insulator structure to a second structure comprises thermally treating the bonded structure to strengthen the bond between the silicon-on-insulator structure and the second structure and to form the damage layer.

12. The method of claim 11 wherein thermally treating the bonded structure comprises subjecting the bonded structure to a low temperature thermal anneal.

13. The method of claim 11 wherein the low temperature thermal anneal comprises heating the multi-layered structure to a temperature of from about 150ºC to about 600ºC for a period of from about 1 minute to about 100 hours.

~~14. The method of claim 1 further comprising forming the silicon-on-insulator structure by bonding a handle wafer to a donor wafer to form a bonded wafer pair and transferring a layer of the donor wafer to the handle wafer.~~

14. The method of claim 1, wherein the device layer comprises a material selected from the group consisting of silicon, silicon carbide, sapphire, germanium, silicon germanium, gallium nitride, aluminum nitride, gallium arsenic, indium gallium arsenic or any combination thereof.

15. The method of claim 1 wherein the intervening layer is a dielectric layer.

16. The method of claim 15 wherein the intervening layer comprises a material selected from the group consisting of silicon dioxide and silicon nitride.

17. The method of claim 1 wherein the handle layer comprises a material that is splittable.

18. The method of claim ~~14~~17, wherein the ~~donor wafer is cleaved to transfer the layer of the donor wafer to the handle wafer~~handle layer comprises a material selected from the group consisting of silicon, silicon carbide, sapphire, germanium, silicon germanium, gallium nitride, aluminum nitride, gallium arsenic, indium gallium arsenic or any combination thereof.

19. The method of claim 1 wherein the second structure is selected from the group consisting of sapphire, quartz crystal, glass, silicon carbide, silicon, gallium nitride, aluminum nitride, gallium aluminum nitride, gallium arsenic, indium gallium arsenic or any combination thereof.

20. The method of claim 1 wherein implanting the silicon-on-insulator structure comprises implanting atoms selected from the group consisting of helium and hydrogen through the device layer and into the intervening layer of the silicon-on-insulator structure.

21. The method of claim 1 wherein the ions are implanted to depth D1 of at least about 200 Angstroms.

22. The method of claim 1 wherein the ions are implanted to depth D1 of from about 200 Angstroms to about 1 micron beneath the implantation surface.

~~22. The method of claim 1 wherein the ions are implanted to depth D1 of from about 20 nm to about 500 nm beneath the device layer.~~

23. The method of claim 1 wherein the second structure comprises a material selected from the group consisting of sapphire.

24. The method of claim 1 wherein the second structure comprises a multi-layer substrate.

25. The method of claim 1 wherein the method further comprises depositing or growing a bonding layer on at least one of the second structure and the device layer prior to bonding the silicon-on-insulator structure to the second structure.

26. The method of claim 1 wherein the bonded structure consists essentially of the silicon-on-insulator structure and the second structure.

27. The method of claim 1 further comprising forming the silicon-on-insulator structure by bonding a handle wafer to a donor wafer to form a bonded wafer pair and transferring a layer of the donor wafer to the handle wafer.

28. The method of claim 27 wherein the donor wafer is cleaved to transfer the layer of the donor wafer to the handle wafer.

29. The method of claim 1 wherein the ions are implanted to depth D1 of from about 20 nm to about 500 nm beneath the device layer.