CLAIMS

What is claimed is:

1. A method of ~~reclamation or recycling of a semiconductor workpiece~~ completely removing structures or materials deposited, implanted, or formed in or on a surface of a semiconductor substrate without chemicals comprising:

focusing coherent light on ~~a~~ the surface of ~~a~~ the ~~semiconductor~~ substrate, wherein the coherent light has a predetermined wavelength, power, pulse width, and pulse rate or number of pulses per unit area that causes direct ionic vaporization of ~~material~~ metals, dielectrics, and semiconducting materials deposited, implanted, or formed in or on the ~~s~~surface of the substrate up to a predetermined penetration depth with minimally acceptable damage to the crystalline substrate;

purging the surface of the substrate with an inert purge gas or liquid; and

exhausting the surface of the substrate,

wherein the substrate is free from heavy metal surface contamination and has a surface roughness capable of being polished back to a mirror-like finish.

2. The method of claim 1, further comprising:

disposing the substrate on a substrate holder; ~~.~~

disposing the substrate holder on a substrate staging system; and

controlling an environment of the substrate to a predetermined pressure.

~~3. The method of claim 1, further comprising:~~

~~disposing the substrate holder on a substrate staging system.~~

~~4. The method of claim 1, further comprising:~~

~~controlling an environment of the substrate to a predetermined pressure.~~

~~5.~~3.The method of claim 1, further comprising:

directing the coherent light ~~generated by the coherent light source~~ through a moveable lens or mirror.

~~6.~~4.The method of claim 1, further comprising:

moving the substrate to ensure one or more surfaces of the substrate are exposed to the coherent light ~~source~~.

~~7.~~5.The method of claim 1, further comprising:

rotating the substrate to ensure one or more surfaces of the substrate are exposed to the coherent light ~~source~~.

~~8.~~6.The method of claim 1, further comprising:

moving ~~the~~ a coherent light source or a mirror to ensure one or more surfaces of the substrate are exposed to the coherent light ~~source~~.

~~9.~~7.The method of claim 1, further comprising:

inspecting a surface roughness of one or more surfaces of the substrate for compliance.

~~10.~~8. The method of claim 1, further comprising:

inspecting a final thickness of the substrate for compliance.

~~11.~~9. The method of claim 1, further comprising:

inspecting the ionic ~~ablated~~ vaporized surface of the substrate for compliance.

~~12. The method of claim 1, further comprising:~~

~~polishing the ionic ablated surface of the substrate.inspecting the polished substrate for reuse.~~

~~13. The method of claim 1, further comprising:~~

~~inspecting the polished substrate for reuse.~~

~~14.~~10. The method of claim 1, wherein the substrate is disposed within a vacuum chamber.

~~15.~~11. The method of claim 1, wherein a focal point is adjusted by moving the substrate or moving a coherent light source.

~~16. The method of claim 1, wherein a focal point is adjusted by moving the coherent light source.~~

~~17.~~12. The method of claim 1, wherein a focal point is directed at a predetermined ~~ablation threshold~~location on or within the surface of the substrate.

~~18.~~13. The method of claim ~~4~~2, wherein the predetermined pressure is in a range between 1 and 2 atmospheres.

~~19.~~14. The method of claim ~~4~~2, wherein the predetermined pressure is in a range between 1 millitorr and 1 atmosphere.

~~20.~~15. The method of claim ~~4~~2, wherein the predetermined pressure is in a range between 10^{-7} torr and 1 millitorr.

~~21.~~16. The method of claim 1, wherein the coherent light is generated by a coherent light source ~~comprises~~ comprising an ultraviolet laser.

~~22.~~17. The method of claim 1, wherein the coherent light is generated by a coherent light source ~~comprises~~ comprising a visible light laser.

~~23.~~18. The method of claim 1, wherein the coherent light is generated by a coherent light source comprising~~es~~ an infrared laser.

~~24.~~19. The method of claim 1, wherein the coherent light is generated by a coherent light source comprising~~es~~ an excimer laser.

~~25.~~20. The method of claim 1, wherein the coherent light is generated by a coherent light source comprising~~es~~ an extreme ultraviolet source.

~~26.~~21. The method of claim 1, wherein the coherent light is generated by a coherent light source comprising~~es~~ a beam of light.

~~27.~~22. The method of claim 1, wherein the predetermined wavelength is in a range between 13.5 and 355 nanometers.

~~28.~~23. The method of claim 1, wherein the predetermined wavelength is in a range between 300 and 800 nanometers.

~~29.~~24. The method of claim 1, wherein the predetermined wavelength is in a range between 700 nanometers and 1.4 microns.

~~30.~~25. The method of claim 1, wherein the predetermined wavelength is in a range between 900 nanometers and 5 microns.

~~31. The method of claim 1, wherein the predetermined wavelength is in a range between 5 microns and 500 microns.~~

~~32.~~26. The method of claim 1, wherein the predetermined power is in a range between 1 and 1,000 watts.

~~33.~~27. The method of claim 1, wherein the predetermined pulse width is in a range between 10^{-6} and 10^{-18} seconds.

~~34.~~28. The method of claim 1, wherein the predetermined pulse rate is in a range between 1 and 50,000 Hertz.

~~35.~~29. The method of claim 1, wherein the predetermined penetration depth is in a range between 1 and 30 microns.

~~36. A system for reclamation or recycling of a semiconductor workpiece comprising:~~

~~a coherent light source that generates a coherent light having a predetermined wavelength, power, pulse width, pulse rate or number of pulses per unit area that causes direct ionic vaporization of material formed on or in the surface a semiconductor substrate up to a predetermined penetration depth;~~

~~a lens or mirror that focuses the coherent light on the surface of the substrate;~~

~~a gas purging system that purges the surface of the substrate; and~~

~~an exhaust system that exhausts the substrate.~~

30. A system for completely removing structures or materials deposited, implanted, or formed in or on a surface of a semiconductor substrate without chemicals comprising:

a coherent light source that generates a coherent light having a predetermined wavelength, power, pulse width, and pulse rate or number of pulses per unit area that causes direct ionic vaporization of metals, dielectrics, and semiconducting materials deposited, implanted, or formed in or on the surface of the substrate up to a predetermined penetration depth with minimally acceptable damage to the crystalline substrate;

a lens or -mirror that focuses the coherent light on the surface of the substrate;

a gas purging system that purges the surface of the substrate; and

an exhaust system that exhausts the substrate.

~~37. The system of claim 36, further comprising:~~

~~a substrate holder that holds the substrate.~~

~~38. The system of claim 36, further comprising:~~

~~a substrate staging system that stages the substrate holder.~~

~~39. The system of claim 36, further comprising:~~

~~a vacuum chamber that controls a pressure environment of the substrate.~~

~~40. The system of claim 36, wherein the substrate is moved to ensure one or more surfaces of the substrate are exposed to the coherent light source.~~

~~41. The system of claim 36, wherein the substrate is rotated to ensure one or more surfaces of the substrate are exposed to the coherent light source.~~

~~42. The system of claim 36, wherein the coherent light source is moved to ensure one or more surfaces of the substrate are exposed to the coherent light source.~~

~~43. The system of claim 36, wherein a focal point is adjusted by moving the substrate.~~

~~44. The system of claim 36, wherein a focal point is adjusted by moving the coherent light source.~~

~~45. The system of claim 39, wherein the predetermined pressure is in a range between 1 and 2 atmospheres.~~

~~46. The system of claim 39, wherein the predetermined pressure is in a range between 1 millitorr and 1 atmosphere.~~

~~47. The system of claim 39, wherein the predetermined pressure is in a range between 10^{-7} torr and 1 millitorr.~~

~~48. The system of claim 36, wherein the coherent light source comprises an ultraviolet laser.~~

~~49. The system of claim 36, wherein the coherent light source comprises a visible light laser.~~

~~50. The system of claim 36, wherein the coherent light source comprises an infrared laser.~~

~~51. The system of claim 36, wherein the coherent light source comprises an excimer laser.~~

~~52. The system of claim 36, wherein the coherent light source comprises an extreme ultraviolet source.~~

~~53. The system of claim 36, wherein the coherent light source comprises a beam of light.~~

~~54. The system of claim 36, wherein the predetermined wavelength is in a range between 13.5 and 355 nanometers.~~

~~55. The system of claim 36, wherein the predetermined wavelength is in a range between 300 and 800 nanometers.~~

~~56. The system of claim 36, wherein the predetermined wavelength is in a range between 700 nanometers and 1.4 microns.~~

~~57. The system of claim 36, wherein the predetermined wavelength is in a range between 900 nanometers and 5 microns.~~

~~58. The system of claim 36, wherein the predetermined wavelength is in a range between 5 microns and 500 microns.~~

~~59. The system of claim 36, wherein the predetermined power is in a range between 1 and 1,000 watts.~~

~~60. The system of claim 36, wherein the predetermined pulse width is in a range between 10^{-6} and 10^{-18} seconds.~~

~~61. The system of claim 36, wherein the predetermined pulse rate is in a range between 1 and 50,000 Hertz.~~

~~62. The method of claim 36, wherein the predetermined penetration depth is in a range between 1 and 30 microns.~~