What is claimed is:

1. An ultra-fast laser annealing system for annealing a semiconductor wafer having a wafer surface, comprising:

a primary laser system that forms a primary image on the wafer surface at a first wavelength, wherein the primary image increases an amount of absorption of light at a second wavelength;

a secondary laser system that forms a secondary image on the wafer surface at the second wavelength, wherein the secondary image resides at least partially within the primary image; and

wherein the secondary laser system includes a scanning optical system that scans the secondary image over the wafer surface to define a scan path wherein the secondary image has ~~with~~ a dwell time of between 1 μs and 100 μs, thereby causing the wafer surface to reach a peak annealing temperature T_{AP} between 350 °C and 1250 °C.

2. The ultra-fast laser annealing system of claim 1, further comprising:

a thermal emission detector system operably arranged to detect thermal emission radiation from the wafer surface at the location of the secondary image and generate an electrical thermal emission signal;

a collection optical system operably arranged to collect reflected light from the secondary laser beam that reflects from the wafer surface at the location of the secondary image and generate an electrical reflected light signal;

a power sensor arranged to measure an amount of power in the secondary laser beam and generate an electrical power signal representative thereof;

a controller operably connected to the thermal emission detector system, the collection optical system, the power sensor and the secondary laser system, the controller configured to receive and process the electrical thermal emission signal, the electrical power signal and the electrical reflected light signal and determine a wafer surface temperature T_S at the location of the secondary image.

3. The ultra-fast laser annealing system of claim 2, wherein the thermal emission detector system and the scanning optical system include overlapping optical path sections.

4. The ultra-fast laser annealing system of claim 2, wherein the controller is configured to control an amount of power in the secondary laser beam based on the measured wafer surface temperature T_S.

5. The ultra-fast laser annealing system of claim 4, wherein the primary and secondary images generate a peak annealing temperature that does not vary over the semiconductor wafer by more than +/- 3°C.

6. The ultra-fast laser annealing system of claim 2, wherein the scanning optical system includes a scanning mirror operably connected to a mirror driver, wherein the mirror driver is operably connected to and controlled by the controller.

7. The ultra-fast laser annealing system of claim 1, wherein the first wavelength is in the range from 300 nm to 650 nm.

8. The ultra-fast laser annealing system of claim 1, wherein the second wavelength is in the range from 500 nm to 10.6 microns.

9. The ultra-fast laser annealing system of any of claims 1 through 8, wherein the secondary laser system includes a fiber laser having an output power of between 50 watts and 5000 watts.

10. The ultra-fast laser annealing system of claim 1, wherein the semiconductor wafer includes a device wafer having thickness in a range: a) from 10 μm to 100 μm, or b) from 500 μm to 1,000 μm.

11. A method of annealing a semiconductor wafer having a wafer surface, comprising:

forming a primary image on the wafer surface at a first wavelength, wherein the primary image increases an amount of absorption of light at a second wavelength;

forming a secondary image on the wafer surface at the second wavelength, wherein the secondary image resides at least partially within the primary image;

scanning the secondary image over the wafer surface to define a scan path wherein the secondary image has ~~with~~ a dwell time of between 1 µs and 100 µs ~~and that causes~~ thereby causing the wafer surface to reach a peak annealing temperature T_{AP} between 350 °C and 1250 °C.

12. The method of claim 11, wherein the first wavelength is in the range from 300 nm to 650 nm.

13. The method of claim 12, wherein the second wavelength is in the range from 500 nm to 10.6 microns.

14. The method of claim 11, further comprising:

measuring a wafer surface temperature T_S at the location of the scanned secondary image; and

controlling an amount of power in the secondary laser beam for forming the secondary image in order to keep the peak annealing temperature T_{AP} to within +/- 3 °C.

15. The method of claim 14, wherein measuring the wafer surface temperature T_S includes:

measuring an amount of power in the secondary laser beam;

measuring an amount of thermal radiation emitted from the location of the scanned secondary image;

measuring an amount of reflected light from the location of the secondary image caused by reflection of the secondary light beam; and

calculating the wafer surface temperature T_S using a look up table obtained from a calibration process.

~~16. An ultra-fast laser annealing system for annealing a semiconductor wafer having an annealing surface, comprising:~~

~~a laser that generates a laser beam having an annealing wavelength in the range from about 300 nm to about 650 nm;~~

~~a scanning optical system that receives the laser beam and scans the laser beam age over the annealing surface as a scanned image having a dwell time of between 1 μs and 100 μs, thereby causing the annealing surface to reach a peak annealing temperature T_{AP} between 350 °C and 1250 °C.~~

~~17. The ultra-fast laser annealing system of claim 16, wherein the semiconductor wafer is a product wafer formed from a device wafer and a carrier wafer, wherein the device wafer defines the annealing surface and has a thickness in the range from about 10 μm to about 100 μm.~~

~~18. The ultra-fast laser annealing system of claim 16, wherein the scanning optical system is configured as an F-theta scanning system.~~

~~19. A method of annealing a semiconductor wafer having an annealing surface, comprising:~~

~~forming an image on the annealing surface using a laser beam having a wavelength in the range from about 300 μm to about 650 μm; and~~

~~scanning the image over the annealing surface with a dwell time of between 1 μs and 100 μs, thereby causing the annealing surface to reach a peak annealing temperature T_{AP} between 350 °C and 1250 °C.~~

~~20. The method of claim 19, wherein the semiconductor wafer is a product wafer formed from a device wafer and a carrier wafer, wherein the device wafer defines the annealing surface and has a thickness in the range from about 10 μm to about 100 μm.~~

~~21. The method of claim 19, wherein scanning the image is performing using an F-theta scanning optical system.~~

~~22. A method of annealing a photoresist layer supported by a surface of a semiconductor wafer, comprising:~~

~~forming an image on the surface of the semiconductor wafer using a laser beam having a wavelength in the range from about 300 nm to about 1000 nm; and~~

~~scanning the image over the surface of the semiconductor wafer with a dwell time of between 100 μs and 1 ms, thereby causing the photoresist layer to reach a peak annealing temperature T_{AP} between about 300 °C and about 400 °C.~~

~~23. The method of claim 22, wherein the laser beam and semiconductor wafer define a thermal diffusion length L_{DIFF} and an associated optical absorption depth D_{AD} in the semiconductor wafer, and wherein the image scanning is carried out such that $D_{AD} < L_{DIFF}$.~~

16. The method of claim 11, wherein the primary image remains stationary.

17. The method of claim 11, wherein the secondary image falls entirely within the primary image.

18. The method of claim 11, wherein the wafer has opposite edges and wherein the primary image extends between the opposite wafer edges.

19. The method of claim 11, wherein the secondary image defines a line image.

20. The method of claim 11, wherein the secondary image has a width in the range from 25 μm to 100 μm and a length in the range from 500 μm to 2000 μm.

21 The method of claim 11, wherein the semiconductor wafer has a device surface and an opposite unpatterned surface, wherein the device surface supports device features having a melt temperature and the unpatterned surface defines the wafer surface, the method further comprising:

maintaining the device side of the product wafer at a temperature below the melt temperature of the device features.

22. The method of claim 11, wherein scanning the secondary image is performed using a scanning optical system.