Claims

1. A method of cutting a wafer by irradiating the wafer with laser energy, comprising the steps of:

i) providing a laser source adapted to emit a sequence of successive laser beam pulses,

ii) emitting laser beam pulses from the laser source,

iii) guiding the emitted laser beam pulses to irradiate thea wafer to be cut, and

iv) moving the wafer relative to the irradiating laser beam pulses to cut the wafer along a cutting line,

wherein the sequence of laser beam pulses comprises:

first and second sets of laser beam pulses arranged within the sequence such that a second set of laser beam pulses follows a first set of laser beam pulses,

the first set comprising:

at least one laser beam pulse having a pulse width in the range from 0.1 to 300 nanoseconds, or

at least one burst of laser beam pulses, each pulse within the burst having a pulse width of 100 picoseconds or less, and

the second set comprising at least one laser beam pulse having a pulse width of 100 picoseconds or less,

wherein the first set of laser beam pulses is used to form at least one cut in the wafer, and the second set of laser beam pulses is used to perform post-processing of the at least one formed cut.

2. The method of claim 1, wherein the first plurality set of laser beam pulses comprise laser beam pulses having respective pulse widths in the range from 0.1 to 300 nanoseconds.

3. The method of claim 1, wherein the first set comprises at least one burst of laser beam pulses, each pulse within the burst having a pulse width of 100 picoseconds or less.

4. The method of claim 3, wherein the first set comprises a plurality of bursts of laser beam pulses, having an inter-burst spacing in the range from 0.1 to 100 nanoseconds.

5. The method of claim 1, comprising the step of cyclically repeating the sequence of laser beam pulses.

6. The method of claim 5, wherein the first set of each sequence comprises a single laser beam pulse or single laser beam pulse burst ~~of the first set~~, and the second set comprises a single laser beam pulse ~~of the second set~~, such that the wafer is irradiated with alternate laser beam pulses or laser beam bursts of the first set and laser beam pulses of the second set.

7. The method of claim 6, wherein each sequence comprises the first set comprising a laser beam pulse ~~of the first set~~ followed by the second set comprising a laser beam pulse ~~of the second set~~, with the gap between the pulse of the first set and the pulse of the second set~~se two pulses~~ being between 100 ps and 1 ms.

8. The method of claim 5, wherein the first set ~~each sequence~~ comprises a laser beam pulse burst and the second set comprises~~of the first set followed by~~ a laser beam pulse ~~of the second set~~, and wherein each sequence comprises the first set followed by the second set, with the gap between the first set and the second set~~burst and the following pulse~~ being at least 100 ps.

9. The method of claim 5, wherein ~~each~~ the first set ~~sequence~~ comprises at least two successive laser beam pulses or laser beam pulse bursts ~~of the first set~~ and the second set comprises~~, followed by~~ a laser beam pulse, and wherein each sequence comprises the first set followed by the second set ~~of the second set~~.

10. The method of claim 5, wherein the first set ~~each sequence~~ comprises a laser beam pulse or a laser beam pulse burst ~~of the first set,~~ and the second set comprises ~~followed by~~ at least two successive laser beam pulses, and wherein each sequence comprises the first set followed by ~~of~~ the second set.

11. The method of claim 1, wherein the energy of each laser beam pulse of the second set of laser beam pulses is different from the energy of each laser beam pulse of the first set of laser beam pulses.

12. The method of claim 11, wherein the energy of each laser beam pulse of the second set of laser beam pulses is greater than the energy of each laser beam pulse of the first set of laser beam pulses.

13. The method of claim 11, wherein the energy of each laser beam pulse of the second set of laser beam pulses is lower than the energy of each laser beam pulse of the first set of laser beam pulses.

14. The method of claim 1, comprising the step of controlling the polarisation of the emitted laser beam pulses, such that the laser beam pulses of the second set have a different laser beam polarisation state from those of the first set.

~~15. The method of claim 1, wherein the first set of laser beam pulses is used to form at least one cut in the wafer, and the second set of laser beam pulses is used to perform post-processing of the at least one formed cut.~~

~~16~~15. Laser cutting apparatus for performing the method of claim 1.

~~17~~16. Laser cutting apparatus for cutting a semiconductor material wafer, comprising:

a laser source adapted to emit a sequence of successive laser beam pulses, the sequence comprising first and second sets of laser beam pulses arranged within the sequence such that a second set of laser beam pulses follows a first set of laser beam pulses, the first set comprising at least one laser beam pulse having a pulse width in the range from 0.1 to 300 nanoseconds, or

at least one burst of laser beam pulses, each pulse within the burst having a pulse width of 100 picoseconds or less, and the second set comprising at least one laser beam pulse having a pulse width of 100 picoseconds or less,

a laser beam guiding assembly for directing the laser beam pulses from the laser source to irradiate a semiconductor material wafer to be cut, and

a driving assembly for relatively moving the semiconductor material wafer and the irradiating laser beam pulses,

wherein the first set of laser beam pulses is used to form at least one cut in the semiconductor material wafer, and the second set of laser beam pulses is used to perform post-processing of the at least one formed cut.