

CLAIMS:

1. Method of dicing a plurality of integrated devices included in a semiconductor substrate using laser energy, the method comprising the steps
5 of:
 - directing a first laser beam onto a cutting line along the substrate to ablate a portion of the substrate located along the cutting line to be diced, the portion of the substrate that is ablated forming a recast material adjacent to the cutting line of the substrate that has been diced; and
 - 10 directing a second laser beam onto another portion of the substrate adjacent to the cutting line to conduct heat processing of the recast material formed adjacent to the cutting line.
2. The method as claimed in claim 1, wherein the recast material that is
15 formed by the first laser beam is allowed a sufficient time to solidify before the second laser beam is directed to conduct heat processing of it.
3. The method as claimed in claim 1, wherein the second laser beam
20 comprises the first laser beam which has been defocused to decrease its intensity.
4. The method as claimed in claim 1, wherein the first and second laser
beams are directed onto the substrate at the same time.
- 25 5. The method as claimed in claim 4, wherein the first and second laser beams are arranged to be formed at the same time at different portions of the substrate by a diffractive optical element.
6. The method as claimed in claim 4, wherein the first laser beam is
30 located in front of and leads the second laser beam in a direction in which the first and second laser beams are moving relative to the substrate, and the first laser beam has a higher energy level than the second laser beam.

7. The method as claimed in claim 6, wherein the first laser beam but not the second laser beam is configured to have a sufficient energy level to create enough melting and evaporation to dice the substrate.

5 8. The method as claimed in claim 4, further comprising the step of directing a third laser beam onto a portion of the substrate adjacent to the cutting line on a side of the cutting line that is opposite to a side where the second laser beam is directed so as to conduct heat processing of recast material formed on both sides of the cutting line.

10 9. The method as claimed in claim 8, wherein the first, second and third laser beams are directed onto respective portions of the substrate at the same time.

15 10. The method as claimed in claim 9, wherein the first, second and third laser beams are together arranged in the V-shaped configuration.

11. The method as claimed in claim 9, wherein the first, second and third lasers beams are patterned by a diffractive optical element, and wherein
20 dicing of a second cutting line further comprises the step of rotating the diffractive optical element, and moving the substrate relative to the diffractive optical element in an opposite direction to that moved when dicing along a first cutting line, so as to dice the substrate along the second cutting line.

25 12. The method as claimed in claim 8, wherein the laser beams comprise more than three laser beams and the plurality of laser beams are arranged with a leading laser beam located in front of multiple trailing laser beams arranged on opposite sides of the cutting line which individually have lower energy levels than the leading laser beam.

30 13. The method as claimed in claim 8, further comprising additional laser beams which are arranged relative to the first, second and third laser beams to form an X-shaped configuration.

35 14. The method as claimed in claim 13, wherein an energy level distribution of the laser beam is such that an energy level of a central laser

beam located at the cutting line is higher than an energy level of a laser beam located away from the cutting line.

15. The method as claimed in claim 1, further comprising the step of further
5 melting the portion of the substrate located along the cutting line to be diced
by directing one or more laser beams onto the cutting line of the substrate in
addition to the first laser beam.

CLAIMS:

1. Method of dicing a plurality of integrated devices included in a semiconductor substrate using laser energy, the method comprising the steps of:

5 directing a first laser beam onto a cutting line along the substrate to ablate a portion of the substrate located along the cutting line to be diced, the portion of the substrate that is ablated forming a recast material adjacent to the cutting line of the substrate that has been diced; and

10 directing a second laser beam onto another portion of the substrate adjacent to the cutting line to conduct heat processing of the recast material formed adjacent to the cutting line.

15 2. The method as claimed in claim 1, wherein the recast material that is formed by the first laser beam is allowed a sufficient time to solidify before the second laser beam is directed to conduct heat processing of it.

3. The method as claimed in claim 1 or claim 2, wherein the second laser beam comprises the first laser beam which has been defocused to decrease its intensity.

20 4. The method as claimed in any one of the preceding claims, wherein the first and second laser beams are directed onto the substrate at the same time.

25 5. The method as claimed in claim 4, wherein the first and second laser beams are arranged to be formed at the same time at different portions of the substrate by a diffractive optical element.

30 6. The method as claimed in claim 4 or claim 5, wherein the first laser beam is located in front of and leads the second laser beam in a direction in which the first and second laser beams are moving relative to the substrate, and the first laser beam has a higher energy level than the second laser beam.

7. The method as claimed in claim 6, wherein the first laser beam but not the second laser beam is configured to have a sufficient energy level to create enough melting and evaporation to dice the substrate.

8. The method as claimed in any one of claims 4 to 7, further comprising the step of directing a third laser beam onto a portion of the substrate adjacent to the cutting line on a side of the cutting line that is opposite to a side where the second laser beam is directed so as to conduct heat processing of recast material formed on both sides of the cutting line.

9. The method as claimed in claim 8, wherein the first, second and third laser beams are directed onto respective portions of the substrate at the same time.

10. The method as claimed in claim 9, wherein the first, second and third laser beams are together arranged in the V-shaped configuration.

11. The method as claimed in claim 9 or claim 10, wherein the first, second and third lasers beams are patterned by a diffractive optical element, and wherein dicing of a second cutting line further comprises the step of rotating the diffractive optical element, and moving the substrate relative to the diffractive optical element in an opposite direction to that moved when dicing along a first cutting line, so as to dice the substrate along the second cutting line.

12. The method as claimed in any of claims 8 to 11, wherein the laser beams comprise more than three laser beams and the plurality of laser beams are arranged with a leading laser beam located in front of multiple trailing laser beams arranged on opposite sides of the cutting line which individually have lower energy levels than the leading laser beam.

13. The method as claimed in any of claims 8 to 12, further comprising additional laser beams which are arranged relative to the first, second and third laser beams to form an X-shaped configuration.

14. The method as claimed in claim 13, wherein an energy level distribution of the laser beam is such that an energy level of a central laser beam located at the cutting line is higher than an energy level of a laser beam located away from the cutting line.

15. The method as claimed in any one of the preceding claims, further comprising the step of further melting the portion of the substrate located along the cutting line to be diced by directing one or more laser beams onto the cutting line of the substrate in addition to the first laser beam.