

CLAIMS

What is claimed is:

1. A method of dicing a semiconductor wafer comprising a plurality of integrated circuits, the method comprising:
 - forming a mask above the semiconductor wafer, the mask comprising a layer covering and protecting the integrated circuits;
 - patterning the mask with a rotating laser beam laser scribing process to provide a patterned mask with gaps, exposing regions of the semiconductor wafer between the integrated circuits; and
 - plasma etching the semiconductor wafer through the gaps in the patterned mask to singulate the integrated circuits.
2. The method of claim 1, wherein the rotating laser beam laser scribing process is a rotating shaped laser beam laser scribing process.
3. The method of claim 1, wherein the rotating laser beam laser scribing process is based on a smooth Gaussian beam.
4. The method of claim 1, wherein the rotating laser beam laser scribing process is based on a smooth line-shaped beam having a flat top.
5. The method of claim 1, wherein rotating laser beam laser scribing process comprises rotating a beam around an on-axis of an input laser beam.
6. The method of claim 1, wherein rotating laser beam laser scribing process comprises rotating a beam around an off-axis of an input laser beam.
7. The method of claim 1, wherein scribing with the rotating laser beam laser scribing process comprises scribing with a rotating femto-second based laser beam.
8. The method of claim 1, wherein patterning the mask with the laser scribing process comprises forming trenches in the regions of the semiconductor wafer between the integrated circuits, and

wherein plasma etching the semiconductor wafer comprises extending the trenches to form corresponding trench extensions.

9. A method of dicing a semiconductor wafer comprising a plurality of integrated circuits, the method comprising:

laser scribing the semiconductor wafer with a rotating laser beam laser scribing process to singulate the plurality of integrated circuits.

10. The method of claim 9, wherein the rotating laser beam laser scribing process is a rotating shaped laser beam laser scribing process.

11. The method of claim 9, wherein the rotating laser beam laser scribing process is based on a smooth Gaussian beam.

12. The method of claim 9, wherein the rotating laser beam laser scribing process is based on a smooth line-shaped beam having a flat top.

13. The method of claim 9, wherein rotating laser beam laser scribing process comprises rotating a beam around an on-axis of an input laser beam.

14. The method of claim 9, wherein rotating laser beam laser scribing process comprises rotating a beam around an off-axis of an input laser beam.

15. A system for dicing a semiconductor wafer comprising a plurality of integrated circuits, the system comprising:

a factory interface;

a laser scribe apparatus coupled with the factory interface and comprising a laser assembly configured to provide a rotating laser beam; and

a plasma etch chamber coupled with the factory interface.

16. The system of claim 15, wherein the laser assembly is configured to provide the rotating laser beam as a rotating shaped laser beam, the laser assembly including beam shaping optics selected from the group consisting of a diffractive optical element, one or more slit aperture, and axicons.

17. The system of claim 15, wherein the laser assembly is configured to rotate a laser beam around an on-axis of an input laser beam.
18. The system of claim 15, wherein the laser assembly is configured to rotate a laser beam around an off-axis of an input laser beam.
19. The system of claim 15, wherein the laser assembly comprises a motor having a rotor with a core, and wherein the rotating laser beam is output from a tubular light pipe housed in the core of the rotor.
20. The system of claim 15, wherein the laser assembly comprises a motor having a rotor with a core, and wherein the rotating laser beam is output from a cylindrical light pipe housed in the core of the rotor.