CLAIMS

1. A processing apparatus that forms minute protrusions and recesses on a surface of a substrate by ablation processing using irradiation energy of a laser beam, the apparatus comprising:

a first optical function unit including a laser light source that performs irradiation with the laser beam in pulse and a shaping optical system that shapes an irradiation shape of the laser beam from the laser light source into a rectangular shape;

a second optical function unit including a mask containing an effective area having a pattern corresponding to an area to be processed of the substrate; and

a substrate stage that holds the substrate,

wherein the mask includes a mask irradiation area to be irradiated with the laser beam that has passed through the first optical function unit, the mask irradiation area being a part of the effective area of the mask,

the substrate includes a substrate irradiation area onto which the pattern is to be projected by the laser beam that has passed through the mask,

the substrate irradiation area is smaller than the area to be processed of the substrate,

the mask and the substrate stage are configured to operate in synchronization in a plane direction that is substantially perpendicular to a direction of irradiation with the laser beam to thereby maintain a relatively corresponding positional relationship therebetween, and

the processing apparatus is configured to, during

processing operation on the substrate, cause the mask and the substrate stage to operate in synchronization and subject the mask and the substrate stage to sweep irradiation along a fixed sweep axis with an irradiation position of the laser beam being fixed to perform a surface protrusions-and-recesses forming process on the area to be processed of the substrate,

the processing apparatus is configured to make a length of the substrate irradiation area in a direction of the fixed sweep axis smaller than a length of the area to be processed of the substrate in the direction of the fixed sweep axis, and

the processing apparatus is configured to make a length of the substrate irradiation area in a direction orthogonal to the fixed sweep axis smaller than a length of the area to be processed of the substrate in the direction orthogonal to the fixed sweep axis.

2. The processing apparatus according to claim 1, wherein the laser beam is an excimer laser.

3. The processing apparatus according to claim 1 or 2, further comprising a mask stage that holds the mask and makes the mask move with sweeping.

4. The processing apparatus according to any one of claims 1 to 3, further comprising, between the second optical function unit and the substrate stage, a third optical function unit including a reduced projection optical system.

5. The processing apparatus according to claim 4, wherein the third optical function unit further

includes a cooling means for cooling the reduced projection optical system.

6. The processing apparatus according to any one of claims 1 to 5,

wherein the shaping optical system is an optical system that includes a plurality of cylindrical lenses and shapes the laser beam from the laser light source into a laser beam having the rectangular irradiation shape and uniform irradiation energy density.

7. The processing apparatus according to any one of claims 1 to 5,

wherein the shaping optical system is an optical system that includes a plurality of cylindrical lenses and shapes the laser beam from the laser light source into a laser beam that has the rectangular and top-hat type irradiation shape.

8. The processing apparatus according to any one of claims 1 to 7,

wherein the second optical function unit further shapes the irradiation shape of the laser beam through the mask, the laser beam having passed through the first optical function unit.

9. The processing apparatus according to any one of claims 1 to 8,

wherein the apparatus is configured to make the mask and the substrate stage move with sweeping without rest in the sweep irradiation in at least one direction while irradiating the mask and the substrate stage with the laser beam in pulse.

10. The processing apparatus according to any one of claims 1 to 9, further comprising:

an imaging means for reading a feature portion of the substrate;

an imaging means for reading a feature portion of the mask; and

an alignment mechanism that aligns relative positions of the substrate and the mask based on positional information on the feature portion of the substrate and the feature portion of the mask.

11. The processing apparatus according to claim 10, further comprising a means for correcting a processing shape of the substrate with respect to the pattern of the mask based on information of the alignment mechanism.

12. The processing apparatus according to any one of claims 1 to 11,

wherein the mask is installed in a substantially perpendicular direction with respect to a horizontal plane on which the processing apparatus is installed.

13. A processing method for forming minute protrusions and recesses on a surface of a substrate by ablation processing using irradiation energy of a laser beam, the method comprising:

providing a processing apparatus comprising a first optical function unit including a laser light source and a shaping optical system, a second optical function unit including a mask containing an effective area having a pattern corresponding to an area to be processed of the

substrate, and a substrate stage that holds the substrate;

irradiating, in the first optical function unit, the shaping optical system with the laser beam in pulse from the laser light source to shape an irradiation shape of the laser beam into a rectangular shape;

irradiating, in the second optical function unit, a mask irradiation area with the laser beam that has passed through the first optical function unit, the mask irradiation area being a part of the effective area of the mask; and

irradiating a substrate irradiation area of the substrate with the laser beam that has passed through the mask to project the pattern onto the substrate irradiation area,

wherein the substrate irradiation area is made smaller than the area to be processed of the substrate,

the mask and the substrate stage are caused to operate in synchronization in a plane direction that is substantially perpendicular to a direction of irradiation with the laser beam to thereby maintain a relatively corresponding positional relationship therebetween, and,

during processing operation on the substrate, with an irradiation position of the laser beam being fixed, the mask and the substrate stage are caused to operate in synchronization and subjected to sweep irradiation_ along a fixed sweep axis to perform a surface protrusions-and-recesses forming process on the area to be processed of the substrate,

the length of the substrate irradiation area in the direction of the fixed sweep axis is made smaller than the length of the area to be processed of the substrate

in the direction of the fixed sweep axis, and

the length of the substrate irradiation area in the direction orthogonal to the fixed sweep axis is made smaller than the length of the area to be processed of the substrate in the direction orthogonal to the fixed sweep axis.

14. The processing method according to claim 13,

wherein an excimer laser is used as the laser beam.

15. The processing method according to claim 13 or 14,

wherein a mask stage that holds the mask and makes the mask move with sweeping is further used.

16. The processing method according to any one of claims 13 to 15,

wherein the processing apparatus further includes, between the second optical function unit and the substrate stage, a third optical function unit with a reduced projection optical system provided.

17. The processing method according to claim 16,

wherein the third optical function unit further includes a cooling means for cooling the reduced projection optical system.

18. The processing method according to any one of claims 13 to 17,

wherein an optical system including a plurality of cylindrical lenses is used as the shaping optical system to shape the laser beam from the laser source into a uniform laser beam having the rectangular irradiation shape.

19. The processing method according to any one of claims 13 to 18,

wherein, in the second optical function unit, the irradiation shape of the laser beam that has passed through the first optical function unit is further shaped through the mask.

20. The processing method according to any one of claims 13 to 19,

wherein, in the sweep irradiation in at least one direction, the mask and the substrate stage are made to move with sweeping without rest while being irradiated with the laser beam in pulse.

21. The processing method according to any one of claims 13 to 20,

wherein the sweep irradiation is repeatedly performed multiple times for each area to be processed of the substrate.

22. The processing method according to any one of claims 13 to 21, further comprising:

reading a feature portion of the substrate and a feature portion of the mask; and

aligning, by using an alignment mechanism, relative positions of the substrate and the mask based on positional information on the feature portion of the substrate and the feature portion of the mask.

23. The processing method according to claim 22, further comprising correcting a processing shape of the substrate with respect to the pattern of the mask based

on the information of the alignment mechanism.

24. The processing method according to any one of claims 13 to 23,

wherein the processing apparatus in which the mask is installed in a perpendicular direction with respect to a horizontal plane on which the processing apparatus is to be installed is used.

25. A manufacturing method of a substrate having a surface on which minute protrusions and recesses are formed by ablation processing using irradiation energy of a laser beam, the method comprising:

providing a processing apparatus comprising a first optical function unit including a laser light source and a shaping optical system, a second optical function unit including a mask containing an effective area having a pattern corresponding to an area to be processed of the substrate, and a substrate stage that holds the substrate;

irradiating, in the first optical function unit, the shaping optical system with the laser beam in pulse from the laser light source to shape an irradiation shape of the laser beam into a rectangular shape;

irradiating, in the second optical function unit, a mask irradiation area with the laser beam that has passed through the first optical function unit, the mask irradiation area being a part of the effective area of the mask; and

irradiating a substrate irradiation area of the substrate with the laser beam that has passed through the mask to project the pattern onto the substrate irradiation area,

wherein the substrate irradiation area is made smaller than the area to be processed of the substrate,

the mask and the substrate stage are caused to operate in synchronization in a plane direction that is substantially perpendicular to a direction of irradiation with the laser beam to thereby maintain a relatively corresponding positional relationship therebetween, and,

during processing operation on the substrate, the mask and the substrate stage are caused to operate in synchronization with an irradiation position of the laser beam being fixed and subjected to sweep irradiation along a fixed sweep axis to perform a surface protrusions-and-recesses forming process on the area to be processed of the substrate,

the length of the substrate irradiation area in the direction of the fixed sweep axis is made smaller than the length of the area to be processed of the substrate in the direction of the fixed sweep axis, and

the length of the substrate irradiation area in the direction orthogonal to the fixed sweep axis is made smaller than the length of the area to be processed of the substrate in the direction orthogonal to the fixed sweep axis.

26. The manufacturing method of a substrate according to claim 25,

wherein the substrate is a substrate for a semiconductor package.

27. A manufacturing method of a semiconductor package,

wherein a substrate for a semiconductor package is manufactured by the manufacturing method of a substrate

according to claim 26, and

a semiconductor package is manufactured using the substrate for a semiconductor package.