WHAT IS CLAIMED IS:

1. A wafer manufacturing method in which a focal point of a laser beam with a wavelength having transmissibility with respect to a semiconductor ingot is positioned inside the semiconductor ingot from an end surface of the semiconductor ingot, the semiconductor ingot is irradiated with the laser beam to form a separation layer, and a wafer is manufactured from the separation layer, the wafer manufacturing method comprising:

a preparation step of preparing a laser processing apparatus including a holding unit that holds the semiconductor ingot, a laser beam irradiation unit that includes a beam condenser capable of moving the focal point in a Z-axis direction and executes irradiation with the laser beam from the end surface of the semiconductor ingot held by the holding unit, an X-axis movement mechanism that relatively moves the holding unit and the beam condenser in an X-axis direction, a Y-axis movement mechanism that relatively moves the holding unit and the beam condenser in a Y-axis direction, and a pair of Z-coordinate measuring units, each of the pair of Z-coordinate measuring units disposed on each of both sides of the beam condenser in the X-axis direction;

a Z-coordinate measurement step of deeming the separation layer to be formed as an XY plane and measuring a plurality of heights $Z_{(X, Y)}$ of an upper surface of the semiconductor ingot to be irradiated with the laser beam, corresponding to an X-coordinate and a Y-coordinate by using one of the pair of Z-coordinate measuring units when the X-axis movement mechanism relatively moves the holding unit and the beam condenser toward one side of the X axis direction, and using the other of the pair of Z-coordinate measuring units when the X-axis movement mechanism relatively moves the holding unit and the beam condenser toward the other side of the X axis direction;

a calculation step of defining a Z-coordinate of the separation layer to be formed as Z_0 and calculating a difference from the measured height $Z_{(X, Y)}$ ($Z_{(X, Y)} - Z_0$) to obtain a Z-coordinate of the beam condenser;

a separation layer forming step of actuating the X-axis movement mechanism and the Y-axis movement mechanism to relatively move the holding unit and the beam condenser in the X-axis direction and the Y-axis direction, moving the beam condenser in the Z-axis direction on a basis of the Z-coordinate obtained in the calculation step to position the focal point to Z_0, and

forming the separation layer; and

a wafer separation step of separating the wafer and the semiconductor ingot from each other at the separation layer,

wherein the Z-coordinate measurement step, the calculation step, and the separation layer forming step are concurrently executed.

2. The wafer manufacturing method according to claim 1, wherein the Z-coordinate measurement step, the calculation step, and the separation layer forming step concurrently executed further comprises:

while moving the holding unit toward one side in the X-axis direction by the X-axis movement mechanism, measuring the height $Z_{(X, Y)}$ of the upper surface of the semiconductor ingot;

obtaining the Z-coordinate of the beam condenser by using the measured height $Z_{(X, Y)}$ of the upper surface of the semiconductor ingot; and

irradiating the semiconductor ingot with the laser beam while moving the beam condenser in the Z-axis direction on the basis of the Z-coordinate obtained.

3. The wafer manufacturing method according to any one of claim 1 or claim 2, wherein,

in the calculation step, when a numerical aperture

of an objective lens of the beam condenser is defined as NA(sinθ), a focal length of the objective lens is defined as h, a refractive index of the semiconductor ingot is defined as n(sinθ/sinβ), and a Z-coordinate of the objective lens is defined as Z,

the Z-coordinate to which the objective lens is positioned is obtained by

$$Z = h + (Z_{(X, Y)} - Z_0)(1 - \tan\beta/\tan\theta).$$

4. The wafer manufacturing method according to claim 1, wherein

the semiconductor ingot is an SiC ingot, and

the separation layer forming step includes

a processing feed step of executing processing feed of the holding unit and the beam condenser relatively in the X-axis direction in such a manner that a direction orthogonal to a direction in which a c-plane tilts with respect to an end surface of the SiC ingot and an off-angle is formed is aligned with the X-axis direction, and

an indexing feed step of executing indexing feed of the holding unit and the beam condenser relatively in the Y-axis direction.

5. The wafer manufacturing method according to claim 1, wherein

the semiconductor ingot is an Si ingot,

in the separation layer forming step, a crystal plane (100) is employed as an end surface of the Si ingot, and

the separation layer forming step includes

a processing feed step of executing processing feed of the holding unit and the beam condenser relatively in the X-axis direction in such a manner that a direction <110> parallel to an intersection line at which a crystal plane {100} and a crystal plane {111} intersect or a direction [110] orthogonal to the intersection line is aligned with the X-axis direction, and

an indexing feed step of executing indexing feed of the holding unit and the beam condenser relatively in the Y-axis direction.

6. The wafer manufacturing method according to any one of claim 4 or claim 5, wherein

the separation layer is formed in both forward and backward movement of the holding unit, further comprising

after first executing the processing feed step of the holding unit toward the one side in the X-axis direction to form the separation layer,

subsequently executing the indexing feed step,

and

executing the processing feed step of the holding unit toward the other side in the X-axis direction to form the separation layer.

7. The wafer manufacturing method according to any one of the preceding claims,

wherein at least a first end surface of the semiconductor ingot is planarized by grinding or polishing to such an extent that incidence of the laser beam is not precluded.