

CONFIRMING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a confirming method for confirming the effect that a laser beam applied to the reverse side of a workpiece has on the face side of the workpiece.

Description of the Related Art

Workpieces to be processed into device chips have devices disposed in areas demarcated on face sides thereof by a plurality of intersecting streets or projected dicing lines on the face sides. The workpieces are divided along the streets into device chips including the respective devices. For dividing such a workpiece along the streets, it is necessary to form modified layers in the workpiece along the streets by applying a laser beam to the reverse side of the workpiece along the streets.

However, when the laser beam is applied to the reverse side of the workpiece, the devices on the face side of the workpiece may possibly be adversely affected by the applied laser beam. It has been desired in the art to confirm whether or not or how much devices on the face

side of a workpiece has been adversely affected by the application of a laser beam applied to the reverse side of the workpiece. JP 2017-37912A, for example, discloses a confirmation wafer that is used to confirm the effect that a laser beam applied to the reverse side of the confirmation workpiece has on devices on the face side thereof. When a laser beam is applied to the reverse side of the confirmation wafer to form modified layers therein, damage, hereinafter referred to as "surface damage," caused to the face side of the confirmation wafer by the laser beam can be detected. In this manner, the effect that the laser beam applied to the reverse side of the confirmation workpiece has on devices on the face side thereof can be confirmed, making it possible to select appropriate processing conditions for processing workpieces and detect malfunctions of a processing apparatus for processing workpieces.

SUMMARY OF THE INVENTION

When modified layers are formed in a workpiece along streets thereon by a laser applied to the workpiece, any surface damage caused by the laser beam to the streets that are directly behind the positions where the laser beam is applied gives rise to no problem as no

devices are formed in the streets. It is therefore important to know how far the position of surface damage that has occurred is spaced from the positions where the laser beam is applied.

However, the confirmation wafer disclosed in JP 2017-37912A is free of streets and hence makes it difficult to determine the positions where the laser beam is applied from the appearance of the confirmation wafer. Though one might think that the positions where the laser beam is applied could be determined from the modified layers that have been formed, it is difficult to locate the modified layers from the appearance of the confirmation wafer because the modified layers are formed within the confirmation wafer. Consequently, the confirmation wafer disclosed in JP 2017-37912A is problematic in that it is hard to grasp exactly the positions where the laser beam is applied.

It is therefore an object of the present invention to provide a confirming method for determining positions where a laser beam is applied to the reverse side of a confirmation wafer free of streets to form modified layers therein, and easily confirming the effect that a laser beam applied to the reverse side of a workpiece has on the face side of the workpiece.

In accordance with an aspect of the present invention, there is provided a confirming method for confirming an effect that a laser beam applied to a reverse side of a workpiece has on a face side of the workpiece in forming a modified layer in the workpiece when a laser processing apparatus applies, to the reverse side of the workpiece, the laser beam whose wavelength is transmittable through the workpiece, the confirming method including the steps of preparing a confirmation wafer including a base member and a metal foil disposed on a face side of the base member, forming a modified layer in the base member by applying a laser beam having a wavelength transmittable through the base member to the confirmation wafer from a reverse side of the base member while positioning a focused spot of the laser beam within the base member, and moving the focused spot and the confirmation wafer relatively to each other in a process-feeding direction, forming a linear processing mark on a face side of the metal foil by applying a laser beam having a wavelength transmittable through the base member to the confirmation wafer from the reverse side of the base member while positioning a focused spot of the laser beam at an interface between the base member and the metal foil of the confirmation wafer at a position spaced

a predetermined distance from a position where the laser beam is applied to the confirmation wafer in the step of forming the modified layer in the base member in an index-feeding direction perpendicular to the process-feeding direction, and moving the focused spot and the confirmation wafer relatively to each other in the process-feeding direction, and after the step of forming the modified layer in the base member and the step of forming the linear processing mark on the face side of the metal foil, confirming the effect that a laser beam applied in the step of forming the modified layer in the base member has on the face side of the metal foil on the basis of a position of the linear processing mark.

Preferably, the step of forming the modified layer in the base member is carried out after the step of forming the linear processing mark on the face side of the metal foil.

Preferably, the confirming method further includes a step of, after the step of preparing the confirmation wafer, setting a position where the modified layer is formed in the confirmation wafer as a reference position, in which the laser beam is applied to the confirmation wafer at the reference position in the step of forming the modified layer in the base member, and the laser beam

is applied to the confirmation wafer at a position spaced the predetermined distance from the reference position in the index-feeding direction in the step of forming the linear processing mark on the face side of the metal foil.

According to the present invention, though the modified layer formed in the base member of the confirmation wafer is difficult to visually recognize, the linear processing mark can easily be visually recognized by an operator of the laser processing apparatus because when the reverse side of the metal foil is processed by the laser beam, the metal foil is melted thicknesswise across the metal foil and discolored on the face side thereof to appear as the linear processing mark.

Therefore, the operator can easily grasp the position of the modified layer, i.e., the position where the laser beam was applied to form the modified layer in the base member, from the appearance of the confirmation wafer on the basis of the linear processing mark. Inasmuch as the operator can acquire the positional relationship between the position where the laser beam was applied to form the modified layer and surface damage spots formed on the metal foil by part of the laser beam that has not contributed to the formation of the modified layer and may directly reach the face side of the base

member or may reach the face side of the base member after being reflected, scattered, or refracted by the modified layer or cracks produced around the modified layer, the operator can appropriately confirm the occurrence of surface damage spots, i.e., the effect that the laser beam leakage has on the face side of the base member. As a result, the operator can easily confirm the effect that the applied laser beam will have on the face sides of workpieces. The operator is thus able to select suitable processing conditions for the laser processing apparatus and detect malfunctions of the laser processing apparatus.

In the confirming method, preferably, the step of forming the modified layer in the base member is carried out after the step of forming the linear processing mark on the face side of the metal foil. Depending on the relationship between the position where the modified layer is formed and the position where the linear processing mark is formed, if the modified layer is formed earlier than the linear processing mark, then the laser beam applied to form the linear processing mark may possibly be obstructed by the modified layer. Such a shortcoming is prevented from occurring by carrying out the step of forming the linear processing mark prior to

the step of forming the modified layer.

In the confirming method, preferably, the step of setting the position where the modified layer is formed in the confirmation wafer as the reference position is carried out prior to the step of forming the linear processing mark. Therefore, the position where the modified layer is formed may be set as the reference position, and the linear processing mark and the modified layer may be formed on the basis of the reference position. The positional relationship between the linear processing mark and the modified layer can thus be set appropriately.

The above and other objects, features, and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a confirmation wafer;

FIG. 2 is an enlarged fragmentary cross-sectional

view of the confirmation wafer;

FIG. 3 is a perspective view illustrating the structure of a laser processing apparatus;

FIG. 4 is a diagram, partly in block form, illustrating the makeup of a processing head of the laser processing apparatus;

FIG. 5 is a plan view illustrating a reference position set on the confirmation wafer;

FIG. 6 is a cross-sectional view illustrating a focused spot of a laser beam in a linear processing mark forming step according to an embodiment of the present invention;

FIG. 7 is a view illustrating linear processing marks formed on a metal foil of the confirmation wafer in the linear processing mark forming step;

FIG. 8 is a cross-sectional view illustrating a focused spot of a laser beam in a modified layer forming step;

FIG. 9 is a view illustrating the linear processing marks and surface damage spots formed on the metal foil in the modified layer forming step; and

FIG. 10 is a view illustrating a linear processing mark formed on a metal foil in a linear processing mark forming step according to another embodiment of the

present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A confirming method according to a preferred embodiment of the present invention, hereinafter referred to as "present confirming method," is a confirming method for confirming the effect that a laser beam applied to the reverse side of a workpiece by a laser processing apparatus to form modified layers in the workpiece has on the face side of the workpiece, the laser beam having a wavelength transmittable through the workpiece.

Various steps of the confirming method will hereinafter be described below with reference to the drawings.

(1) Confirmation wafer preparing step

According to the present confirming method, the effect that a laser beam applied to the reverse side of a workpiece has on the face side of the workpiece is confirmed using a confirmation wafer that is different from the workpiece that is to be divided into products, i.e., device chips. The confirmation wafer is free of streets and devices.

As illustrated in FIGS. 1 and 2, a confirmation wafer 1 has a base member 2 shaped as a circular plate

and a metal foil 5 disposed on a face side 3 (see FIG. 2) of the base member 2. As illustrated in FIG. 2, the base member 2 has the face side 3 and a reverse side 4 opposite the face side 3, with the metal foil 5 on the face side 3. The base member 2 has a notch 9 defined in an outer circumferential edge thereof for indicating the crystal orientation of the confirmation wafer 1. The outer circumferential edge of the base member 2 may be beveled (see FIG. 6).

In a confirmation wafer preparing step, a circular as-sliced wafer is ground and polished to a predetermined thickness after deformations including warpage and undulation have been removed therefrom, and the notch 9 is formed in the outer circumferential edge thereof, producing the base member 2. Then, the metal foil 5 is deposited on the face side 3 of the base member 2 by evaporation, for example. In this manner, the confirmation wafer 1 is prepared.

The base member 2 is preferably be made of a material, such as silicon or the like, that is the same as the material of a workpiece from which products, i.e., device chips, will actually be fabricated. The metal foil 5 may be a tin film produced by growing a film of tin, for example, and preferably has a thickness of

approximately several hundreds nanometers.

(2) Reference position setting step, linear processing mark forming step, and modified layer forming step

Next, a reference position setting step for setting a reference position on the confirmation wafer 1, a linear processing mark forming step for forming linear processing marks on the surface of the metal foil 5, and a modified layer forming step for forming modified layers in the base member 2 are carried out. First, the structure of a laser processing apparatus used to perform these steps will be described below.

As illustrated in FIG. 3, the laser processing apparatus, denoted by 10, includes a base table 11 in the shape of a rectangular parallelepiped, an upstanding wall 13 erected on an end of the base table 11, and control means 51 for controlling various components of the laser processing apparatus 10.

The base table 11 supports on an upper surface thereof a holding table moving mechanism 14 for moving a holding table 43. The holding table moving mechanism 14 includes a holding table assembly 40 including the holding table 43, an index-feeding assembly 20 for moving the holding table 43 in index-feeding directions, i.e., Y-axis directions, and a process-feeding assembly 30 for

moving the holding table 43 in process-feeding directions, i.e., X-axis directions, perpendicular to the index-feeding directions.

The index-feeding assembly 20 includes a pair of parallel guide rails 23 extending in the Y-axis directions, a Y-axis table 24 movably disposed on the guide rails 23, a ball screw 25 disposed between and extending parallel to the guide rails 23, and a drive motor 26 for rotating the ball screw 25 about its own axis.

The guide rails 23 are disposed on the upper surface of the base table 11 parallel to the Y-axis directions. The Y-axis table 24 is disposed on the guide rails 23 for sliding movement along the guide rails 23. The process-feeding assembly 30 and the holding table assembly 40 are disposed on the Y-axis table 24.

The ball screw 25 is threaded through a nut, not illustrated, mounted on a lower surface of the Y-axis table 24. The drive motor 26 is coupled to an end of the ball screw 25 for rotating the ball screw 25 about its own axis. When the ball screw 25 is rotated about its own axis by the drive motor 26, the Y-axis table 24, the process-feeding assembly 30, and the holding table assembly 40 are moved in the index-feeding directions,

i.e., the Y-axis directions, along the guide rail 23.

The process-feeding assembly 30 includes a pair of parallel guide rails 31 extending in the X-axis directions, an X-axis table 32 movably disposed on the guide rails 31, a ball screw 33 disposed between and extending parallel to the guide rails 31, and a drive motor 35 for rotating the ball screw 33 about its own axis. The guide rails 31 are disposed on an upper surface of the Y-axis table 24 parallel to the X-axis directions. The X-axis table 32 is disposed on the guide rails 31 for sliding movement along the guide rails 31. The holding table assembly 40 is disposed on the X-axis table 32.

The ball screw 33 is threaded through a nut, not illustrated, mounted on a lower surface of the X-axis table 32. The drive motor 35 is coupled to an end of the ball screw 33 for rotating the ball screw 33 about its own axis. When the ball screw 33 is rotated about its own axis by the drive motor 35, the X-axis table 32 and the holding table assembly 40 are moved in the process-feeding directions, i.e., the X-axis directions, along the guide rail 31.

The holding table assembly 40 includes the holding table 43 for holding the confirmation wafer 1 or a workpiece under suction thereon, four clamps 45 disposed

around the holding table 43, and a θ table 47 supporting the holding table 43 thereon. The θ table 47 is rotatably mounted on an upper surface of the X-axis table 32 for rotation about its own axis in an XY plane. The holding table 43 is shaped as a circular plate and mounted on the θ table 47.

The holding table 43 has, as an upper surface thereof, a holding surface including a porous ceramics material. The holding surface is held in fluid communication with a suction source, not illustrated. In a case where the holding table 43 holds a workpiece including a ring frame, the four clamps 45 grips the ring frame at four positions thereon, thereby securing the ring frame in place.

A laser processing unit 12 for laser-processing a workpiece on the holding table 43 is mounted on a front surface of the upstanding wall 13 disposed behind the holding table moving mechanism 14. The laser processing unit 12 has a processing head 18 for applying a laser beam to the confirmation wafer 1 or the like that is held on the holding table 43, and an arm 17 supporting the processing head 18 on an end thereof and coupled at an opposite end thereof to the upstanding wall 13.

The arm 17 and the processing head 18 house therein

an optical system of the laser processing unit 12. As illustrated in FIG. 4, the processing head 18 includes, as part of the optical system, a laser oscillator 53 for generating a laser beam L and a condensing lens 54 for condensing the laser beam L generated by the laser oscillator 53. The processing head 18 condenses the laser beam L emitted from the laser oscillator 53 with the condensing lens 54 and applies the condensed laser beam L to the confirmation wafer 1 or the like held on the holding table 43.

The laser beam L emitted from the laser oscillator 53 is a pulsed laser beam, for example, and has a wavelength transmittable through the confirmation wafer 1. The condensing lens 54 condenses the laser beam L into a focused spot P, and the optical system of the processing head 18 can control the focused spot P to be placed at a desired height, i.e., a desired position along Z-axis directions, i.e., vertical directions, perpendicular to the X-axis directions and the Y-axis directions.

The control means 51 controls various components of the laser processing apparatus 10, as described above. The control means 51 includes a processor for performing various processing sequences. The control means 51 is supplied with detection signals from various detectors,

not illustrated.

(2-1) Reference position setting step

The reference position setting step carried out by the laser processing apparatus 10 will be described below. The reference position setting step is carried out after the confirmation wafer preparing step.

In the reference position setting step, the operator of the laser processing apparatus 10 places the confirmation wafer 1 on the holding table 43 such that the exposed reverse side 4 of the base member 2 illustrated in FIG. 2 faces upwardly. Then, in response to the confirmation wafer 1 being placed on the holding table 43, the control means 51 controls the suction source to produce a negative pressure that acts on the holding surface of the holding table 43, holding the metal foil 5 of the confirmation wafer 1 under suction on the holding surface of the holding table 43.

Thereafter, as illustrated in FIG. 5, the control means 51 sets a position where a modified layer is to be formed in the confirmation wafer 1 as a reference position B on the confirmation wafer 1. Since the confirmation wafer 1 is free of streets and devices, the reference position B may be set anywhere on the confirmation wafer 1. As a result, it is not necessary to

make any angular adjustments on the confirmation wafer 1 using the θ table 47.

Specifically, for example, the control means 51 controls the index-feeding assembly 20 to set the position of the holding table 43 that is holding the confirmation wafer 1 in the index-feeding directions, i.e., the Y-axis directions, to a first preset position. With the holding table 43 set in the first preset position, the position where the laser beam L is to be applied from the processing head 18 to the confirmation wafer 1 now becomes the reference position B.

(2-2) Linear processing mark forming step

In the linear processing mark forming step, the laser beam L is positioned at a position that is spaced a predetermined distance from the reference position B in the index-feeding directions that are perpendicular to the process-feeding directions.

Specifically, the control means 51 controls the index-feeding assembly 20 to move the holding table 43 that is holding the confirmation wafer 1 to set the position where the laser beam L is to be applied from the processing head 18 to the confirmation wafer 1 to a position that is spaced a predetermined offset distance "d" (see FIG. 7) from the reference position B in one of

the index-feeding directions, i.e., a + Y-axis direction.

Then, as illustrated in FIG. 6, the control means 51 controls the optical system of the processing head 18 to place the position of the focused spot P of the laser beam L from the processing head 18 at the interface between the base member 2 and the metal foil 5 of the confirmation wafer 1. The control means 51 controls the processing head 18 to apply the laser beam L to the confirmation wafer 1 from the reverse side 4, and also controls the process-feeding assembly 30 to move the holding table 43 holding the confirmation wafer 1 in one of the process-feeding directions as indicated by the arrow A, thereby moving the processing head 18 relatively to the confirmation wafer 1 in the other of the process-feeding directions. The reverse side of the metal foil 5 is now processed by the laser beam L so as to melt thicknesswise across the metal foil 5, thus forming a first linear processing mark M1 (see FIG. 7) representing the melted streak of the metal foil 5, on the face side of the metal foil 5 at a position spaced from the reference position B in the + Y-axis direction.

Thereafter, the control means 51 sets the position where the laser beam L is to be applied from the processing head 18 to the confirmation wafer 1 to a

position that is spaced the predetermined offset distance "d" (see FIG. 7) from the reference position B in the other of the index-feeding directions, i.e., a - Y-axis direction. Then, the control means 51 applies the laser beam L and process-feeds the holding table 43 in the same manner as when the first linear processing mark M1 was formed.

Now, a second linear processing mark M2 is formed on the face side of the metal foil 5 at a position spaced from the reference position B in the - Y-axis direction. In this manner, the two linear processing marks M1 and M2 are formed respectively on both sides of the reference position B and parallel to the reference position B in the linear processing mark forming step. The linear processing marks M1 and M2 have face sides discolored due to the metal foil 5 melted thicknesswise across the metal foil 5 by the applied laser beam L, and hence can be visually confirmed on the face side of the metal foil 5.

The distance between the first linear processing mark M1 and the second linear processing mark M2 is preferably be the same as the width of each of the streets on a workpiece in which modified layers are to be actually formed. The distance thus selected allows the operator to recognize at a glance whether or not the

extent of the effect that the application of a laser beam has on the face side of the workpiece falls within the streets.

In the linear processing mark forming step, the laser beam L has a wavelength of 1064 nm, for example, and an output power level of 0.2 W, for example, and the process-feeding assembly 30 moves the holding table 43 at a speed of 500 mm/second, for example.

(2-3) Modified layer forming step

In the modified layer forming step, the control means 51 forms modified layers in the confirmation wafer 1 along the reference position B.

Specifically, the control means 51 controls the index-feeding assembly 20 to move the holding table 43 holding the confirmation wafer 1 to set the position where the laser beam L is to be applied from the processing head 18 to the confirmation wafer 1 to the reference position B.

Then, the control means 51 controls the optical system of the processing head 18 to place the focused spot P of the laser beam L from the processing head 18 at a position within the base member 2 of the confirmation wafer 1. The control means 51 applies the laser beam L from the processing head 18 to the confirmation wafer 1

from the reverse side 4, and controls the process-feeding assembly 30 to move the holding table 43 in one of the process-feeding directions as indicated by the arrow A, thereby moving the processing head 18 relatively to the confirmation wafer 1 in the other of the process-feeding directions.

Thereafter, the control means 51 changes the height of the focused spot P of the laser beam L from the processing head 18 within the base member 2, and applies the laser beam L and process-feeds the holding table 43 in the same manner as described above.

As a consequence, as illustrated in FIG. 9, a modified layer T is formed in the base member 2 along the reference position B illustrated in FIG. 7. In the modified layer forming step, the laser beam L has a wavelength of 1064 nm, for example, and an output power level of 1.5 W, for example, and the process-feeding assembly 30 moves the holding table 43 at a speed of 700 mm/second, for example.

(3) Confirming step

In the confirming step, the operator visually confirms the effect that the laser beam L applied in the modified layer forming step has on the face side of the metal foil 5, on the basis of the positions of the linear

processing marks M1 and M2.

Specifically, in the modified layer forming step, the laser beam L is applied to the confirmation wafer 1 from the reverse side 4 of the base member 2 such that the focused spot P is positioned within the base member 2. At this time, part of the laser beam L that has not contributed to the formation of the modified layer may directly reach the face side 3 of the base member 2 or may reach the face side 3 of the base member 2 after being reflected, scattered, or refracted by the modified layer or cracks produced around the modified layer. If this happens to workpieces from which actual products or device chips are to be fabricated, then the laser beam L that has reached the face side 3 of the base member 2 may possibly adversely affect devices on the face sides of the workpieces. On the confirmation wafer 1, the laser beam L that has reached the face side 3 of the base member 2 leaves surface damage spots, i.e., laser damage spots, LD on the face side of the metal foil 5, as illustrated in FIG. 9. In the confirming step, the operator visually observes such surface damage spots LD. In the confirming step, the operator removes the confirmation wafer 1 from the holding table 43, and visually observes surface damage spots LD from the face

side of the metal foil 5 deposited on the face side of the base member 2.

In the confirming method according to the present embodiment, the laser beam L is applied to the confirmation wafer 1 at the two positions that are spaced the predetermined offset distance "d" from the reference position B, forming the two linear processing marks M1 and M2 on the face side of the metal foil 5 of the confirmation wafer 1. Then, the laser beam L is applied to the confirmation wafer 1 along the reference position B to form the modified layer T in the base member 2 intermediate between the two linear processing marks M1 and M2.

Though the modified layer T formed in the base member 2 is difficult to visually recognize, the linear processing marks M1 and M2 that are present on both sides of the modified layer T can easily be visually recognized by the operator as they clearly represent the melted streaks of the metal foil 5 on the face side of the metal foil 5.

Therefore, the operator can easily grasp the position of the modified layer T, i.e., the position where the laser beam L was applied to form the modified layer T in the base member 2, from the appearance of the

confirmation wafer 1 on the basis of the linear processing marks M1 and M2. Inasmuch as the operator can acquire the positional relationship such as distances or the like between the position where the laser beam L was applied to form the modified layer T in the base member 2 and the surface damage spots LD formed on the metal foil 5 by the laser beam that has reached the face side 3 of the base member 2, the operator can appropriately confirm the occurrence of surface damage spots LD, i.e., the effect that the laser beam leakage has on the face side 3 of the base member 2. As a result, the operator can easily confirm the effect that the applied laser beam L will have on the face sides of workpieces.

The operator is thus able to select suitable processing conditions for the laser processing apparatus 10 and detect malfunctions of the laser processing apparatus 10. Specifically, if the operator confirms that laser damage spots LD have been formed on the face side of the metal foil 5 outside of the linear processing marks M1 and M2 in the modified layer forming step, then the operator appropriately changes processing conditions, e.g., lowers the output power level of the laser beam L in the modified layer forming step, and/or changes the position of the focused spot P, the repetitive frequency

of the pulsed laser beam, the process-feeding speed, the pulse direction of the pulsed laser beam, and other parameters. If, on the other hand, a plurality of laser damage spots LD are localized to an area closer from the center intermediate between the two linear processing marks M1 and M2, i.e., the modified layer, to one of the linear processing marks M1 and M2, then the operator decides that the optical axis is shifted out of position and checks the optical system of the laser processing unit 12, etc., for example.

According to the present embodiment, furthermore, the linear processing mark forming step is carried out before the modified layer forming step. Depending on the relationship between the position where the modified layer T is formed, i.e., the reference position B, and the positions where the linear processing marks M1 and M2 are formed, if the modified layer T is formed earlier than the linear processing marks M1 and M2, then the laser beam L applied to form the linear processing marks M1 and M2 may possibly be obstructed by the modified layer T. Such a shortcoming is prevented from occurring by carrying out the linear processing mark forming step prior to the modified layer forming step.

According to the present embodiment, moreover, the

reference position setting step is carried out before the linear processing mark forming step. The position where the modified layer T is to be formed is set as the reference position B, and the linear processing marks M1 and M2 and the modified layer T are formed on the basis of the reference position B. It is thus easy to form the modified layer T intermediate between the linear processing marks M1 and M2.

According to the present embodiment, the two linear processing marks M1 and M2 are formed at respective positions that are spaced the offset distance "d" in the + Y-axis direction and the - Y-axis direction from the reference position B. At this time, the process-feeding assembly 30 may be process-fed in one of the X-axis directions, e.g., a - X-axis direction, to form the first linear processing mark M1, then the holding table 43 may be moved in the - Y-axis direction, and thereafter the process-feeding assembly 30 may be process-fed in the other of the X-axis directions, e.g., a + X-axis direction, to form the second linear processing mark M2. Alternatively, providing the processing head 18 is arranged to be able to apply two laser beams L at the same time, the two linear processing marks M1 and M2 may be formed simultaneously.

Furthermore, as illustrated in FIG. 10, a single linear processing mark M may be formed on only one side of the reference position B in one of the index-feeding directions. According to this alternative, it is possible for the operator to visually grasp the position where the laser beam L is applied to form the modified layer T from the appearance of the confirmation wafer 1, on the basis of the visible linear processing mark M and the positional relationship between the linear processing mark M and the reference position B, i.e., the offset distance "d."

In the modified layer forming step, the control means 51 is not required to apply the laser beam L from one end to the other end of an outer circumferential edge of the confirmation wafer 1. However, it is preferable to form a modified layer T whose length is equal to or smaller than the lengths of the two linear processing marks M1 and M2 formed in the linear processing mark forming step.

According to the present embodiment, the linear processing mark forming step is carried out before the modified layer forming step, as described above. However, the linear processing mark forming step may be carried out after the modified layer forming step.

The reference position setting step according to the present embodiment may not necessarily be carried out. For example, the linear processing mark forming step may be carried out at desired two positions on the confirmation wafer 1 to form two linear processing marks M1 and M2 at those two positions, and the modified layer forming step may be carried out at a position intermediate between the two linear processing marks M1 and M2 to form a modified layer T at the position.

According to the present embodiment, in the modified layer forming step, the laser beam L is applied and the holding table 43 is process-fed in two cycles at different heights of the focused spot P in the base member 2. Instead, in the modified layer forming step, the laser beam L is applied and the holding table 43 is process-fed in one cycle or three or more cycles.

The present invention is not limited to the details of the above described preferred embodiment. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A confirming method for confirming an effect that a laser beam applied to a reverse side of a workpiece has on a face side of the workpiece in forming a modified layer in the workpiece when a laser processing apparatus applies, to the reverse side of the workpiece, the laser beam whose wavelength is transmittable through the workpiece, the confirming method comprising the steps of:

preparing a confirmation wafer including a base member and a metal foil disposed on a face side of the base member;

forming a modified layer in the base member by applying a laser beam having a wavelength transmittable through the base member to the confirmation wafer from a reverse side of the base member while positioning a focused spot of the laser beam within the base member, and moving the focused spot and the confirmation wafer relatively to each other in a process-feeding direction;

forming a linear processing mark on a face side of the metal foil by applying a laser beam having a wavelength transmittable through the base member to the confirmation wafer from the reverse side of the base member while positioning a focused spot of the laser beam

at an interface between the base member and the metal foil of the confirmation wafer at a position spaced a predetermined distance from a position where the laser beam is applied to the confirmation wafer in the step of forming the modified layer in the base member in an index-feeding direction perpendicular to the process-feeding direction, and moving the focused spot and the confirmation wafer relatively to each other in the process-feeding direction; and

after the step of forming the modified layer in the base member and the step of forming the linear processing mark on the face side of the metal foil, confirming the effect that a laser beam applied in the step of forming the modified layer in the base member has on the face side of the metal foil on a basis of a position of the linear processing mark.

2. The confirming method according to claim 1, wherein the step of forming the modified layer in the base member is carried out after the step of forming the linear processing mark on the face side of the metal foil.

3. The confirming method according to claim 1 or 2, further comprising:

a step of, after the step of preparing the confirmation wafer, setting a position where the modified

layer is formed in the confirmation wafer as a reference position,

wherein the laser beam is applied to the confirmation wafer at the reference position in the step of forming the modified layer in the base member, and

the laser beam is applied to the confirmation wafer at a position spaced the predetermined distance from the reference position in the index-feeding direction in the step of forming the linear processing mark on the face side of the metal foil.