

WORKPIECE PROCESSING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a processing method for dividing a workpiece along division lines into individual chips.

Description of the Related Art

In a semiconductor device manufacturing process, a plurality of regions are partitioned by a plurality of division lines, called streets, arranged in a grid pattern on a front surface of a semiconductor workpiece having a substantially disk-like shape, and a circuit (functional element) such as an integrated circuit (IC) or a large scale integration (LSI) is formed in each of the thus partitioned regions. Then, the semiconductor workpiece is cut along the division lines to divide the regions formed with the circuits, thereby manufacturing individual semiconductor chips.

As a method for cutting the semiconductor workpiece along the division lines, there has been known a method including laser processing in which a pulsed laser beam of such a wavelength as to be transmitted through the workpiece is applied to the workpiece, with a focal point

adjusted to the inside of the region to be divided of the workpiece (see, for example, Japanese Patent No. 4733934).

In the workpiece dividing method using laser processing, a pulsed laser beam of such a wavelength in the infrared region as to be transmitted through the workpiece is applied from one surface side of the workpiece, with a focal point adjusted to the inside of the workpiece, to continuously form modified layers in the inside of the workpiece along the division lines, a back surface of the workpiece is ground, and the workpiece is ruptured and divided by a stress generated in the workpiece along the division lines where strength of the workpiece has been lowered by the formation of the modified layers.

SUMMARY OF THE INVENTION

However, according to the dividing method described in Japanese Patent No. 4733934, since gaps are generated between the divided chips, there arises a problem in which when the workpiece is ground to a finished thickness after the dividing into chips, grinding water (water for cooling and cleaning the contact site between the grindstone and the workpiece at the time of grinding)

containing grinding swarf enters into the gaps between the chips, and the grinding swarf adheres to chip side surfaces. It is very difficult to remove the grinding swarf adhered to the chip side surfaces by cleaning by a cleaning mechanism of the grinding apparatus.

Accordingly, it is an object of the present invention to provide a workpiece processing method for continuously forming modified layers in an inside of a workpiece along division lines and dividing the workpiece into chips, with the modified layers as start points, in which grinding swarf is prevented from adhering to side surfaces of the chips.

In accordance with an aspect of the present invention, there is provided a workpiece processing method of dividing a workpiece having a functional element formed in each of regions partitioned by a plurality of division lines formed in a grid pattern on a front surface, along the division lines into individual chips, the workpiece processing method including: a first modified layer forming step of applying a laser beam of such a wavelength as to be transmitted through the workpiece to the workpiece from a back surface side of the workpiece along the division lines, to form first modified layers which are not cracked vertically and

lower ends of which are located slightly on the back surface side as compared to a height position corresponding to a finished thickness of the chips; a second modified layer forming step of applying a laser beam of such a wavelength as to be transmitted through the workpiece to the workpiece from the back surface side of the workpiece along the division lines, to form second modified layers which are cracked vertically on the back surface side of the first modified layers formed in the first modified layer forming step; and a back surface grinding step of grinding the back surface of the workpiece formed with the first modified layers and the second modified layers, to form the workpiece to the finished thickness of the chips and to divide the workpiece into the individual chips, with the cracked second modified layers as start points. In the back surface grinding step, the first modified layers remain until just before completion of the back surface grinding, such that grinding water containing grinding swarf can be prevented from penetrating into gaps between the chips.

Preferably, in the back surface grinding step, the workpiece is ruptured, by a grinding stress generated in the workpiece, at the second modified layers formed to be

cracked vertically in the second modified layer forming step.

According to the present invention, in the back surface grinding step, the first modified layers remain until just before completion of the back surface grinding, whereby grinding water containing grinding swarf can be prevented from penetrating into gaps of the chips formed by the division.

Specifically, in addition to the second modified layers which will serve as start points for dividing the workpiece into the chips, the first modified layers are formed in the vicinity of the position corresponding to the finished thickness of the chips. This ensures that in the back surface grinding step, the first modified layers having narrow width dividing grooves are present even after the division of the workpiece into the chips with the second modified layers as start points, and the first modified layers play the role of preventing the grinding water containing the grinding swarf from penetrating to the chip side surfaces, whereby adhesion of the grinding swarf onto the chip side surfaces can be restrained.

In addition, the first modified layers formed in the first modified layer forming step are formed by applying a laser beam at such a low output as not to

generate cracks vertically. Therefore, at the time of forming the first modified layers, scattering of the laser beam through such cracks is prevented from occurring, and the laser beam is restrained from attaching the functional elements present at the front surface of the workpiece, so that the functional elements are not damaged. Therefore, no problem is generated even where the first modified layers are formed in the vicinity of the position corresponding to the finished thickness of the chips, and penetration of grinding swarf to chip side surfaces can be prevented by the first modified layers which remain until just before completion of the grinding.

Further, since the first modified layers and the second modified layers are both formed on the back surface side as compared to the position corresponding to the finished thickness of the chips, both the modified layers are removed by grinding the workpiece to the finished thickness in the back surface grinding step. Therefore, a lowering in the strength of the chips due to remaining of the modified layers can be prevented from occurring.

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 illustrating a state in which a laser beam of such a wavelength as to be transmitted through a workpiece is applied to the workpiece from a back surface side along division lines;

FIG. 2 is a sectional view illustrating a state in which a laser beam of such a wavelength as to be transmitted through a workpiece is applied to the workpiece from a back surface side along division lines, to form first modified layers which are not cracked vertically and lower ends of which are located slightly on the back surface side as compared to a height position corresponding to a finished thickness of chips;

FIG. 3 is a sectional view illustrating the first modified layers in an enlarged form;

FIG. 4 is a sectional view illustrating, in an enlarged form, second modified layers which are formed by applying a laser beam of such a wavelength as to be

transmitted through a workpiece from a back surface side of the workpiece along division lines, and which are cracked vertically on the back surface side of the first modified layers formed in a first modified layer forming step;

FIG. 5 is a sectional view illustrating a state in which the second modified layers cracked vertically on the back surface side of the first modified layers formed in the first modified layer forming step are formed;

FIG. 6 is a perspective view illustrating a state in which a back surface of the workpiece formed with the first modified layers and the second modified layers is ground to form the workpiece to a finished thickness of chips, and to divide the workpiece into the individual chips with the cracked second modified layers as start points;

FIG. 7 is a sectional view illustrating a state in which the back surface of the workpiece formed with the first modified layers and the second modified layers is ground, to form the workpiece to the finished thickness of the chips, and to divide the workpiece into the individual chips with the cracked second modified layers as start points; and

FIG. 8 is an enlarged sectional view illustrating

gaps (dividing grooves) between the chips formed when the workpiece is divided by grinding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Steps in the case of carrying out a workpiece processing method according to the present invention to divide a workpiece W depicted in FIG. 1 along division lines S into individual chips each having a functional element D will be described below.

The workpiece W illustrated in FIG. 1 is, for example, a semiconductor wafer formed in a disk-like outer shape from silicon as a parent material, in which a front surface Wa faced down in FIG. 1 is formed with a plurality of crossing division lines S, and a functional element (device) D is formed in each of regions partitioned in a grid pattern by the division lines S. For instance, the front surface Wa of the workpiece W is protected by adhering a protective tape T thereto. Note that the parent material of the workpiece W may be gallium arsenide, sapphire, gallium nitride, silicon carbide or the like, other than silicon.

A laser processing apparatus 1 depicted in FIG. 1 is an apparatus that applies a laser beam from laser beam applying means 6 to the workpiece W held by a holding

table 30. The holding table 30 for holding the workpiece W has a flat holding surface 300 that is circular in outer shape in plan view, includes a porous member or the like, and suction holes the workpiece W, and a suction source (not illustrated) is communicating with the holding surface 300. The holding table 30 is rotatable around an axis in the vertical direction (Z-axis direction), and reciprocally movable in an X-axis direction and a Y-axis direction by moving means (not illustrated).

The laser beam applying means 6 includes, for example, a cylindrical housing 60 extending horizontally in the Y-axis direction on the upper side of the holding surface 300. A laser beam oscillator 61 is disposed inside the housing 60. The laser beam oscillator 61 is, for example, neodymium doped yttrium orthovanadate (Nd:YVO₄) laser or the like, which can oscillate a laser beam (pulsed laser) of a predetermined wavelength (for example, a wavelength of 1,342 nm) such as to be transmitted through the workpiece W.

A laser head 62 provided therein with a focusing lens 62a is disposed at a tip portion of the housing 60. The laser beam applying means 6 has a configuration in which the laser beam oscillated in the -Y-axis direction

from the laser beam oscillator 61 is reflected by a mirror (not illustrated) provided inside the housing 60 and the laser head 62 to be incident on the focusing lens 62a, whereby the laser beam going in the -Z-axis direction can be accurately focused and applied to a predetermined height position of the workpiece W held by the holding table 30. Note that the focal point position of the laser beam focused by the laser head 62 can be controlled in the direction (Z-axis direction) perpendicular to the holding surface 300 of the holding table 30 by focal point position controlling means (not illustrated).

In the vicinity of the laser head 62 (for example, at an outside surface of the housing 60), there is disposed alignment means 64 that detects the division lines S of the workpiece W. The alignment means 64 includes infrared ray applying means (not illustrated) that applies infrared rays, and an infrared camera 640 including an optical system for capturing the infrared rays and an imaging element (infrared charge-coupled device (CCD)) for outputting an electrical signal corresponding to the infrared rays. Based on an image acquired by the infrared camera 640, the alignment means 64 can detect the division line S on the front surface Wa

of the workpiece by image processing such as pattern matching.

(1) First Modified Layer Forming Step

For example, as depicted in FIGS. 1 and 2, the workpiece W is suction held by the holding table 30, with a back surface Wb faced up. Next, the holding table 30 with the workpiece W held thereon is fed in the -X direction (forward direction) as depicted in FIG. 2, infrared rays are transmitted from the back surface Wb side of the workpiece W by the infrared camera 640 to image the division lines S, and based on an image of the division lines S picked up by the infrared camera 640, the alignment means 64 performs image processing such as pattern matching, whereby the position of the division line S serving as a reference in applying the laser beam is detected.

As the position of the division line S is detected, the holding table 30 holding the workpiece W thereon is put to indexing feeding in the Y-axis direction, whereby alignment between the division line S serving as a reference in applying the laser beam and the laser head 62 in the Y-axis direction is performed. Next, as depicted in FIG. 3, a focal point position P1 of a laser beam LB1 focused by the focusing lens 62a is positioned

slightly on the back surface Wb side (upper side) as compared to a predetermined height position inside the workpiece W, for example, a height position Z1 corresponding to a finished thickness H1 (for example, 30 μm) of chips illustrated in FIG. 3. Then, the laser beam LB1 of a wavelength such as to be transmitted through the workpiece W is oscillated from the laser beam oscillator 61 depicted in FIG. 2, and the laser beam LB1 is focused and applied to the inside of the workpiece W held by the holding table 30 as illustrated in FIGS. 2 and 3.

The output, repetition frequency and the like of the laser beam oscillated from the laser beam oscillator 61 are set in such conditions that first modified layers M1 (see FIG. 3) formed in the workpiece W are not cracked vertically. Particularly, an average output is set to be low (not more than 0.5 W).

An example of the conditions is, for example, as follows.

Wavelength:	1,342 nm
Repetition frequency:	90 kHz
Average output:	0.5 W
Processing feeding rate:	700 mm/s

While the laser beam LB1 is being applied from the back surface Wb side of the workpiece W along the

division line S, the workpiece W is put to processing feeding at the above-mentioned processing feeding rate in the -X direction, to form the first modified layers M1 inside the workpiece W as depicted in FIGS. 2 and 3. While the laser beam LB1 before reaching the focal point position P1 has a property of being transmitted through the workpiece W, the laser beam LB1 having reached the focal point position P1 illustrated in FIG. 3 locally indicates a very high absorption characteristic in relation to the workpiece W. Therefore, the workpiece W in the vicinity of the focal point position P1 absorbs the laser beam LB1 and is modified thereby, so that the first modified layer M1 of a predetermined length is formed to extend mainly upward (toward the back surface Wb side) from the focal point position P1.

Since the average output of the laser beam LB1 is set to be low, the first modified layers M1 are formed inside the workpiece W as illustrated in FIG. 3, but the first modified layers M1 are not cracked vertically (alternatively, if the modified layers M1 are cracked, the cracks are extremely fine to a negligible degree). Specifically, the first modified layers M1 which are not cracked vertically and lower ends of which are located slightly on the back surface Wb side as compared to the

height position Z1 corresponding to the finished thickness H1 of the chips are formed while being aligned rectilinearly inside the workpiece W at minute intervals in the X-axis direction along the division line S from the -X direction toward the +X direction.

The first modified layers M1 are formed with their lower ends located slightly on the back surface Wb side as compared to the height position Z1 corresponding to the finished thickness H1. In this case, since the average output of the laser beam LB1 is set to be low and cracks are not formed, the laser beam LB1 would not be scattered through the cracks from the focal point position P1 toward the front surface Wa side. Therefore, a situation in which the laser beam LB1 attacks the functional element D formed at the front surface Wa to damage the functional element D is not generated, and there arises no problem even when the first modified layers M1 are formed in the vicinity of the height position Z1 corresponding to the finished thickness H1 of the chips.

When the workpiece W is moved in the -X direction to a predetermined position in the X-axis direction such as to finish application of the laser beam LB1 along one row of the division line S, the application of the laser

beam LB1 is stopped, and the processing feeding of the workpiece W in the -X direction is stopped.

(2) Second Modified Layer Forming Step

Next, a laser beam of such a wavelength as to be transmitted through the workpiece W is applied from the back surface Wb side of the workpiece W along the division line S, whereby second modified layers cracked vertically are formed on the back surface Wb side (upper side) of the first modified layers M1 formed in the first modified layer forming step.

For example, the output, repetition frequency and the like of the laser beam oscillated from the laser beam oscillator 61 are set in such conditions that cracks are vertically generated from second modified layers M2 (see FIG. 4) formed inside the workpiece W. Particularly, the average output is set to be higher (not less than 0.8 W) than at the time of forming the first modified layers M1.

An example of the conditions is, for example, as follows.

Wavelength:	1,342 nm
Repetition frequency:	90 kHz
Average output:	0.8 W
Processing feeding rate:	700 mm/s

As depicted in FIG. 4, a focal point position P2 of

a laser beam LB2 focused by the focusing lens 62a (see FIG. 5) is positioned, by focal point position control means (not illustrate), at a height position Z2 which is near the back surface Wb side of the workpiece W and is spaced upward by a predetermined spacing from the focal point position P1 at the time of forming the first modified layers M1.

Note that in the present embodiment, the spacing between the focal point position P1 and the focal point position P2 is set such that cracks Ma extending downward from the second modified layers M2 formed do not reach the first modified layers M1, as depicted in FIG. 4. However, the spacing may be set in such a manner that the cracks Ma extending downward from the second modified layers M2 reach the first modified layers M1.

Then, the laser beam LB2 of a wavelength such as to be transmitted through the workpiece W is oscillated from the laser beam oscillator 61 illustrated in FIG. 5, and the laser beam LB2 is focused and applied to the inside of the workpiece W held by the holding table 30 as depicted in FIGS. 4 and 5.

While the laser beam LB2 is being applied to the workpiece W from the back surface Wb side along the division line S along which the first modified layers M1

have previously been formed, the workpiece W is put to processing feeding at a processing feeding rate of 700 mm/s in the +X direction (backward direction), whereby the second modified layers M2 are formed inside the workpiece W as illustrated in FIGS. 4 and 5.

Specifically, as depicted in FIG. 4, the workpiece W in the vicinity of the focal point position P2 absorbs the laser beam LB2 and is modified thereby, whereby the second modified layers M2 of a predetermined length are formed to extend mainly upward (toward the back surface Wb side) from the focal point position P2. In addition, fine cracks Mb and Ma are simultaneously formed in the vertical direction from the second modified layers M2. While the cracks Ma extending downward from the second modified layers M2 do not reach the first modified layers M1 in the present embodiment, the cracks Ma may reach the first modified layers M1.

The second modified layers M2 in which the cracks Mb and Ma are vertically generated on the back surface Wb side (upper side) of the first modified layers M1 are formed while aligned rectilinearly inside the workpiece W at minute intervals in the X-axis direction along the division line S from the +X direction toward the -X direction as illustrated in FIGS. 4 and 5. Then, when the

workpiece W is moved in the +X direction to a predetermined position in the X-axis direction such as to finish the application of the laser beam LB2 along one row of division line S, the application of the laser beam LB2 is stopped, and the processing feeding of the workpiece W in the +X direction is stopped.

In this way, laser processing is applied to the workpiece W along one row of division line S, by a method in which a first modified layer forming step conducted together with the processing feeding of the workpiece W in the -X direction (forward direction) and a second modified layer forming step conducted together with the processing feeding of the workpiece W in the +X direction (backward direction) are performed as one set.

Note that in the second modified layer forming step, the laser beam LB2 may be applied to the workpiece W from the back surface Wb side in a plurality of passes, while the focal point position is deviated to the upper side by a predetermined spacing at a time in the forward and backward directions in regard of the same one row of division line S, whereby a second modified layer M2 at a second stage, a second modified layer M2 at a third stage and the like may be further formed on the upper side of the previously formed second modified layer M2 (referred

to as the second modified layer M2 at a first stage). In this case, the cracks Mb extending to the upper side of the second modified layers M2 at the first stage and the cracks Ma extending to the lower side of the second modified layers M2 at the second stage are in continuity with each other.

For example, after the first modified layer forming step and the second modified layer forming step are conducted as one set for one row of division line S, the holding table 30 depicted in FIGS. 1 and 5 is put to indexing feeding in the Y-axis direction, and the division line S located adjacent to the division line S formed with the first modified layers M1 and the second modified layers M2 and the laser head 62 are aligned with each other in the Y-axis direction. After the alignment is performed, the first modified layer forming step and the second modified layer forming step are conducted as one set for the new one row of division line S, whereby the first modified layers M1 and the second modified layers M2 are formed. Subsequently, the first modified layer forming step and the second modified layer forming step are sequentially and similarly conducted as one set for each division line S, whereby the first modified layers M1 and the second modified layers M2 are formed

along all the division lines S extending in the X-axis direction.

Further, after the holding table 30 is rotated by 90 degrees, the application of the laser beam similar to the above is applied to the workpiece W, whereby the first modified layers M1 and the second modified layers M2 can be formed inside the workpiece W along all the division lines S in the crossing directions.

Note that a configuration may be adopted in which, for example, the first modified layer forming step is conducted along all the division lines S in the crossing directions to form the first modified layers M1 in the crossing directions inside the workpiece W, and thereafter the second modified layer forming step is performed along all the division lines S in the crossing directions to form the second modified layers M2 in the crossing directions inside the workpiece W.

(3) Back Surface Grinding Step

Next, the workpiece W formed with the first modified layers M1 and the second modified layers M2 is carried, for example, to a grinding apparatus 2 depicted in FIG. 6. The grinding apparatus 2 illustrated in FIG. 6 is an apparatus for grinding the workpiece W held on a holding table 20 by grinding means 21.

The holding table 20 for holding the workpiece W has a holding surface 200 that is circular in outer shape, includes a porous member or the like, and suction holds the workpiece W. A suction source (not illustrated) is communicating with the holding surface 200. The holding table 20 is rotatable around an axis in the vertical direction (Z-axis direction) by rotating means 23 connected to the bottom surface side thereof, and is reciprocally movable in the X-axis direction.

The grinding means 21 includes a spindle 210 whose axial direction is in the Z-axis direction, a motor (not illustrated) for rotationally driving the spindle 210, a mount 211 connected to a lower end side of the spindle 210, and a grinding wheel 212 detachably attached to a lower surface of the mount 211.

The grinding wheel 212 includes a circular annular wheel base 212b, and a plurality of substantially rectangular parallelepiped grindstones 212a arranged in an annular pattern on a lower surface of the wheel base 212b. The grindstones 212a are formed, for example, by binding diamond abrasive grains or the like with an appropriate binder.

For example, a flow path (not illustrated) that communicates with a grinding water supply source and

serves as a passage of grinding water is formed inside the spindle 210 in the state of penetrating the spindle 210 in the axial direction, and the flow path is opening in a bottom surface of the grinding wheel 212 in such a manner that the grinding water can be jetted toward the grindstones 212a.

First, the workpiece W is mounted on the holding surface 200 with the back surface Wb side faced up, in such a manner that the center of the holding table 20 and the center of the workpiece W coincide substantially with each other. Then, a suction force generated by a suction source (not illustrated) is transmitted to the holding surface 200, whereby the holding table 20 suction holds the workpiece W.

Next, the holding table 20 holding the workpiece W thereon is moved in the -X direction to a position beneath the grinding means 21, and alignment between the grinding wheel 212 possessed by the grinding means 21 and the workpiece W is performed. The alignment is conducted, for example, in such a manner that the rotational center of the grinding wheel 212 is deviated from the rotational center of the workpiece W by a predetermined distance in a horizontal direction and that the rotational trajectory of the grindstones 212a passes through the rotational

center of the workpiece W, as depicted in FIGS. 6 and 7.

After the alignment between the grinding wheel 212 and the workpiece W is performed, the spindle 210 is rotationally driven and, attendantly, the grinding wheel 212 is rotated. In addition, the grinding means 21 is fed in the -Z direction, and the grindstones 212a of the grinding wheel 212 being rotated come into contact with the back surface Wb of the workpiece W, whereby grinding is conducted. During the grinding, the holding table 20 is rotated and, attendantly, the workpiece W held on the holding surface 200 is also rotated, so that the grindstones 212a perform grinding of the whole surface of the back surface Wb of the workpiece W. During the grinding, the grinding water is supplied to the contact site of the grindstones 212a and the workpiece W, to clean and cool the contact site.

Note that a configuration may be adopted in which a grinding water nozzle (not illustrated) is disposed such as to face inside surfaces of the grindstones 212a protruding relative to the workpiece W, and the grinding water jetted from the grinding water nozzle is supplied from the inside surface side of the grinding wheel 212 being rotated to the contact site of the grindstones 212a and the workpiece W.

During the grinding, a grinding pressure in the -Z direction is exerted from the grindstones 212a onto the workpiece W. Then, as the back surface Wb is ground, a grinding stress corresponding to the grinding pressure is generated along the second modified layer M2 depicted in FIG. 8, and the workpiece W is divided into individual chips, with the second modified layers M2 accompanied by the cracks Mb and Ma as start points. Specifically, the cracks Mb and Ma extend respectively toward the back surface Wb and the front surface Wa of the workpiece W, to become a dividing groove (gap) Md. Then, the dividing grooves Md reach the front surface Wa at a stroke while passing through the first modified layers M1, so that the workpiece W is divided into individual chips C.

Here, the first modified layer M1 is formed with a narrow width dividing groove Me smaller in groove width than the dividing groove Md formed in that portion of the workpiece W in which the first modified layer M1 is not formed. This is considered to be because the first modified layer M1 is made to be amorphous and is in a state in which atoms and molecules are present irregularly. In addition, the first modified layer M1 is formed such that its lower end is located slightly on the back surface Wb side as compared to the height position

Z1 corresponding to the finished thickness H1 of the chips C, and, therefore, even in the case where grinding water containing grinding swarf enters into the dividing groove (gap) Md, the grinding water is not liable to enter into the narrow width dividing groove Me.

Accordingly, the first modified layer M1 plays the role of preventing penetration of the grinding swarf after division into the chips, and adhesion of the grinding swarf onto side surfaces Cd of the chips C is restrained.

When the grinding progresses further, the second modified layer M2 is removed from the workpiece W by the grinding, and the workpiece W approaches the finished thickness H1, but the first modified layer M1 still remains, so that adhesion of grinding swarf onto the chip side surfaces Cd is restrained. Further, when the first modified layer M1 is removed by the workpiece W by the grinding and the workpiece W reaches the finished thickness H1, the grinding means 21 is raised in the +Z direction, the grindstones 212a are separated from the workpiece W, and, further, the supply of grinding water is stopped and the grinding is finished. The first modified layers M1 and the second modified layers M2 have been removed by the grinding of the workpiece W until the workpiece W reaches the finished thickness H1, and,

therefore, a lowering in strength of the chips C due to remaining of the modified layers is not generated.

Note that the workpiece processing method according to the present invention is not limited to the above-described example. In addition, the components of the laser processing apparatus 1 and the grinding apparatus 2 depicted in the attached drawings are also not limited to those illustrated, and appropriate modifications are possible within such ranges that the effect of the present invention can be produced.

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 workpiece processing method of dividing a workpiece having a functional element formed in each of regions partitioned by a plurality of division lines formed in a grid pattern on a front surface, along the division lines into individual chips, the workpiece processing method comprising:

a first modified layer forming step of applying a laser beam of such a wavelength as to be transmitted through the workpiece to the workpiece from a back surface side of the workpiece along the division lines, to form first modified layers which are not cracked vertically and lower ends of which are located slightly on the back surface side as compared to a height position corresponding to a finished thickness of the chips;

a second modified layer forming step of applying a laser beam of such a wavelength as to be transmitted through the workpiece to the workpiece from the back surface side of the workpiece along the division lines, to form second modified layers which are cracked vertically on the back surface side of the first modified layers formed in the first modified layer forming step; and

a back surface grinding step of grinding the back

surface of the workpiece formed with the first modified layers and the second modified layers, to form the workpiece to the finished thickness of the chips and to divide the workpiece into the individual chips, with the cracked second modified layers as start points,

wherein in the back surface grinding step, the first modified layers remain until just before completion of the back surface grinding, such that grinding water containing grinding swarf can be prevented from penetrating into gaps between the chips.

2. The workpiece processing method according to claim 1, wherein in the back surface grinding step, the workpiece is ruptured, by a grinding stress generated in the workpiece, at the second modified layers formed to be cracked vertically in the second modified layer forming step.