Trial decision

Invalidation No. 2019-800016

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The case of trial regarding the invalidation of Japanese Patent No. 3408805, entitled "Object to be Processed Cutting Method" between the parties above has resulted in the following trial decision:

Conclusion

The trial of the case was groundless.

The costs in connection with the trial shall be borne by the Demandant.

Reason

No. 1 History of the procedures

1. The application of the inventions according to Claims 1 to 37 of the patent of the case, Japanese Patent No. 3408805, is an application claiming priority filed on September 13, 2001 (Priority date, September 13, 2001), and the establishment of the patent right of the inventions was registered on March 14, 2003.

2. Oppositions to the granted patent were filed on November 14, 2003 by the Opponent Masaru KORESAWA, and on November 19, 2003 by the Opponent Keiji SHINDO, respectively. The decision on opposition "The correction shall be approved. The patent according to Claims 1 to 37 of Japanese Patent No. 3408805 is maintained" was made, and the registration of decision was established on March 22. 2005.

3. A demand for invalidation trial requesting the trial decision "The patent for the inventions according to Claims 1 to 6, and 11 to 37 of Japanese Patent No. 3408805 shall be invalidated. The costs in connection with the trial shall be borne by the Demandee." was filed by the Demandant Eiki SHIRASAWA, on May 31, 2005, a correction request was made on August 15, 2005, the trial decision of "The correction shall be approved. The trial of the case was groundless. The costs in connection with the trial shall be borne by the Demandant" was made on March 3, 2006, and the binding of the trial decision was registered on November 9, 2006 (the number of claims: 31).

4. A demand for invalidation trial requesting the trial decision "The patent for the inventions according to Claims 1 to 31 of Japanese Patent No. 3408805 shall be invalidated. The costs in connection with the trial shall be borne by the Demandee." was filed by the Demandant TOKYO SEIMITSU CO., LTD., on February 25, 2019.

5. The Demandee Hamamatsu Photonics K.K. submitted a written reply on May 10, 2019, a notification of matters to be examined was given on June 20, 2019, and the Demandee Hamamatsu Photonics K.K. submitted an oral proceedings statement brief on August 8, 2019. The Demandant TOKYO SEIMITSU CO., LTD. submitted an oral

proceedings statement brief on August 9, 2019, a notification of matters to be examined was given on September 3, 2019, the Demandee Hamamatsu Photonics K.K. submitted an oral proceedings statement brief (Part 2) and TOKYO SEIMITSU CO., LTD. submitted an oral proceedings statement brief (2) on September 9, 2019, and simultaneously the first oral proceeding was held, the Demandee Hamamatsu Photonics K.K. submitted a written statement on September 27, 2019, and the Demandant TOKYO SEIMITSU CO., LTD. submitted a written statement on October 11, 2019.

No. 2. The Invention

(1) It is recognized that the inventions according to Claims 1 to 31 (hereinafter, respectively referred to as "Invention 1" etc.) that are subjects of the demand for invalidation trial are as follows, as specified by the matters described in Claims 1 to 31 of the scope of claims.

"[Claim 1] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; forming a modified region caused by multiphoton absorption within the object to be processed; forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 2] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region including a crack region within the object to be processed; forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 3] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region including a molten processed region within the object to be processed; forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 4] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 ns or less; forming a modified region including a refractive index change region which is a region with a changed refractive index within the object to be processed; forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 5] The object to be processed cutting method according to any one of Claims 1 to 4, wherein the laser light emitted from a laser light source includes pulse laser light.

[Claim 6] The object to be processed cutting method according to any one of Claims 1 to 5, wherein the radiation of laser light with a light-converging point set within the object to be processed is performed by converging laser light emitted from one laser light source and radiating the converged laser light with a light-converging point set within the object to be processed.

[Claim 7] The object to be processed cutting method according to any one of Claims 1 to 5, wherein the radiation of laser light with a light-converging point set within the object to be processed is performed by radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof.

[Claim 8] The object to be processed cutting method according to Claim 7, wherein each laser light emitted from the plurality of laser light sources is incident from a surface of the object to be processed.

[Claim 9] The object to be processed cutting method according to Claim 7, wherein the plurality of laser light sources include a laser light source emitting laser light incident from a surface of the object to be processed, and a laser light source emitting laser light incident from a back surface of the object to be processed.

[Claim 10] The object to be processed cutting method according to any one of Claims 7 to 9, wherein the plurality of laser light sources include light sources arranged in array along the line to cut.

[Claim 11] The object to be processed cutting method according to any one of Claims 1 to 10, wherein the modified region is formed by relatively moving the object to be processed with respect to the light-converging point set within the object to be processed.

[Claim 12] The object to be processed cutting method according to any one of Claims 1 to 11, wherein the object to be processed is a material having transmittance of radiated laser light.

[Claim 13] The object to be processed cutting method according to any one of Claims 1 to 12, wherein an electronic device or an electrode pattern is formed on a surface of the object to be processed.

[Claim 14] The object to be processed cutting method according to any one of Claims 1 to 13, wherein the object to be processed is cut along the line to cut, by applying force to the object to be processed to generate cracks in a thickness direction of the object to be processed from the region that is a starting point of cutting.

[Claim 15] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region within the object to be processed; forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 16] The object to be processed cutting method according to any one of Claims 1 to 15, wherein the object to be processed is formed with a plurality of circuit portions on a surface thereof, and a light-converging point of laser light is set within the object to be processed facing a space formed between circuit portions adjacent to each other among the plurality of circuit portions.

[Claim 17] The object to be processed cutting method according to Claim 16, wherein laser light is converged at an angle at which the plurality of the circuits are not irradiated with the laser lights.

[Claim 18] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; forming a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure, within the object to be processed; forming a region that is a starting point of cutting, constituted by the molten processed region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region.

[Claim 19] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; forming a modified region caused by multiphoton absorption, in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed; and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region.

[Claim 20] The object to be processed cutting method according to Claim 19, wherein the modified region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 21] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region including a crack region in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed; and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region.

[Claim 22] The object to be processed cutting method according to Claim 21, wherein the modified region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 23] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region including a molten processed region in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed, and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region.

[Claim 24] The object to be processed cutting method according to Claim 23, wherein the modified region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 25] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 ns or less; forming a modified region including a refractive index change region which is a region with a changed refractive index in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed; and cutting the object to be processed by generating cracks in a thickness direction of the object, starting from the modified region.

[Claim 26] The object to be processed cutting method according to Claim 25, wherein the modified region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 27] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed under a condition with a peak power density of 1×10^8 (W/cm^2) or more at the light-converging point and a pulse width 1 μs or less; forming a modified region in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed; and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region.

[Claim 28] The object to be processed cutting method according to Claim 27, wherein the modified region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 29] An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; forming a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure, in a direction along a laser light incident surface of the object to be processed within the object to be processed along a line to cut of the object to be processed; and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region.

[Claim 30] The object to be processed cutting method according to Claim 29, wherein the molten processed region is formed on the inner side from the laser light incident surface by a predetermined distance.

[Claim 31] The object to be processed cutting method according to Claim 18, wherein the object to be processed is cut along the line to cut, by applying force to the object to be processed to generate cracks in a thickness direction of the object to be processed from the region that is a starting point of cutting".

(2) Regarding multiphoton absorption

The Demandant alleges in the oral proceeding on September 9, 2019 that the definition of multiphoton absorption of the Invention should be clarified. However, in Paragraph [0027] of the specification of the Patent, it is described that "It becomes optically transparent when the energy hν of a photon is lower than the band gap E_G of absorption of the material. Therefore, the condition under which absorption occurs in the material is $h\nu > E_G$. However, even if it is optically transparent, when the intensity of the laser light is very high, adsorption occurs in the material under the condition of $nh\nu > E_G$: ($n = 2, 3, 4, ...$). This phenomenon is called multiphoton absorption," and the multiphoton absorption of the Invention is clearly defined, so that multiphoton absorption was certified based on the above definition.

No. 3 Reason for invalidation alleged by the Demandant

The Demandant, as means of proof, submitted Evidence A No. 1 to Evidence A No. 7 along with the written demand for trial, submitted Evidence A No. 8 to Evidence A No. 17 along with the oral proceedings statement brief, submitted Evidence A No. 18 along with the oral proceedings statement brief (Part 2), submitted Evidence A No. 19 along with the written statement, and alleges that the patent according to Claims 1 to 31 of the case should be invalidated for the following reasons.

1. Reason for Invalidation 1 (violation of inventive step)

The inventions according to Claims 1 to 31 of the Patent can be easily conceived by a person skilled in the art by combining the inventions described in Evidence A No. 4, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3 with the invention described in Evidence A No. 1, and thus do not have inventive step.

2. Reason for Invalidation 2 (violation of inventive step)

The inventions according to Claims 1 to 31 of the Patent can be easily conceived by a person skilled in the art by combining the inventions described in Evidence A No. 1, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3 with the invention described in Evidence A No. 4, and thus do not have inventive step.

3. Reason for Invalidation 3 (violation of inventive step)

The inventions according to Claims 1 to 31 of the Patent can be easily conceived by a person skilled in the art by combining the inventions described in Evidence A No. 1, Evidence A No. 6, Evidence A No. 3, and Evidence A No. 4 with the invention described in Evidence A No. 2, and thus do not have inventive step.

4. Reason for Invalidation 4 (violation of inventive step)

The inventions according to Claims 1 to 31 of the Patent can be easily conceived by a person skilled in the art by combining the inventions described in Evidence A No. 1, Evidence A No. 3, Evidence A No. 6, and Evidence A No. 4 with the invention described in Evidence A No. 5, and thus do not have inventive step.

5. Reason for Invalidation 5 (violation of novelty and inventive step)

(1) Violation of novelty

The inventions according to Claims 15, 27, and 28 of the Patent are identical with the invention described in Evidence A No. 7, and thus do not have novelty.

(2) Violation of inventive step

The inventions according to Claims 1 to 31 of the Patent can be easily conceived by a person skilled in the art by combining the inventions described in Evidence A No. 1, Evidence A No. 6, Evidence A No. 3, and Evidence A No. 4 with the invention described in Evidence A No. 7, and thus do not have inventive step.

[Means of proof]

Evidence A No. 1 Japanese Unexamined Patent Application Publication No. H04-111800

Evidence A No. 2 Japanese Unexamined Patent Application Publication No. H11-71124

Evidence A No. 3 Japanese Unexamined Patent Application Publication No. H11-

267861

Evidence A No. 4 Japanese Unexamined Patent Application Publication No. H11-163403

Evidence A No. 5 Japanese Unexamined Patent Application Publication No. H11-138896

Evidence A No. 6 Japanese Unexamined Patent Application Publication No. S53-148097

Evidence A No. 7 International Publication No. 00/32349

Evidence A No. 8 Copy of YUASA and HARA Law and Patent Office, Lawyer Toshiaki IIMURA, "The written opinion about the trial decision of Invalidation No. 2005-80166," June 10, 2019

Evidence A No. 9 Copy of "New Commentary on Patent Act [2nd edition] [Volume 2], edited by Nobuhiro NAKAYAMA and Naoki KOIZUMI, Seirin Shoin, October 5, 2017, Chapter 6 Trial Article 167 (the effect of the trial decision), Pages 2820 to 2823

Evidence A No. 10 Japanese Unexamined Patent Application Publication No. S50-131458

Evidence A No. 11 Japanese Unexamined Patent Application Publication No. S50-64898

Evidence A No. 12 Copy of the written trial decision of Appeal decision No. 2009-17417 (Japanese Patent Application No. 2003-067264)

Evidence A No. 13 Japanese Unexamined Patent Application Publication No. H04-110944

Evidence A No. 14 Japanese Unexamined Patent Application Publication No. 2003-338468

Evidence A No. 15 Japanese Patent No. 4703983

Evidence A No. 16 Japanese Unexamined Patent Application Publication No. 2002-205180

Evidence A No. 17 Copy of the written demand for appeal of Appeal No. 2011-3045 (Japanese Patent Application No. 2004-212059)

Evidence A No. 18 Copy of "sapphire processing" (internal materials), TOKYO SEIMITSU CO., LTD. (the Demandant), August 27, 2019, Pages 1 to 6

Evidence A No. 19 Copy of the written trial decision of Invalidation No. 2005-80166 (Japanese Patent No. 3408805)

No. 4 Summary of the Demandee's allegation

Against this, the Demandee, as means of proof, attached Evidence B No. 1 to Evidence B No. 3 to the written reply, submitted Evidence B No. 4 to Evidence B No. 7 along with the oral proceedings statement brief, and alleges that none of the inventions of the case could have been easily invented by a person skilled in the art based on the inventions described in Evidence A No. 1 to Evidence A No. 7, for the following reasons.

1. Regarding Reason for Invalidation 1 (violation of inventive step)

Evidence A No. 1 does not describe the matter that an object to be processed is a wafer-shaped object to be processed made of a semiconductor material and the matter that laser light is radiated to form a region that is a starting point of cutting within the object to be processed and to generate cracks in a thickness direction of the object to be processed, starting from the region. Since the former matter is not a design matter, and the latter matter is not described in Evidence A No. 4, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3, the inventions according to Claims 1 to 31 could not have been easily invented by a person skilled in the art, based on the inventions described in Evidence A No. 1, Evidence A No. 4, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3.

2. Regarding Reason for Invalidation 2 (violation of inventive step)

Evidence A No. 4 does not describe the matter that an object to be processed is a wafer-shaped object to be processed made of a semiconductor material and the matter that laser light is radiated to form a region that is a starting point of cutting within the object to be processed and to generate cracks in a thickness direction of the object to be processed, starting from the region. Since neither matter can be easily conceived in Evidence A No. 4, and neither matter is described in Evidence A No. 1, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3, the inventions according to Claims 1 to 31 could not have been easily invented by a person skilled in the art, based on the inventions described in Evidence A No. 4, Evidence A No. 1, Evidence A No. 7, Evidence A No. 6, and Evidence A No. 3.

3 Regarding Reason for Invalidation 3 (violation of inventive step)

Reason for Invalidation 3 violates the provisions of Article 167 of the Patent Act before the revision in 2011.

Evidence A No. 2 does not describe the matter that a wafer-shaped object to be processed made of a semiconductor material such as silicon is cut. Since the matter is not a design matter, and is not described in Evidence A No. 1, Evidence A No. 6, Evidence

A No. 3, and Evidence A No. 4, the inventions according to Claims 1 to 31 could not have been easily invented by a person skilled in the art, based on the inventions described in Evidence A No. 2, Evidence A No. 1, Evidence A No. 6, Evidence A No. 3, and Evidence A No. 4.

4. Regarding Reason for Invalidation 4 (violation of inventive step)

Evidence A No. 5 does not describe the matter that laser light is radiated to form a region that is a starting point of cutting within the object to be processed and to generate cracks in a thickness direction of the object to be processed, starting from the region and the matter of an object to be processed cutting method. Further, concerning the former matter, there is an inhibiting factor in generating cracks in the invention of a marking method of Evidence A No. 5, and concerning the latter matter, changing the invention of a marking method to a cutting method is not a design change. Therefore, the inventions according to Claims 1 to 31 could not have been easily invented by a person skilled in the art, based on the inventions described in Evidence A No. 5, Evidence A No. 1, Evidence A No. 3, Evidence A No. 6, and Evidence A No. 4.

5 Regarding Reason for Invalidation 5 (violation of novelty and inventive step)

(1) Regarding violation of novelty

Evidence A No. 7 does not describe the matter that an object to be processed is a wafer-shaped object to be processed made of a semiconductor material and the matter that laser light is radiated to form a region that is a starting point of cutting within the object to be processed and to generate cracks in a thickness direction of the object to be processed, starting from the region, and the inventions according to Claims 15, 27, and 28 are not identical with the invention described in Evidence A No. 7.

(2) Regarding violation of inventive step

Evidence A No. 7 does not describe the matter that an object to be processed is a wafer-shaped object to be processed made of a semiconductor material and the matter that laser light is radiated to form a region that is a starting point of cutting within the object to be processed and to generate cracks in a thickness direction of the object to be processed, starting from the region. Concerning the former matter, there is an inhibiting factor in that the object to be processed is a semiconductor material in Evidence A No. 7, and the latter matter cannot be easily conceived in Evidence A No. 7 and is not described in Evidence A No. 1, Evidence A No. 6, Evidence A No. 3, and Evidence A No. 4. Therefore, the inventions according to Claims 1 to 31 could not have been easily invented by a person skilled in the art, based on the inventions described in Evidence A No. 7, Evidence A No. 1, Evidence A No. 6, Evidence A No. 3, and Evidence A No. 4.

[Means of proof]

Evidence B No. 1-1 "Electronic Materials," September 2002 issue, the table of contents, Pages 17 to 21

Evidence B No. 1-2 "Electronic Materials," September 2002 issue, Page 23

Evidence B No. 1-3 "Laser Society of Japan Industrial Prize for 'an excellent work' award"

Evidence B No. 1-4 "Hamamatsu Photonics: Cut processing system by internal condensing of permeability pulse laser"

Evidence B No. 1-5 "Details of business results of the winner of machine promotion prize"

Evidence B No. 1-6 "Laser-processing technology The top 3 in comprehensive patent ranking power are Hamamatsu Photonics, DISCO, and MITSUBISHI ELECTRIC," [online], patent result, the internet <URL: https://www.patentresult.co.jp/news/2018/07/laserprotech.html>

Evidence B No. 2 Shinji KAMIYAMA, "description of a cutting mechanism of a semiconductor wafer and glass," Hamamatsu Photonics, December 27, 2005

Evidence B No. 3 "Laser A to Z," [online], the website of Japan Laser Processing Society, the internet <URL: http://www.jlps.gr.jp/laser/atoz/2/>

Evidence B No. 4 "What is 'scribe' using a diamond scribe tool," [online], TECDIA technology improving blog, the internet <URL: https://tecdlab.com/2018/05/09/dictionary-%E3%83%80%E3%82%A4%E3%83%A4%E3%83%A2%E3%83%B3%E3%83%89%E3%83%BB%E3%82%B9%E3%82%AF%E3%83%A9%E3%82%A4%E3%83%96%E3%83%84%E3%83%BC%E3%83%AB%E3%82%92%E5%88%A9%E7%94%A8%E3%81%97%E3%81%9F%E3%80%8C/>

Evidence B No. 5 Japanese Unexamined Patent Application Publication No. H08-274371

Evidence B No. 6 Japanese Unexamined Patent Application Publication No. H10-64854

Evidence B No. 7 Naoko TOMEI, "Development of ceramics cutting scribing wheel and a cutting technology thereof," Journal of the Japan Society for Abrasive Technology, December 2015, Vol. 59, No. 12, Pages 705 to 710

No. 5 Descriptions of Evidence A No. 1 to Evidence A No. 7

(1) Matters described in Evidence A No. 1

Evidence A No. 1, distributed on April 13, 1992 before the priority date of the present application, describes the following matters with drawings. Further, the underlines are given by the body for the convenience of understanding.

A. "A high energy beam that is not absorbed by the transparent material is focused on the inside of the transparent material via an optical system composed of a lens and a mirror, and the high energy beam is radiated to the inside of the transparent material. Then, a minute crack of several tens of microns or less is generated at the place where the high energy beam is radiated. The transparent material is cut by moving the radiation position of the high energy beam to generate a continuous crack in the transparent material.
The generation of the cracks will be described in more detail.
In a solid, the energy level of valence electrons has a strip-shaped, so-called band structure. Insulators do not absorb photons with photon energies below the bandgap; that is, long wavelength light.
However, even with light with energy lower than the bandgap, if the photon density is extremely high, such as by focusing with a lens, electrons are excited from a fill band (the energy band with lower energy than the energy gap) to a conduction band (the energy band with higher energy than the energy gap and no electrons in the normal state) by absorbing two or more photons at the same time.
Absorption of two photons at the same time in this way is called two-photon absorption, and more generally, absorption of a plurality of photons is called multiphoton absorption. In the present invention, multiphoton absorption is used to break the uniting bond of the transparent material by allowing the transparent material to absorb light having a wavelength with energy lower than that of the band gap and in which absorption does not originally occur, or heat generated is used to generate minute cracks inside the transparent material". (Page 2, upper right column, line 17 to lower right column, line 7)

B. "Example 1
A synthetic quartz glass (containing 1300 ppm OH) of 150×150×150 mm is used as a transparent material, excimer laser (KrF 248 nm energy density 50 m J/cm^2•pulse, repeat frequency 150 Hz) is used as a high energy beam, is focused with a lens with a focal distance of 500 mm, and is reflected by a mirror. By focusing an excimer laser beam on the inside of a thick synthetic quartz glass that is a workpiece whose upper surface is pre-polished, radiating the excimer laser from the top surface of the workpiece, and pulling the focal position from the bottom surface of the workpiece at a speed of 3 mm/min while rotating the workpiece at a rotation speeds of 3 rpm, a cylindrical shaped hole with a

diameter of 30 mm was bored.
At this time, the vertical focal position of the excimer laser beam inside the workpiece was changed by moving the position of the lens.
Further, the horizontal movement of the focal position inside the workpiece was performed by moving the workpiece itself in the horizontal direction.
In cutting, the focal position was moved upward from the bottom surface of the workpiece.
[Effect]
As described above, when focusing on the inside of the transparent material and irradiating the transparent material with a high energy beam that is not absorbed, for example, irradiating quartz glass with an excimer laser, minute cracks are generated inside the transparent material. By making this continuous, the transparent material can be cut into a complicated shape.
Since the focus is on the inside of the workpiece, this does not affect the thickness of the workpiece and the workpiece can be processed into any shape". (Page 3, upper left column, line 11 to lower left column, line 4)

C. According to the description "excimer laser (KrF 248 nm energy density 50 m J/cm^2•pulse, repeat frequency 150 Hz) is used as a high energy beam" of B. above, and the description "is reflected by a mirror. By focusing an excimer laser beam on the inside of a thick synthetic quartz glass that is a workpiece whose upper surface is pre-polished, radiating the excimer laser from the top surface of the workpiece" of B. above, it is described in Evidence A No. 1 that "while focusing on the inside of a thick synthetic quartz glass, an excimer laser beam formed by repeating an excimer laser pulse with high energy density is radiated".

D. According to the description "In the present invention, multiphoton absorption is used to break the uniting bond of the transparent material by allowing the transparent material to absorb light having a wavelength with energy lower than that of the band gap and in which absorption does not originally occur, or heat generated is used to generate minute cracks inside the transparent material" of A. above, the description "By focusing an excimer laser beam on the inside of a thick synthetic quartz glass that is a workpiece" of B. above, and the description "when irradiating quartz glass with an excimer laser, minute cracks are generated inside the transparent material" of B. above, it is described in Evidence A No. 1 that "minute cracks due to multiphoton absorption are formed inside quartz glass".

E. According to the description "By focusing an excimer laser beam on the inside of a thick synthetic quartz glass that is a workpiece whose upper surface is pre-polished, radiating the excimer laser from the top surface of the workpiece, and pulling the focal position from the bottom surface of the workpiece at a speed of 3 mm/min while rotating the workpiece at a rotation speed of 3 rpm, a cylindrical shaped hole with a diameter of 30 mm was bored" of B. above, and the description "when irradiating quartz glass with an excimer laser, minute cracks are generated inside the transparent material. By making this continuous, the transparent material can be cut and processed into a complicated shape" of B. above, Evidence A No. 1 describes "a synthetic quartz glass cutting and processing method comprising the step of moving a focal position upward from a bottom surface of synthetic quartz glass while moving a workpiece within a horizontal surface along a line to cut to make minute cracks continue inside the synthetic quartz glass and to cut and process the synthetic quartz glass into a complicated shape".

F. Although in Evidence A No. 1, various transparent materials such as quartz glass are used as objects to be processed, specifically in the example, only synthetic quartz glass is actually cut into a complicated cylindrical shape, and there is no disclosure about processing conditions for other objects. Therefore, it is recognized that only synthetic quartz glass is disclosed as the object to be processed.

G. Accordingly, it is recognized that Evidence A No. 1 describes the following invention (hereinafter, referred to as "Invention A-1").
"A synthetic quartz glass cutting and processing method comprising steps of:

radiating an excimer laser beam formed by repetition of excimer laser pulse with high energy density while focusing on the inside of a thick synthetic quartz glass;

forming minute cracks due to multiphoton absorption inside the synthetic quartz glass; and

moving a focal position upward from a bottom surface of the synthetic quartz glass while moving a workpiece within a horizontal surface along a line to cut to make minute cracks continue inside the synthetic quartz glass and to cut and process the synthetic quartz glass into a complicated shape".

(2) Matters described in Evidence A No. 2

Evidence A No. 2, distributed on March 16, 1999 before the priority date of the present application, describes the following matters with drawings. Further, the underlines are given by the body for the convenience of understanding.

A. "[0001]
[Field of the Invention] The present invention relates to a method of forming (producing) a desired breaking point for breaking the glass wall of a glass body, in particular a break-open ampule or a tube, or for separating a glass pane by generating microcracks in the breaking zone".

B. "[0013]
[Problem to be Solved by the Invention]

The object of the invention is to form a predetermined breaking point in the breaking zone of the break-open ampule in such a manner as to allow reproducible and safe opening of the break-open ampule. In particular, it is intended to avoid injuries which can occur when opening ampules which are difficult to break open and to preclude impairment to the medicament caused by opening the ampule.
[0014]
[Means for Solving the Problem] The object of the invention, in a method of forming a desired breaking point for breaking the glass wall of a glass body, in particular a break-open ampule or a tube, or for separating a glass pane by generating microcracks in the breaking zone, is achieved by a method of forming a breaking point in which the microcracks are formed inside the glass wall or the glass pane".

C. "[0021]
[Embodiments of the Invention] According to the present invention, the desired breaking point is produced by forming microcracks in a controlled manner in the inside of the glass wall of the ampule. In contrast to the prior art discussed at the outset, in which in each case, the glass wall is weakened by microcracks from its surface, the surfaces of a workpiece in question remain undamaged when using the method according to the invention".

D. "[0028] Advantageously, the microcracks according to the invention are generated by means of concentrated laser irradiation; in the case of ampules, as is known from the prior art, this takes place in the region of the ampule neck. It has proven advantageous here to focus the laser beam with a diameter less than 100 μm. In order to implement this, it is clear that it is necessary to use laser radiation with wavelengths to which the glass is transparent or at least translucent. Appropriate selection of laser parameters will allow a person skilled in the art to adjust the formation and promotion of microcrack lengths, geometric arrangements, etc. in a controlled manner. Finding proper parameters to implement this does not require inventive step; these can be easily decided by a person skilled in the art, based on, for example, appropriate normal experiments. As is clear from the above, it is easy to adopt process parameters for various geometries of glass objects (e.g. ampules). Microcracks can be formed using a single laser pulse or a series of laser pulses with a repetition frequency of about 10 to 1000 Hz".

E. "[0032] 1) The desired breaking point may, for example, be generated at a point on the circumference of the constriction of the ampule by means of one or more microcrack zones arranged in the circumferential direction along the desired parting line. This process (one point cut) requires marking of the desired breaking point in order to align or adjust the ampule when it is broken open".

F. "[0035] Advantageously, the laser radiation source employed is a Q-switched or mode-locked Nd solid-state laser. A suitable optical system with a short focal length focuses the laser beam, which if necessary has a widened beam cross-section, to a spot diameter less than 0.1 mm. With a large curved surface, it is necessary to provide a beam with an additional shape by, for example, a columnar or refracting optical system (prior art). Using a non-Gaussian laser beam profile, it is possible to achieve additional orientation of microcracks in the breaking direction. Although, due to the short laser pulse time, if necessary, a desired breaking point can be applied during ampule transport, this requires a lot of expense to maintain the focal position of the wall more accurately than 0.1 mm. Process control may be implemented, for example, by photoelectron observation of plasma formation and readjustment of laser parameters".

G. "[0038]
[Examples] An exemplary embodiment of the invention is illustrated in the drawing and described in more detail below.
[0039] FIG. 1 shows a diagrammatic layout of a station for generating a desired breaking point in a break-open ampule in accordance with the invention.
[0040] In FIG. 1, a desired breaking point is generated in a 2-ml ampule 1 made of borosilicate glass in the region of the ampule neck 2 (constriction).
[0041] The constriction was formed previously in the production process of the ampule on a turret machine with a secondary forming tool to a diameter of about 6.5 mm and a wall thickness of about 0.8 mm. The desired breaking point is applied in the further processing line illustrated diagrammatically in FIG. 1, where the ampule 1 is lifted out of

the chain conveyor and against a stop roller 4 using a lifting device 3. The ampule 1 is mounted on the rollers (roller tables) 5 and 6 in such a manner that the roller 6 tracks the secondary forming tool.
[0042] A Q-switched Nd:YAG laser 7 with a pulse duration of approx. 10 ns and a pulse energy of 25 ml is used to generate the desired breaking point. The laser beam is focused onto the center of the glass wall using a laser lens 8 with a focal length of 50 mm: it has a diameter of about 0.1 mm. In order to ensure that the desired breaking point is generated in the center of the glass wall, the diameter of the ampule neck 2 (constriction) may have a tolerance of at most 0.1 mm. With a laser repetition frequency of 10 Hz, three desired breaking points are applied to the ampule neck at a spacing of 1 mm along the circumferential direction. The rotation of the ampules which is required to achieve this is brought about by the drive of the roller 4.
[0043] The three desired breaking points are visible under a microscope and allow the ampule to be broken clearly and mechanically".

H. According to the description "The present invention relates to a method of forming (producing) a desired breaking point for breaking the glass wall of a glass body, in particular a break-open ampule or a tube, or for separating a glass pane by generating microcracks in the breaking zone" in Paragraph [0001] of A. above, and the description "The laser beam is focused onto the center of the glass wall using a laser lens 8 with a focal length of 50 mm" in Paragraph [0042] of G. above, it is described that in Evidence A No. 2 that "laser is radiated while focusing on the inside of a glass body".

I. According to the description "is achieved by a method of forming a breaking point in which the microcracks are formed inside the glass wall or the glass pane" in Paragraph [0014] of B. above, it is described in Evidence A No. 2 that "the microcracks are formed inside the glass body".

J. According to the description "The desired breaking point may, for example, be generated at a point on the circumference of the constriction of the ampule by means of one or more microcrack zones arranged in the circumferential direction along the desired parting line" in Paragraph [0032] of E., above, the description "is achieved by a method of forming a breaking point in which the microcracks are formed inside the glass wall or the glass pane" in Paragraph [0014] of B. above, and the description "The present invention relates to a method of forming (producing) a desired breaking point for breaking the glass wall of a glass body, in particular a break-open ampule or a tube, or for separating a glass pane by generating microcracks in the breaking zone" in Paragraph [0001] of A. above, Evidence A No. 2 describes "a glass body breaking method comprising the step of forming a breaking point in the inside of a glass body along a parting line of the glass body with microcracks to break open the glass body". On the other hand, there is no explicit description about the matter that cracks are generated starting from the breaking point.

K. According to the descriptions of A. to G. above, it is recognized that Evidence A No. 2 describes the following invention (hereinafter, referred to as "Invention A-2").

"A glass body breaking method of radiating laser while focusing on the inside of a glass body; forming microcracks in the inside of the glass body; and forming a breaking point along a parting line of the glass body in the inside of the glass body with the microcracks to break open the glass body".

(3) Matters described in Evidence A No. 3

Evidence A No. 3, distributed on October 5, 1999 before the priority date of the present application, describes the following matters. Further, the underlines are given by the body for the convenience of understanding.

A. "[0001]
[Field of the Invention] The present invention relates to a method for marking a light-transmitting material, and more particularly to a method for marking a light-transmitting material using a laser beam".

B. "[0002]
[Conventional Art] In a conventional marking method using a laser beam, the surface of a material to be marked such as a transparent glass substrate is processed by utilizing an ablation (explosion) phenomenon caused by the laser beam, so that there is a problem in that the surface of the material to be marked is finely cracked and the fragments are mixed in the production process".

C. "[0012] A detailed observation of the phenomenon of focusing laser light to cause dielectric breakdown is as follows. FIG. 10 is an enlarged cross-sectional side view of a main part of the transparent glass substrate 1, in which a crack 5 is generated inside the glass in the vicinity where the laser beam 3 is most focused, and occurrence of a hole-shaped mark pattern 7 in which a crevice 6 propagates in the laser incident direction following the crack 5 is observed. When a lens having a beam diameter of 3 mmφ, an energy of about 400 μJ, and a focal length of f = 100 mm is used, as the size thereof, the width of the crack 5 reaches about 100 μm, and the length of the hole-shaped mark pattern 7 reaches about 500 μm".

D. "[0016]
[Problem to be Solved by the Invention] In view of the above problems, an object of the present invention is to provide a marking method of a light transmissive material suitable for a clean system.
[0017] Another object of the present invention is to provide a method for marking a light-transmitting material so that fragments of the material to be marked are not generated by marking.
[0018] Another object of the present invention is to provide a method for marking a light-transmitting material that does not require post-treatment for cleaning the surface of the light-transmitting material after marking.
[0019] The present invention also provides a marking method for a light-transmitting material capable of precisely adjusting a marking position with a predetermined depth particularly on a thin glass material so that cracks and the like are not generated on the surface thereof".

E. "[0020]
[Means for solving the problem] The present invention focuses on the matter that when marking a light-transmitting material such as a transparent glass substrate with laser light, the laser light is focused not on the surface of the light-transmitting material but on the inside thereof, and the matter that marking is not performed only by the generation of cracks, and focusing laser light with lower radiation energy to mainly cause changes in the optical properties of the light-transmitting material is used for marking. This is a marking method for a light-transmitting material which performs marking of the light-transmitting material with a laser beam. The light-transmitting material is a glass material and selects laser light having transmission with respect to the transmitting material, in which the laser light is focused inside the light-transmitting material at a predetermined depth, and the intensity of the laser light is made to be of a degree of causing the changes in the optical properties of the light-transmitting material, thereby making the marking possible. The changes in the optical properties mean, for example, changes in refractive index or any other optical properties, which can be recognized from the outside by a

predetermined measuring means".

(4) Matters described in Evidence A No. 4

Evidence A No. 4, distributed on June 18, 1999 before the priority date of the present application, describes the following matters with drawings. Further, the underlines are given by the body for the convenience of understanding.

A. "[0001]
[Field of the Invention] The present invention relates to a method for manufacturing a light emitting diode or laser diode capable of emitting light from an ultraviolet region to an orange color, and a group 3-5 semiconductor element capable of being driven even at a high temperature, and particularly relates to a method for manufacturing a nitride semiconductor element formed on a substrate".

B. "[0004] However, it is difficult for a semiconductor element using a nitride semiconductor to form a single crystal, unlike a semiconductor element such as GaAsP, GaP, or InGaAlAs formed on a GaP, GaAlAs, or GaAs semiconductor substrate. In order to obtain a single crystal film of a nitride semiconductor having good crystallinity, it is formed on a sapphire or spinel substrate via a buffer layer by using an MOCVD method, an HDVPE method, or the like. A semiconductor element such as an LED chip must be formed by cutting and separating a nitride semiconductor layer formed on a sapphire substrate or the like to a desired size.
[0005] Nitride semiconductors laminated on sapphire, spinel, etc. have a heteroepitaxial structure. Nitride semiconductors have a large lattice constant irregularity with those of sapphire substrates. In addition, the sapphire substrate has a hexagonal crystal structure and does not have cleavage due to its nature. Furthermore, both sapphire and nitride semiconductors are extremely hard substances with a Mohs hardness of approximately 9.
[0006] Therefore, it has been difficult to cut them with a diamond scriber. Further, when a full cut was made with a dicer, cracks and chipping were likely to occur on the cutting surface, and it was not possible to cut cleanly. In some cases, the nitride semiconductor layer may be partially peeled off from the substrate".

C. "[0009]
[Problem to be Solved by the Invention] However, if a scribe line or the like is formed on only one of the semiconductor wafers, cracks and chipping tend to occur on the other cut surface at the time of separation. Although one surface shape of the separated nitride

semiconductor element can be made uniform, the other surface shape of the nitride semiconductor element tends to vary, and cracks and chipping are likely to occur in the semiconductor wafer. Therefore, there is a problem in that when separating the semiconductor wafers, it is extremely difficult to control how the semiconductor wafers are cracked from the scribe line forming surface side to the semiconductor wafer surface side on which a scribe line is not formed, and to completely align the shapes of the nitride semiconductor elements for cutting".

D. "[0013] Therefore, the present invention further reduces the occurrence of cracks and chipping on the cut surface when the nitride semiconductor wafer is separated into chips. Another object of the present invention is to provide a manufacturing method for forming a nitride semiconductor element separated into a desired shape and size with good yield and with good mass productivity without impairing the crystallinity of a nitride semiconductor.

[0014]

[Means for Solving the Problem] The present invention is a method for manufacturing a nitride semiconductor element (110) that divides a semiconductor wafer (100) in which a nitride semiconductor (102) is formed on a substrate (101) into nitride semiconductor elements (110). In particular, it is a method for manufacturing a nitride semiconductor element in which the semiconductor wafer (100) has first and second main surfaces, including a step of forming a scribe line (103) at a focal point formed at least on the second main surface (121) of a substrate (101) and/or the first main surface (111) of the substrate (101) by radiating laser from the first main surface (111) side and/or the second main surface (121) side via the semiconductor wafer (100), and a step of separating the semiconductor wafer along the scribe line.

[0015] In the method for manufacturing a nitride semiconductor element according to Claim 2 of the present invention, the first main surface (111) is on a nitride semiconductor laminated side on which the nitride semiconductor (102) is formed on only one side of the substrate (101), and the second main surface (121) is on a substrate exposed surface side opposing the first main surface (111) via the semiconductor wafer (100).

[0016] In the method for manufacturing a nitride semiconductor element according to Claim 3 of the present invention, the scribe line is a recess (103) formed on the substrate exposed surface.

[0017] In the method for manufacturing a nitride semiconductor element according to Claim 4 of the present invention, the scribe line is a processed alteration layer (206) formed inside the substrate.

[0018] The method for manufacturing a nitride semiconductor element according to Claim 5 of the present invention includes a step of forming a groove portion (104) generally parallel with the scribe line on the first main surface (111) side and/or the second main surface (121) of the semiconductor wafer (100) irradiated with the laser, by at least one selected from a diamond scriber, a dicer, and a laser machine".

E. "[Embodiments of the Invention] As a result of various experiments, the present inventors found that when manufacturing a nitride semiconductor element, a nitride semiconductor element having excellent mass productivity can be manufactured without damaging semiconductor characteristics by irradiating a specific portion of a semiconductor wafer with a laser from a specific direction, and thereby made the present invention.

[0022] That is, according to the method of the present invention, a scribe line serving as a separation guide for a nitride semiconductor element can be formed at an arbitrary point other than a laser irradiation surface side by passing through a nitride semiconductor wafer without damaging a nitride semiconductor layer. In particular, both sides of the semiconductor wafer can be processed comparatively easily from the same surface side without causing an adverse effect on the nitride semiconductor element. Hereinafter, the producing method of the present invention will be described in detail".

F. "[0024] (Nitride semiconductor wafers 100, 200, 300, 400) The nitride semiconductor wafers 100, 200, 300, 400 are those in which the nitride semiconductor 102 is formed on the substrate 101. Although examples of the substrate 101 of the nitride semiconductor 102 include sapphire, spinel, silicon carbide, zinc oxide, gallium nitride single crystal, and the like, a sapphire substrate, a spinel substrate, and the like are preferably used for forming a nitride semiconductor layer having good mass productivity and good crystallinity. Since the sapphire substrate and the like are not cleavable and are extremely hard, the present invention works particularly effectively. The nitride semiconductor may be formed on one side of the substrate or on both sides".

G. "[0030] It is considered that the nitride semiconductor wafer irradiated with the laser becomes the recesses 103 and 403 in which an irradiating portion to be a focal point of the wafer is selectively blown, or the processed alteration layers 206, 308 which are a set of microscopic micro cracks. Further, based on the total film thickness of the semiconductor wafer that is processed and separated, the first main surface side and the second main surface side refer to any position toward the first main surface or the second

main surface from a half of the total film thickness. Therefore, it may be on the surface or inside of the semiconductor wafer. Further, in the present invention, in addition to laser machining on the first main surface side and/or the second main surface side, the center of the total film thickness of the semiconductor wafer may be laser machined.
[0031] (Laser Processing Machine) The laser processing machine used in the present invention may be of any type, so long as it can form a groove in which a nitride semiconductor wafer can be separated, a processed alteration layer, and the like. Specifically, a CO2 laser, a YAG laser, an excimer laser, or the like is preferably used.
[0032] The laser emitted by the laser processing machine can be adjusted in various focal points as desired by an optical system such as a lens. Therefore, by radiating the laser from the same direction, a groove, a processed alteration layer, and the like can be formed at an arbitrary focal point of the semiconductor wafer without damaging the nitride semiconductor. Further, the laser irradiation surface can be adjusted to a desired shape such as a perfect circle, an ellipse, or a rectangle by passing it through a filter and the like".

H. "[0034]
[Examples] (Example 1) A Nitride semiconductor wafer was formed by laminating nitride semiconductors using an MOCVD method using sapphire having a thickness of 200 µm and being washed as a substrate. The nitride semiconductor was formed as a multilayer film so that it could be used as a light emitting element after the substrate is separated. First, a buffer layer having a thickness of about 200 angstroms was formed by flowing NH_3 (ammonia) gas, TMG (trimethylgallium) gas, and hydrogen gas that is carrier gas as raw material gases at 510°C.
[0035] Next, after stopping the inflow of TMG gas, the temperature of the reactor was raised to 1050°C, and NH_3 (ammonia) gas, TMG gas, SiH_4 (silane) gas as a dopant gas, and hydrogen gas as a carrier gas were flowed again to form a GaN layer having a thickness of about 4 µm that functions as a n-type contact layer.
[0036] The active layer was once made to contain only carrier gas, the temperature of the reactor was maintained at 800°C, and then NH_3 (ammonia) gas, TMG gas, TMI (trimethylindium) as raw material gas, and hydrogen gas as carrier gas were flowed to deposit an undoped InGaN layer having a thickness of about 3 nm.
[0037] After stopping the inflow of the raw material gas to form a clad layer on the active layer and keeping the temperature of the reactor at 1050°C, NH_3 (ammonia) gas, TMA (trimethylaluminum) gas, TMG gas as raw material gas, Cp_2Mg (cyclopentadienyl magnesium) gas as dopant gas, and hydrogen gas as carrier gas were flowed to form a

GaAlN layer having a thickness of about 0.1 μm as a p-type clad layer.
[0038] Finally, the temperature of the reactor was maintained at 1050°C, NH_3 (ammonia) gas and TMG gas as raw material gas, Cp_2Mg gas as dopant gas, and hydrogen gas as carrier gas were flowed to form a GaN layer having a thickness of about 0.5 μm as a p-type clad layer (FIG. 1 (A)). (The p-type nitride semiconductor layer is annealed at 400°C or higher.)
The semiconductor wafer 100 thus formed was fixed on a table that can be freely driven in the vertical direction and the horizontal plane direction so that the formed nitride semiconductor 102 is on top. A laser beam (wavelength 356 nm) was radiated from the nitride semiconductor 102 side formed on the sapphire substrate 101, and the optical system of the laser was adjusted so that the focal point was focused on substantially the bottom surface of the sapphire substrate 101. By moving the stage while radiating the adjusted laser at 16 J/cm^2, scribe lines 103 having a depth of about 4 μm were formed vertically and horizontally on the bottom surface of the sapphire substrate 101. The formed scribe lines 103 were formed in a size of about 350 μm square, each of which becomes a nitride semiconductor element 110 when viewed from the main surface of the nitride semiconductor wafer 100 (FIG. 1 (B)).
[0039] Next, only the laser irradiation portion of the laser processing machine was replaced with a dicing saw, and a groove portion 104 reaching the sapphire substrate 101 from the upper surface of the nitride semiconductor 102 was formed on the semiconductor wafer 100 by a dicer while maintaining the fixation of the nitride semiconductor wafer. The groove portion 104 formed by the dicer was formed in parallel with the scribe line 103 formed by laser irradiation via the semiconductor wafer 100, and the distance between the bottom surface of the groove portion 104 and the bottom surface on the sapphire substrate 101 side was made almost uniform 100 μm (FIG. 1 (C)).
[0040] Along the scribe line 103, a load was applied by a roller that is not shown to cut and separate the nitride semiconductor wafer. Each of the separated end faces can form a nitride semiconductor element 110 without chipping or cracks (FIG. 1 (D)).
[0041] In Example 1, the scribe line 103 is formed by laser focused on the bottom surface of the sapphire substrate 101 that is not the front surface side of the semiconductor wafer 100 on which the nitride semiconductor 102 irradiated with laser, but the back surface side of the semiconductor wafer 100 which has passed through the nitride semiconductor 102 and the sapphire substrate 101.
[0042] By forming the groove portion 104 that reaches the substrate 101 such as sapphire from the main surface side (laser irradiation side) on which the nitride semiconductor 102 of the semiconductor wafer 100 is formed, the nitride semiconductor element 110 can be

easily and accurately divided along the scribe line 104.

[0043] Since the scribe line 103 is formed by laser, it is possible to reduce variations in processing accuracy, along with costs required for the replacement of cutting edges due to wear and deterioration of a cutter such as a diamond scriber. Further, by processing only from one side of the semiconductor wafer, the same effect as processing from both sides of the semiconductor wafer can be obtained, and it becomes possible to manufacture the nitride semiconductor element 110 having the same shape on the upper surface and the back surface, to improve a manufacturing yield, and reduce the variation in shape. Thereby, it is possible to reduce the cutting allowance and increase the number of semiconductor elements to be used. Further, since the scribe line 110 is formed on the surface of the sapphire substrate 101 side, the scribe line can be formed without processing waste generated by the laser adhering to the nitride semiconductor 102.

[0044] (Example 2) A semiconductor wafer which is etched until an interface with a sapphire substrate on which a groove is formed from a nitride semiconductor surface side by RIE (Reactive Ion Etching) is exposed, and is formed with a plurality of island-shaped nitride semiconductor layers 205 is used for a semiconductor wafer formed in the same manner as in Example 1. A mask is formed so that each pn semiconductor is exposed during etching, and the mask is removed after etching. Further, an electrode 220 is formed on each pn semiconductor layer by a sputtering method (FIG. 2 (A)).

[0045] The semiconductor wafer 200 was fixedly arranged in the same laser processing machine as in Example 1. Also in Example 2, the laser from the laser processing machine is radiated from the nitride semiconductor 205 side of the nitride semiconductor wafer, and the laser optical system is adjusted so that the focal point is focused on the inside of the sapphire substrate at 20 μm from the bottom surface of the sapphire substrate 201. By moving the stage while radiating the adjusted laser beam at 16 J/cm^2, a scribe line to be the processed alteration layer 206 is formed inside the substrate near the bottom surface of the sapphire substrate (FIG. 2 (B)).

[0046] Next, the laser optical system (not shown) was readjusted so that the focal point was focused on the upper surface (the surface side on which the nitride semiconductor was formed) of the sapphire substrate 201 exposed by etching. By moving the stage while radiating the adjusted laser, the groove portion reaching the sapphire substrate from the upper surface on the nitride semiconductor layer side is formed on the semiconductor wafer. The formed groove portion 204 is formed substantially in parallel with the processed alteration layer 206 via the sapphire substrate 201. The groove portion 204 on the sapphire substrate 201 formed by laser irradiation is adjusted so that the distance between the bottom surface of the groove portion and the bottom surface of the sapphire substrate is about 100 μm and is substantially uniform. Further, the laser optical system was readjusted so that the focal point was focused on the bottom surface of the groove portion provided on the sapphire substrate 201. By moving the stage while radiating the adjusted laser at 14 J/cm^2, a scribe line 207 having a depth of about 3 μm is formed on the bottom surface of the groove portion 204 provided on the exposed surface of the sapphire substrate on which the nitride semiconductor is formed (Fig. 2 (C)).

[0047] Subsequently, a load was applied by a roller along the groove portion (scribe line) to cut the semiconductor wafer, and separate the LED chip 210 (FIG. 2 (D)).

[0048] When power was supplied to the LED chips formed in this way, all of them were capable of emitting light, and there was almost no chipping of the cut end faces. The yield was 98% or more.

[0049] In Example 2, by forming the scribe lines on both of the front and back surfaces of the substrate with laser from one surface side of the semiconductor wafer, the nitride semiconductor element can be easily divided along the scribe line even in a thick nitride semiconductor wafer. Further, since the portion where the groove is formed is etched up to the sapphire substrate, it is possible to further decrease damage to the nitride semiconductor due to the groove formation and to improve the reliability of the nitride semiconductor element after separation. In particular, when the scribe line is formed, the focal point of the laser is focused inside the sapphire substrate, so that processing can be realized without damaging the table or adhesive sheet fixing the semiconductor wafer. In addition, there is no processing waste generated by laser irradiation. It should be noted that the nitride semiconductor element can be formed with good mass productivity, the same as in the present invention, even if the groove is formed by a dicer instead of laser machining.

[0050] The groove portion and the scribe line can be processed without contacting the nitride semiconductor wafer, using laser. Therefore, it is possible to reduce variations in processing accuracy, and costs required for the replacement of cutting edges due to a wear and deterioration of a blade and a cutter. Further, by processing only from one side of the semiconductor wafer, the same effect as processing from both sides of the semiconductor wafer can be obtained, and it becomes possible to manufacture semiconductor chips with the same shape. Since a manufacturing yield is improved and variation in shapes can be reduced, so that the cutting allowance can be reduced it becomes possible to increase the number of semiconductor elements taken from the nitride semiconductor wafer.

[0051] Further, by forming the groove portion from the semiconductor layer surface by the laser, it is possible to form a narrower groove. Therefore, it is possible to further increase the number of chips taken from the nitride semiconductor wafer.

[0052] (Example 3) A semiconductor wafer 300 formed in the same manner as in Example 1 is mirror-finished by polishing a sapphire substrate 301 to 80 μm in advance. This semiconductor wafer is fixedly arranged on the stage of the same laser processing machine as in Example 1 with the sapphire substrate 301 surface on which a nitride semiconductor 302 is not laminated facing up (FIG. 3 (A)).

[0053] In Example 3, the laser from the laser processing machine (not shown) is radiated from the sapphire substrate 301 surface side (substrate exposed surface side) on which the nitride semiconductor 302 of the nitride semiconductor wafer 300 is not formed, and the laser optical system is adjusted so that the focal point is focused on the interface between the nitride semiconductor 302 and the sapphire substrate 301. By radiating the laser while driving the stage, scribe lines, which are processed alteration layers 308, are vertically and horizontally formed as first scribe lines near the interface between the nitride semiconductor 302 and the sapphire substrate 301 in contact with the nitride semiconductor. (FIG. 3 (B))

[0054] Next, only the laser irradiation portion of the laser processing machine was replaced with a dicing saw (not shown), and a groove portion 309 that does not reach the nitride semiconductor surface was formed from the sapphire substrate bottom surface side on which nitride semiconductors are not laminated by a dicer at a blade rotation speed of 30,000 rpm and a cutting speed of 3 mm/sec while maintaining the fixation of the nitride semiconductor wafer. The groove portion formed by the dicer is provided substantially parallel to the processed alteration layer 308 in both vertical and horizontal directions, and is formed so that the distance between the bottom surface of the groove portion 309 and the bottom surface of the sapphire substrate is substantially uniform at 50 μm. Further, the dicing saw was replaced with the laser processing machine, and the focal point of the laser was focused on the bottom surface of the groove portion 309 formed by the dicer. By laser irradiation, a second scribe line 307 having a depth of about 3 μm was formed on the bottom surface of the groove portion 309 formed on the sapphire substrate 301 (FIG. 3 (C)).

[0055] A load was applied by a roller (not shown) along the second scribe line 307 to cut and separate the nitride semiconductor wafer to form the nitride semiconductor element 310 (FIG. 3 (D)). Almost no chipping occurred on the cutting end surface of the nitride semiconductor element formed in this way.

[0056] In the method described in Example 3, the groove portion 309 that does not reach the nitride semiconductor 302 is separately formed from the back surface side of the substrate 301 such as sapphire, so that the nitride semiconductor element 310 can be easily and accurately separated along the scribe line formed by the laser. Therefore, it is possible to supply a nitride semiconductor element having a uniform shape on the upper surface and the back surface, and to improve a product yield. It is also possible to form the first and second scribe lines by laser processing after processing with the dicer. It is also possible to process with the dicer after forming the first and second scribe lines.

[0057] Since the scribe line is formed by laser, it is possible to reduce variations in processing accuracy, along with costs required for the replacement of cutting edges due to a wear and deterioration of a cutter of a diamond scriber. Further, the same effect as that of processing from both sides of the semiconductor wafer can be obtained by processing only from one side of the semiconductor wafer without turning over the nitride semiconductor wafer. It is possible to manufacture semiconductor chips with the same shape, increase the manufacturing yield and reduce the variation in shape, so that the cutting allowance can be reduced and the number of semiconductor chips taken from the nitride semiconductor wafer can be increased. Further, processing waste produced by laser processing does not adhere to the surface of the nitride semiconductor.

[0058] (Example 4) A semiconductor wafer 400 which is etched until an interface with a sapphire substrate 401 on which a groove is formed from a nitride semiconductor surface side by RIE (Reactive Ion Etching) is exposed and is formed with a plurality of island-shaped nitride semiconductors 405 is used for a semiconductor wafer formed in the same manner as in Example 1. A mask is formed so that each pn semiconductor is exposed during etching, and the mask is removed after etching. Further, an electrode 420 is formed on each pn semiconductor layer by a sputtering method. The sapphire substrate 401 of the semiconductor wafer 400 is polished to 100 μm to be mirror-finished (FIG. 4 (A)).

[0059] The semiconductor wafer 400 was fixedly arranged on the same laser processing machine (not shown) as in Example 1 with the sapphire substrate 401 on which no nitride semiconductor was laminated at all facing upward. In Example 4, the laser of the laser processing machine is radiated from the sapphire substrate 401 surface side on which the nitride semiconductor 405 of the semiconductor wafer (400) is not formed, and a laser optical system (not shown) is adjusted so that the focal point is focused near the surface (on which the substrate is exposed in advance) on the sapphire substrate surface side on which the nitride semiconductors 405 are laminated. By laser scanning, first scribe lines 403 having a depth of about 4 μm are vertically and horizontally formed on the sapphire substrate 401. (Fig. 4 (B)).

[0060] Next, the laser optical system was readjusted and the laser scanning was performed so that a groove 409 that does not reach the nitride semiconductor 405 surface was formed on the nitride semiconductor wafer from the sapphire substrate 401 side along the first scribe line 403. The laser optical system was readjusted and the laser scanning was performed to form a second scribe line having a depth of approximately 3 μm on the bottom surface of the groove (FIG. 4C).

[0061] A load was applied by a roller (not shown) along the scribe line to separate the nitride semiconductor wafer to form the nitride semiconductor element 410 (FIG. 4 (D)).

[0062] When the LED chips, which are the separated nitride semiconductor elements, were energized, they were all capable of emitting light, and when the end surfaces thereof were examined, there was almost no chipping or cracks. The yield was 98% or more.

[0063] Since the scribe line is formed by laser, it is possible to reduce variations in processing accuracy, along with costs required for the replacement of cutting edges due to a wear and deterioration of a cutter of a diamond scriber. Further, the same effect as that of processing from both sides of the semiconductor wafer can be obtained by processing only from one side of the nitride semiconductor wafer. It is possible to manufacture semiconductor elements with the same shape, increase the manufacturing yield, and reduce the variation in shape, so that the cutting allowance can be reduced and the number of semiconductor chips taken from the nitride semiconductor wafer can be increased.

[0064] (Example 5) A semiconductor wafer was separated to form an LED chip in the same manner as in Example 1 except that an excimer laser was used instead of the YAG laser irradiation of Example 1. Similar to Example 1, when the semiconductor wafer is separated, the semiconductor wafer can be separated without turning over. In addition, each of the separated end surfaces of the formed LED chips can emit light and has a clean surface without chipping or cracks".

I. "[0066]

[Advantage of the Invention] In the method for manufacturing a nitride semiconductor element of the present invention, energy can be concentrated near a desired focal point by focusing laser radiated from a laser source with an optical system such as a lens. A workpiece is processed at the focal point where this energy density becomes extremely high. In particular, the focal point of the laser transmitted through the nitride semiconductor wafer is used. By irradiating the nitride semiconductor wafer, which is an unnecessary separated portion, with laser adjusted by an optical system, it becomes possible to freely perform processing on a laser irradiation surface of the nitride semiconductor wafer to the opposite side of the semiconductor wafer without damaging the necessary nitride semiconductor layer.

[0067] Therefore, in the present invention, by using the processing at the desired focal point transmitting through the nitride semiconductor wafer, it is not necessary to process the nitride semiconductor wafer from both sides, and the same effect as that of processing from both front and back sides of the nitride semiconductor wafer can be obtained by processing only from one side. Therefore, it is possible to provide a nitride semiconductor element having a higher yield and less variation in shape, and a method for manufacturing the nitride semiconductor element with good mass productivity".

J. According to the description "[Examples] (Example 1) A nitride semiconductor wafer was formed by laminating nitride semiconductors using an MOCVD method using sapphire having a thickness of 200 μm and being washed as a substrate" in Paragraph [0034] of H. above, and the description "(Example 2) A semiconductor wafer which is etched until an interface with a sapphire substrate on which a groove is formed from a nitride semiconductor surface side by RIE (Reactive Ion Etching) is exposed, and is formed with a plurality of island-shaped nitride semiconductors 205 is used for a semiconductor wafer formed in the same manner as in Example 1" in Paragraph [0044] of G. above, Example 2 describes "a semiconductor wafer on which nitride semiconductor layers 205 are formed on the surface of the sapphire substrate 201".

K. According to the description "the laser optical system is adjusted so that the focal point is focused on the inside of the sapphire substrate at 20 μm from the bottom surface of the sapphire substrate 201. By moving the stage while radiating the adjusted laser beam at 16 J/cm^2, a scribe line to be the processed alteration layer 206 is formed inside the substrate near the bottom surface of the sapphire substrate (FIG. 2 (B))" in Paragraph [0045] of H. above, in Example 2, it is described in Evidence A No. 4 that a scribe line is formed by "radiating a laser beam at 16 J/cm^2 so that the focal point is focused on the inside of the sapphire substrate 201".

L. According to the description "It is considered that the nitride semiconductor wafer irradiated with the laser becomes the recesses 103 and 403 in which an irradiating portion to be a focal point of the wafer is selectively blown or the processed alteration layers 206, 308 which are a set of microscopic microcracks" in Paragraph [0030] of G. above, and the description "the laser optical system is adjusted so that the focal point is focused on the inside of the sapphire substrate at 20 μm from the bottom surface of the sapphire substrate 201" in Paragraph [0045] of H. above, in Example 2, it is described in Evidence A No. 4 that "the processed alteration layer 206 which is a set of microscopic microcracks is formed inside the sapphire substrate 201".

M. According to the description "there is a problem in that when separating the semiconductor wafers, it is extremely difficult to control how the semiconductor wafers are cracked from the scribe line forming surface side to the semiconductor wafer surface side that is not formed, and to completely align the shapes of the nitride semiconductor elements for cutting" in Paragraph [0009] of C. above, it is understood that "the scribe line" controls how the semiconductor wafers are cracked. Further, according to the description "Also in Example 2, the laser from the laser processing machine is radiated from the nitride semiconductor 205 side of the nitride semiconductor wafer, and the laser optical system is adjusted so that the focal point is focused on the inside of the sapphire substrate at 20 μm from the bottom surface of the sapphire substrate 201. By moving the stage while radiating the adjusted laser beam at 16 J/cm^2, a scribe line to be the processed alteration layer 206 is formed inside the substrate near the bottom surface of the sapphire substrate (FIG. 2 (B))" in Paragraph [0045] of H. above, the description "Next, the laser optical system (not shown) was readjusted so that the focal point was focused on the upper surface (the surface side on which the nitride semiconductor was formed) of the sapphire substrate 201 exposed by etching. By moving the stage while radiating the adjusted laser, the groove portion reaching the sapphire substrate from the upper surface on the nitride semiconductor layer side is formed on the semiconductor wafer. The formed groove portion 204 is formed substantially in parallel with the processed alteration layer 206 via the sapphire substrate 201" in Paragraph [0046] of H. above, the description "Further, the laser optical system was readjusted so that the focal point was focused on the bottom surface of the groove portion provided on the sapphire substrate 201. By moving the stage while radiating the adjusted laser at 14 J/cm^2, a scribe line 207 having a depth of about 3 μm is formed on the bottom surface of the groove portion 204 provided on the exposed surface of the sapphire substrate on which the nitride semiconductor is formed (Fig. 2 (C))" in Paragraph [0046] of H. above, and the description "a load was applied by a roller along the groove portion (scribe line) to cut the semiconductor wafer, and separate the LED chip 210 (FIG. 2 (D))" in Paragraph [0047] of H. above, in Example 2, although the processed alteration layer 206 which is a set of microcracks is formed inside the sapphire substrate 201, since other Examples 1, and 3 to 5 are not provided with a processed alteration layer in "the inside" of a sapphire substrate, Example 2 is considered to be the example closest to the configuration of Invention 1. Therefore, based on the description of Example 2, Evidence A No. 4 describes "a semiconductor wafer cutting method, forming a scribe line for controlling how to crack when a roller load is applied, by a processed alteration layer 206, in the inside of a substrate near a bottom surface of the substrate 201, then forming a groove portion 204, forming a scribe line 207 on a bottom surface of the groove portion 204, and after that, applying a load along the groove portion 204 by a roller to cut a semiconductor wafer".

N. In Evidence A No. 4, although examples of the substrate include semiconductor materials such as silicon carbide, zinc oxide, gallium nitride single crystal, and the like in Paragraph [0024] of F. above, it is described that a sapphire substrate which is not cleavable and is extremely hard, is particularly effective. Further, Examples 1 to 5 of Evidence A No. 4 describe methods of cutting by aligning shapes while controlling how a sapphire substrate cracks. Of this method, although (Example 2) described in Paragraphs [0044] to [0051], which is the closest to the configuration of Invention 1, describes a method of cutting a sapphire substrate which is not cleavable and is extremely hard by being equipped with not only the processed alteration layer 206, but also the groove portion 204 and the scribe line 207, since even Examples 1 and 3 to 5 describe only the case where a sapphire substrate is used, it is recognized that Evidence A No. 4 discloses a cutting method exclusively for a sapphire substrate which is not cleavable, as a processing subject.

O. Although as described in N. above, it is recognized that Evidence A No. 4 discloses a cutting method of a sapphire substrate that is a processing subject as a specific method of Examples 1 to 5, this can be said from the description of the whole of Evidence A No. 4.

That is, Evidence A No. 4 "relates to a method for manufacturing a nitride semiconductor element form on a substrate" (A. above), and since "it is difficult for a semiconductor element using a nitride semiconductor to form a single crystal, unlike a semiconductor element such as GaAsP, GaP, or InGaAlAs formed on a GaP, GaAlAs, or GaAs semiconductor substrate," "In order to obtain a single crystal film of a nitride semiconductor having good crystallinity, it is formed on a sapphire or spinel substrate via a buffer layer.... A semiconductor element such as an LED chip must be formed by cutting and separating a nitride semiconductor layer formed on a sapphire substrate or the like to a desired size" (B. above). Since "Nitride semiconductors laminated on sapphire, spinel, etc. have a heteroepitaxial structure.... the sapphire substrate has a hexagonal crystal structure and does not have cleavage due to its nature. Furthermore, both sapphire and nitride semiconductors are extremely hard substances with a Mohs hardness of approximately 9," there was a problem and the like in that "it was difficult to cut them with a diamond scriber. Further, when a full cut was made with a dicer, cracks and chipping were likely to occur on the cutting surface, and it was not possible to cut cleanly. In some cases, the nitride semiconductor layer may be partially peeled off from the substrate" (B. above). It was made to "reduce the occurrence of cracks and chipping on the cut surface when the nitride semiconductor wafer is separated into chips. Another object of the present invention is to provide a manufacturing method for forming a nitride semiconductor element separated into a desired shape and size with good yield and with good mass productivity without impairing the crystallinity of a nitride semiconductor" (D. above).

Then, "although examples of the substrate 101 of the nitride semiconductor 102 include sapphire, spinel, silicon carbide, zinc oxide, gallium nitride single crystal, and the like, a sapphire substrate, a spinel substrate, and the like are preferably used for forming a nitride semiconductor layer having good mass productivity and good crystallinity. Since the sapphire substrate and the like are not cleavable and are extremely hard, the present invention works particularly effectively" (F. above), and the following descriptions and Examples 1 to 5 all describe a cutting method of a sapphire substrate.

Therefore, as means for solving the problem (D. above), "the present invention is a method for manufacturing a nitride semiconductor element (110) that divides a semiconductor wafer (100) in which a nitride semiconductor (102) is formed on a substrate (101) into nitride semiconductor elements (110). In particular, it is a method for manufacturing a nitride semiconductor element in which the semiconductor wafer (100) has first and second main surfaces, including a step of forming a scribe line (103) at a focal point formed at least on the second main surface (121) of a substrate (101) and/or the first main surface (111) of the substrate (101) by radiating laser from the first main surface (111) side and/or the second main surface (121) side via the semiconductor wafer (100), and a step of separating the semiconductor wafer along the scribe line," and "in the method for manufacturing a nitride semiconductor device according to Claim 4 of the present invention, the scribe line is a processed alteration layer (206) formed inside the substrate". The form is described, which is formally for processing a semiconductor wafer formed with a nitride semiconductor on the substrate which is not limited to a sapphire substrate which is not cleavable, and in which the scribe line is a processed alteration layer (206) formed inside the substrate, and which does not include the structure for cutting another scribe line or a groove and the like. However, there is no description at all that the problem can be solved only by the scribe line formed by the processed alteration layer (206) formed inside the substrate, for processing other than the sapphire substrate, and as a specific configuration, it is recognized that only cutting the sapphire substrate by the methods of Examples 1 to 5 is shown.

P. Accordingly, it is recognized that Evidence A No. 4 describes the following invention (hereinafter, referred to as "Invention A-4").

"A semiconductor wafer cutting method comprising steps of: radiating a laser beam at 16 J/cm^2 so that a focal point is focused on the inside of a sapphire substrate 201 of a semiconductor wafer in which a nitride semiconductor layer 205 is formed on a surface of the substrate 201; forming a processed alteration layer 206, which is a set of microscopic micro clocks, formed inside the sapphire substrate 201; forming a scribe line for controlling how to crack when a roller load is applied, by the processed alteration layer 206, in the inside of a substrate near a bottom surface of the substrate 201; then forming a groove portion 204; forming a scribe line 207 on a bottom surface of the groove portion 204; and after that, applying a load along the groove portion 204 by a roller to cut the semiconductor wafer".

(5) Matters described in Evidence A No. 5

Evidence A No. 5, distributed on May 25, 1999 before the priority date of the present application, describes the following matters with drawings. Further, the underlines are given by the body for the convenience of understanding.

A. "[0001]

[Field of the Invention] The present invention relates to a mark making method and a mark marking device using laser and more particularly, relates to a mark making method and a mark marking device suitable of making marks on a thin plate-shaped object to be processed".

B. "[0005] An object of the present invention is to provide a mark making method and a mark making device capable of suppressing the generation of cracks reaching a surface even when making marks on a thin plate-shaped object to be processed.

[0006]

[Means for Solving the Problem] According to one viewpoint of the present invention, there is provided a mark making method including steps of: splitting a laser beam emitted from a laser source into a plurality of laser beams; and making marks by focusing the plurality of split laser beams onto a very small region of the inner portion of an object to be processed, thereby altering a light condensing part of the object to be processed to make a mark".

C. "[0022] A holding platform 4 is positioned opposing the condenser optics system 3. An object 10 to be processed is mounted on the holding platform 4. The condenser optics system 3 focuses the partial beams 12A and 12B to a very small region 13 in the inner portion of the object 10 to be processed. The density of laser beam in this very small region 13 and its vicinity is increased. If this laser beam density becomes higher than a certain threshold value, then absorption due to optical non-linear effects is thought to occur. This absorption produces optical damage or optical breakdown and the very small region 13 of the object 10 to be processed alters and becomes visible from the outside. In this way, a mark can be made in the inner portion of the object 10 to be processed.

[0023] Light emitted from the very small region 13 is measured by means of a photodetector 5. The measurement results from the photodetector 5 are transmitted to position adjusting means 6. Generally, if abrasion occurs at the surface of the object 10 to be processed, then the intensity of light emission increases as compared to cases where optical damage or optical breakdown occurs in the inner portion thereof. The position adjusting means 6 adjusts the relative position of the condenser optics system 3 and the holding platform 4 in the axial direction of the laser beam, on the basis of the light emission intensity information gathered by the photodetector 5, in such a way that abrasion does not occur at the surface of the object 10 to be processed. In this way, marks can be made in the inner portion thereof without causing damage to the surface of the object 10 to be processed".

D. "[0027] Moreover, a laser beam which is appropriate for use in combination with the object 10 to be processed should be selected. For example, if making marks on a quartz glass, it is possible to use laser beam having a wavelength in the region to which quartz glass is transparent; namely, the infrared spectrum, visible light spectrum, or ultraviolet spectrum. Moreover, if making marks on standard plate glass, then it is possible to use laser beam having a wavelength in the region to which plate glass is transparent to plate glass; namely, the infrared spectrum or visible light spectrum. If making marks on a substrate other than glass, for instance, a silicon substrate, then laser beam in the wavelength region to which a silicon substrate is transparent may be used".

E."[0029] Moreover, by using a pulse laser device as a laser source 1, it is possible to suppress temperature rise in the vicinity of the marked area of the object 10 to be processed. Therefore, adverse effects due to temperature rise can be avoided, and the marking positions can be aligned uniformly in terms of their depth. Desirably, a short pulse width is used. This is because the magnitude of thermal effects is proportional to the square root of the pulse width. In concrete terms, it is desirable to use a laser source oscillating at a pulse width of 1 nanosecond or less".

F. "[0040] Therefore, it is possible to make marks over only a shorter range in the direction of the thickness of the object 10 to be processed, and hence cracks can be prevented from reaching the surface thereof".

G. "[0071]
[Advantage of the Invention] As described above, according to the present invention, a mark can be locally made in the inside of the object to be processed. Since the generation of cracks due to the mark making can be prevented from reaching the surface thereof, it is possible to suppress the generation of dust due to waste of the object to be processed".

H. According to the description "a thin plate-shaped object to be processed" in Paragraph [0001] of A. above, the description "The condenser optics system 3 focuses the partial beams 12A and 12B to a very small region 13 in the inner portion of the object 10 to be processed," in Paragraph [0022] of C. above, the description "If making marks on a substrate other than glass, for instance, a silicon substrate, then laser beam in the wavelength region to which a silicon substrate is transparent may be used" in Paragraph [0027] of D. above, and the description "In concrete terms, it is desirable to use a laser source oscillating at a pulse width of 1 nanosecond or less" in Paragraph [0029] of E. above, it is described in Evidence A No. 5 that "a laser beam oscillating at a pulse width of 1 nanosecond or less is radiated while being focused to the inside of a thin plate-shaped object 10 to be processed including a silicon substrate".

I. According to the description "The condenser optics system 3 focuses the partial beams 12A and 12B to a very small region 13 in the inner portion of the object 10 to be processed. The density of laser beam in this very small region 13 and its vicinity is increased. If this laser beam density becomes higher than a certain threshold value, then absorption due to optical non-linear effects is thought to occur. This absorption produces optical damage or optical breakdown, and the very small region 13 of the object 10 to be processed alters and becomes visible from the outside" in Paragraph [0022] of C. above, it is described in Evidence A No. 5 that a very small region 13 which is altered since optical damage or optical breakdown is produced is formed in the inside of the object to be processed due to the high density of laser beam.

J. According to the description "The condenser optics system 3 focuses the partial beams 12A and 12B to a very small region 13 in the inner portion of the object 10 to be processed. The density of laser beam in this very small region 13 and its vicinity is increased. If this laser beam density becomes higher than a certain threshold value, then absorption due to optical non-linear effects is thought to occur. This absorption produces optical damage or optical breakdown, and the very small region 13 of the object 10 to be processed alters and becomes visible from the outside. In this way, a mark can be made in the inner portion of the object 10 to be processed" in Paragraph [0022] of C. above, and the description "the generation of cracks due to the mark making can be prevented from reaching the surface thereof" in Paragraph [0071] of G. above, Evidence A No. 5 describes "a mark making method for an object to be processed, which makes a mark in the inside of the object 10 to be processed by the very small region 13, and prevents the generation of cracks due to the mark making from reaching the surface thereof".

K. Accordingly, it is recognized that Evidence A No. 5 describes the following invention (hereinafter, referred to as "Invention A-5").
"A mark making method for an object to be processed comprising steps of:

radiating a laser beam oscillating at a pulse width of 1 nanosecond or less while focusing to the inside of a thin plate-shaped object 10 to be processed including a silicon substrate;

forming a very small region 13 which is altered, since optical damage or optical breakdown is produced in the inside of the object to be processed due to the high density of laser beam; and

making a mark in the inside of the object 10 to be processed by the very small region 13, and preventing the generation of cracks due to the mark making from reaching the surface thereof".

(6) Matters described in Evidence A No. 6

Evidence A No. 6, distributed on December 12, 1978 before the priority date of the present application, describes the following matters. Further, the underlines are given by the body for the convenience of understanding.

"Radiating a laser beam to form or cut holes or grooves is performed in many fields.
For example, semiconductor devices such as transistors and thyristors, as generally shown in FIG. 1, are manufactured by forming a large number of semiconductor elements 2 on a semiconductor wafer 1 made of one piece of silicon by diffusion or the like, then

forming grooves 3, 3 in the X and Y directions between the semiconductor elements 2, 2, and next, applying bending force to the semiconductor wafer l by a roller or the like to cut and separate them from the grooves 3, 3.
For forming the grooves 3, 3, there are a mechanical method of engraving scratches using diamond points, and a physical method of radiating a laser beam to melt and remove a part of the semiconductor wafer.
The latter method using a laser beam has the advantages of non-contact, short processing time, and formation of deep grooves". (Page 1, right column, lines 3 to 17)

(7) Matters described in Evidence A No. 7
Evidence A No. 7, distributed on June 8, 2000 before the priority date of the present application, describes the following matters. Further, the underlines are given by the body for the convenience of understanding, and translation by the body are written in parentheses. Further, the translation by the Demandant is partially disputed, so the translation was prepared by the body.

A. "To the best of the Applicant's knowledge, in contrast to marking or image production techniques, there does not exist any prior art which describes the use of volume optical breakdown in true material processing techniques, as used in industrial applications, such as cutting and drilling. This definition of the term "material processing", which is commonly used in industrial laser terminology (where it also includes welding), is assumed throughout this patent specification. Therefore there exists a serious need for new methods for industrial and other applications of optical volume breakdown phenomena in suitable materials." (Page 3, lines 11 to 18)

B. "The present invention seeks to provide new methods for material processing using the volume optical breakdown phenomenon in optically transparent materials. This phenomenon occurs when the beam from a laser emitting ultra-short pulses of the order of tens of picoseconds or less is focused into the volume of the material to be processed by means of a high quality focusing objective lens, such that a focal spot close to the diffraction limit for the laser wavelength is obtained within the material. Such short, high peak power pulse scan be obtained, for example, from temporally compressed backward stimulated Brillouin scattering (SBS) Nd:YAG lasers.
At such high power densities, of the order of 10^{13}watts/cm^2, the material undergoes optical breakdown, since the transmission limit of linear response to power is exceeded in the material, which then strongly absorbs the laser radiation. Because of the intense

power density, atomic and molecular bonds of the material are broken down, and the material decomposes almost instantaneously into its most basic components, generally highly ionized component atoms." (Page 3, line 23 to Page 4, line 10)

C. "In accordance with yet another preferred embodiment of the present invention, there is further provided a method for ultra-fine cutting of transparent materials. The method can be similar to that described in the above-mentioned drilling embodiment, but including the further step of drilling further holes closely spaced to each other such that a continuous cut channel is produced.
Alternatively and preferably, the focused laser beam is made to execute multiple traverses of the material to be cut, first of all at the surface of the material, and slowly workpieceing down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired.
In accordance with yet another preferred embodiment of the present invention, there is provided a method of performing material processing on a material substantially transparent to laser radiation, and consisting of the steps of focusing pulses of the laser radiation into the volume of the material, the pulses being such that the material undergoes optical breakdown, and moving the focal point of the pulses of the laser radiation relative to the material according to a predetermined path." (Page 6, line 24 to Page 7, line 10)

D. "In accordance with a further preferred embodiment of the present invention, there is also provided a method as described hereinabove and wherein the material is a glass, a plastic, a gemstone, or a semiconductor." (Page 7, lines 21 to 23)

E. "There is even further provided in accordance with a preferred embodiment of the present invention a method as described hereinabove and wherein the moving the focal point of the pulses of the laser radiation relative to the material according to a predetermined path is synchronized in a predetermined manner with the emission of the pulses of the laser radiation." (Page 7, line 30 to Page 8, line 4)

F. "Furthermore, in accordance with yet another preferred embodiment of the present invention, there is provided a method of drilling a hole through a sample of material substantially transparent to laser radiation, and consisting of the steps of focusing pulses of the laser radiation through the volume of the sample, onto a location close to the surface of the sample further from the surface on which the laser radiation impinges, the pulses being of width shorter than 100 picoseconds, such that the material of the sample undergoes optical breakdown and produces a first hole, short in length compared with the thickness of the sample, and which breaks out of the surface of sample further from the surface on which the laser radiation impinges, moving the focal point of the pulses of the laser radiation back towards the surface on which the laser radiation impinges, by a predetermined distance, such that a second hole is produced by the optical breakdown of the material, the predetermined distance being such that the second hole just enters the first hole, and repeating the previous step until the first and second holes produce a continuous hole through the complete thickness of the sample.

There is also provided in accordance with a further preferred embodiment of the present invention a method as described hereinabove and wherein the material is a glass, a plastic, a semiconductor, or a gemstone." (Page 9, line 20 to Page 10, line 8)

G. "This method is particularly useful in the semiconductor industry, where a need exists to mark silicon or gallium arsenide wafers with very high resolution identifying marks, and without doing so on the surface of the wafer, where the debris of a surface marking process would be detrimental to the level of cleanliness required in many of the wafer processing stages. Although marks can be applied by conventional microlithographic methods using photoresist and etching procedures, the internal laser marking method is vastly quicker, and is a simple one-stage process, unlike the microlithographic method. Furthermore, the use of an internal marking method, such as that described in this embodiment of the present invention, leaves the surface of the wafer uncluttered with superfluous features. This advantage of this embodiment of the present invention becomes even more important when marking has to be applied at a chip level, rather than at a wafer level, since chip real estate is such a high-value commodity. In the case of silicon, which is substantially transparent from about 1.1 μm to almost 5 μm, a laser emitting pulses at 1.9 μm is suitable for implementing the method of this embodiment.

A further method according to another preferred embodiment of the present invention is that of using the volume optical breakdown effect to drill very parallel ultra-fine holes in transparent samples by means of a reverse drilling procedure. The method consists of the steps of first focusing an ultra-short pulse width laser, such as that described in the first preferred embodiment above, just inside the further surface of the sample through which the hole is to be drilled, and then firing a predetermined number of pulses. The volume optical breakdown incurred causes a narrow void or hole to be drilled, with the debris being ejected forward, in the beam direction, and away from the sample. It is known that in this method, the interaction mechanism of the laser with the material is that of optical breakdown, since a plume of plasma is seen ejected from the front end of the drilled hole.

The void formed has a diameter of the same order of magnitude as the focal size of the laser drilling beam, and is typically only 1 μm in plastic materials, or 2 μm to 3 μm in more refractory materials such as glass or sapphire.
In the next step, the focal position of the laser is moved back a distance of 0.1-10 μm, depending on the material, and another series of pulses is fired. This extends the void to join the already existent void. In this way, a complete hole is drilled through the sample by means of optical breakdown interactions. Since the hole is reverse drilled, the ejected debris, plasma, and gases do not cause the hole to be widened as it is drilled, and good parallelism and high uniformity of bore size can thus be obtained." (Page 12, line 27 to Page 14, line 3)

H. "According to another preferred embodiment of the present invention, a method of microscopic cutting of such transparent materials is provided, whereby a number of holes are drilled sufficiently closely spaced to each other, that adjacent bores run into each other, resulting in the production of a continuous cut channel according to a predetermined path. Alternatively and preferably, the focused laser beam is made to execute multiple traverses of the material to be cut, according to a predetermined path, the first traverse being at the surface of the material, and then slowly working down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired. Alternatively, the cut can be commenced at the far surface of the sample, and the sawed channel moved up through the sample towards the laser impingement surface. These methods of cutting, according to the present invention, are particularly advantageous in diamond processing, where a minimum of material is removed, and in the semiconductor industry, where there is a need to cut extremely fine and smooth channels. The use of these methods enables a smooth cut of width less than 10 μm to be produced through a thickness of 0.2 mm. of glass." (Page 14, line 21 to Page 15, line 8)

I. According to the description "This phenomenon occurs when the beam from a laser emitting ultra-short pulses of the order of tens of picoseconds or less is focused into the volume of the material to be processed by means of a high quality focusing objective lens, such that a focal spot close to the diffraction limit for the laser wavelength is obtained within the material" of B. above, the description "In accordance with a further preferred embodiment of the present invention, there is also provided a method as described hereinabove and wherein the material is a glass, a plastic, a gemstone, or a semiconductor" of D. above, the description "the focused laser beam is made to execute multiple traverses of the material to be cut, first of all at the surface of the material, and slowly working down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired" of C. above, the description "There is also provided in accordance with a further preferred embodiment of the present invention a method as described hereinabove and wherein the material is a glass, a plastic, a semiconductor, or a gemstone" of F. above, and the description "the focused laser beam is made to execute multiple traverses of the material to be cut, according to a predetermined path, the first traverse being at the surface of the material, and then slowly working down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired. Alternatively, the cut can be commenced at the far surface of the sample, and the sawed channel moved up through the sample towards the laser impingement surface" of H. above, it is described in Evidence A No. 7 that "a laser beam is focused in the inside of a material such as a glass, a plastic, a gemstone, or a semiconductor".

J. According to the description "This phenomenon occurs when the beam from a laser emitting ultra-short pulses of the order of tens of picoseconds or less is focused into the volume of the material to be processed by means of a high quality focusing objective lens, such that a focal spot close to the diffraction limit for the laser wavelength is obtained within the material. Such short, high peak power pulse scan be obtained, for example, from temporally compressed backward stimulated Brillouin scattering (SBS) Nd:YAG lasers.
At such high power densities, of the order of 10^{13} watts/cm^2, the material undergoes optical breakdown, since the transmission limit of linear response to power is exceeded in the material, which then strongly absorbs the laser radiation" of B. above, it is described in Evidence A No. 7 that "a laser beam is radiated under the condition that the order (digit) of high power density undergoing optical breakdown is 10^{13} watts/cm^2 and the order (digit) of pulse width is tens of picoseconds or less".

K. According to the description "The volume optical breakdown incurred causes a narrow void or hole to be drilled, with the debris being ejected forward, in the beam direction, and away from the sample. It is known that in this method, the interaction mechanism of the laser with the material is that of optical breakdown, since a plume of plasma is seen ejected from the front end of the drilled hole.
The void formed has a diameter of the same order of magnitude as the focal size of the laser drilling beam, and is typically only 1 μm in plastic materials, or 2 μm to 3 μm in

more refractory materials such as glass or sapphire" of G. above, it is described in Evidence A No. 7 that "voids are formed in the inside of materials by optical breakdown".

L. According to the description "In accordance with yet another preferred embodiment of the present invention, there is further provided a method for ultra-fine cutting of transparent materials. The method can be similar to that described in the above-mentioned drilling embodiment, but including the further step of drilling further holes closely spaced to each other such that a continuous cut channel is produced. Alternatively and preferably, the focused laser beam is made to execute multiple traverses of the material to be cut, first of all at the surface of the material, and slowly working down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired" of C. above, and the description "the focused laser beam is made to execute multiple traverses of the material to be cut, according to a predetermined path, the first traverse being at the surface of the material, and then slowly working down through the material with a sawing motion, to produce a complete cut channel, which can extend through the thickness of the material if desired. Alternatively, the cut can be commenced at the far surface of the sample, and the sawed channel moved up through the sample towards the laser impingement surface" of H. above, it is recognized that when cutting a material, the focused laser beam, first, is made to execute traverse at the surface of the material, then execute multiple traverses of the material to be cut, according to a predetermined path, and extends through the thickness of the material if desired, thereby cutting the material.

Further, according to the description "by a predetermined distance, such that a second hole is produced by the optical breakdown of the material, the predetermined distance being such that the second hole just enters the first hole, and repeating the previous step until the first and second holes produce a continuous hole through the complete thickness of the sample" of F. above, and the description "This extends the void to join the already existent void. In this way, a complete hole is drilled through the sample by means of optical breakdown interactions" of G. above, it is understood that when drilling holes on the material, the holes are produced by connecting the plurality of voids generated by means of optical breakdown.

Furthermore, according to the description "The method can be similar to that described in the above-mentioned drilling embodiment, but including the further step of drilling further holes closely spaced to each other such that a continuous cut channel is produced" of C. above, and the description "a method of microscopic cutting of such transparent materials is provided, whereby a number of holes are drilled sufficiently closely spaced to each other, that adjacent bores run into each other, resulting in the production of a continuous cut channel according to a predetermined path" of H. above, it is understood that when cutting a material, similarly to when drilling holes in the material, a plurality of voids are connected to cut the material.

Therefore, Evidence A No. 7 describes "a material cutting method of cutting the material by connecting a plurality of voids according to a predetermined path from the surface of the material with a sawing motion".

M. Accordingly, it is recognized that Evidence A No. 7 describes the following invention (hereinafter, referred to as "Invention A-7").

"A material cutting method comprising steps of:

focusing a laser beam on the inside of a material such as a glass, a plastic, a gemstone, or a semiconductor;

radiating the laser beam under the condition that the order (digit) of high power density undergoing optical breakdown is 10^{13} watts/cm^2 and the order (digit) of pulse width is tens of picoseconds or less;

forming voids in the inside of the material by optical breakdown; and

connecting the plurality of voids according to a predetermined path from the surface of the material with a sawing motion, thereby cutting the material".

No. 6. Judgment by the body

1. Examination on Reason for Invalidation 1

(1) Regarding Invention 1

A. Comparison with Invention A-1

Invention 1 and Invention A-1 will be compared.

"A thick synthetic quartz glass" of Invention A-1 becomes a processing object, and thus corresponds to "an object to be processed" of Invention 1. Similarly, "focusing," "a laser beam," and "a cutting and processing method" respectively correspond to "a light-converging point," "laser light," and "a cutting method".

Further, "a modified region" of Invention 1 is a region modified by laser and includes a crack region, so that "cracks" of Invention A-1 corresponds to "a modified region" of Invention 1.

In view of above, Invention 1 and Invention A-1 have the following corresponding

feature and different features.
(Corresponding Feature)

"An object to be processed cutting method comprising steps of: radiating laser light with a light-converging point set within the object to be processed; and forming a modified region caused by multiphoton absorption within the object to be processed".

(Different Feature 1)

In Invention 1, an object to be processed is "a wafer-shaped object made of a semiconductor material," and in Invention A-1, it is "a thick synthetic quartz glass".

(Different Feature 2)

In Invention 1, a cutting step is steps of "forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region," and a starting point of cutting is formed inside the object to be processed, whereas, in Invention A-1, a cutting step is "moving a focal position upward from a bottom surface of the synthetic quartz glass while moving workpiece within a horizontal surface to make minute cracks continue inside the synthetic quartz glass and to cut and process the synthetic quartz glass into a complicated shape," and a focal position is moved upward from a bottom surface of the quartz glass to be processed, thereby making minute cracks continue for cutting.

B. Examination on Different Features
(A) Different Feature 1 will be examined.

On Page 2, upper left column, lines 2 to 5 of Evidence A No. 1, it is described that "it is directed to cut and process a transparent material such as a quartz glass into a complicated shape, and to enable flexibly cutting and processing even if it is a thick plate without being affected by the thickness of the object to be processed". On the other hand, a semiconductor wafer for manufacturing a semiconductor element, which is described in Evidence A No. 4, is usually a thin plate shaped one, and although it is required to be linearly cut for cutting into semiconductor chips, the necessity of processing a thick plate into a complicated shape such as a columnar shape is not particularly known. In view of the above, in Invention A-1 for cutting and processing a transparent material such as a quartz glass that is a thin plate into a complicated shape, there is no motivation to assume a wafer-shaped object to be processed made from a semiconductor material as an object to be cut and processed, and it is not easy for a person skilled in the art to use a wafer-shaped one made from a semiconductor material according to Different Feature 1 as an object to be processed.

(B) Different Feature 2 will be examined

In Invention A-1, in order to cut and process the synthetic quartz glass, "moving a focal position upward from a bottom surface of the synthetic quartz glass to make minute cracks continue inside the synthetic quartz glass," so that it is recognized that minute cracks continuously form a cutting surface upward from a bottom surface. On the other hand, Invention 1, in order to cut the semiconductor material, includes steps of "forming a region that is a starting point of cutting, on the inner side from a laser light incident surface of the object to be processed by a predetermined distance; and generating cracks in a thickness direction of the object to be processed, starting from the region," so that cracks progress from the starting point of cutting in the inside toward the outside, and a cutting mechanism is different from that of Invention A-1 in which cutting is performed by continuing cracks. Further, as described in No. 5 (2) to (7) above, Evidence A No. 2 indicates a glass body cutting method, Evidence A No. 3 describes a marking method using changes in refractive index by laser light, Evidence A No. 4 describes a method of cutting a sapphire substrate that is a semiconductor, Evidence A No. 5 describes a mark making method for an object to be processed, Evidence A No. 6 describes melting and removing a part of the semiconductor wafer by radiating a laser beam, and Evidence A No. 7 describes a method of cutting a semiconductor material and the like by a sawing motion of a laser beam, and they do not disclose the above-mentioned step of Invention 1. Then, none of the evidence discloses the above-mentioned step of forming the region that is a starting point of cutting, and there is no motivation to adopt such a step, so that in Invention A-1, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 2.

(C) Although the Demandant, in the oral proceedings statement brief dated August 9, 2019, alleged that "it is clear that the surface (bottom surface, incident surface) of the transparent material is separated (as a result of that, the transparent material is cut) due to the growth of cracks starting from the minute cracks formed inside the transparent material," and that "in order to enable forming minute cracks spirally inside the glass in this way to cut out a cylinder, naturally, it is necessary that continuous cracks start from minute cracks and progress to the surface in the thickness direction. As described above, it is clear from Example 1 that the cutting and processing method inevitably includes the step in which the cracks progress from the minute cracks formed inside toward the surface," since in Invention A-1, "moving a focal position upward from a bottom surface of the synthetic quartz glass to make minute cracks continue inside the synthetic quartz glass," it is not planned to progress cracks starting from minute cracks formed inside the transparent material, and it cannot be said that it is clear that a cutting and processing method by laser inevitably includes the step in which the cracks progress from the minute cracks formed inside toward the surface.

Further, although the Demandant, also in the written statement dated October 11, 2019, alleges that "if it is described that minute cracks are generated inside a material and it is not described that minute cracks are generated on the surface of the material, it is common sense to understand that minute cracks are not generated on the surface of the material, unless the circumstances are exceptional," as described above, in Invention A-1, "moving a focal position upward from a bottom surface of the synthetic quartz glass to make minute cracks continue inside the synthetic quartz glass," and there is no description that the focal position starts from the inside of the synthetic quartz glass above the bottom surface, so that it should be interpreted as generating minute cracks on the bottom surface; that is, generating minute cracks on the surface of the material.

C. Advantageous effects

Further, Invention 1 is equipped with the configuration according to Different Feature 1 and Different Feature 2 above, and thus exerts the effect that "when the melt processing region is formed inside the object to be processed, it is difficult for unnecessary cracks that deviate from the line to cut to be generated at the time of cutting, so that the cutting control becomes easy" as described in Paragraph [0042] of the specification of the patent, and the effect that "the semiconductor chip can be cut out from the semiconductor wafer without causing unnecessary cracking or melting of the line to cut" or the effect that "it is possible to improve the yield of a product (for example, a semiconductor chip, a piezoelectric device chip, or a display device of a liquid crystal etc.) manufactured by cutting an object to be processed," as described in Paragraph [0060] of the specification of the patent, which are advantageous as compared with Invention A-1.

D. In view of the above, it cannot be accepted that Invention 1 could have been easily invented by a person skilled in the art, based on Invention A-1 and matters described in Evidence A No. 2 to Evidence A No. 7.

(2) Regarding Inventions 2 to 31

A. Inventions 2 to 6, and 15 include steps of "forming a region that is a starting point of cutting" in "a wafer-shaped object to be processed made of a semiconductor material" and "within the object to be processed" and "generating cracks in a thickness direction of the object to be processed, starting from the region," which are similar to Invention 1, so that Inventions 2 to 6, and 15 have different features similar to Different Features 1 and 2.

Then, it is the same as shown in (1) B. (A) and (B) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 2, in Inventions 2 to 6, and 15.

B. In comparison of Invention 7 and Invention A-1, the two have different features similar to Different Features 1 and 2 above. Further, the two are different in the point that Invention 7 is equipped with the configuration of "radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof," whereas in Invention A-1, it is unclear whether or not a plurality of laser light sources are used (hereinafter, referred to as Different Feature 3).

Further, Inventions 8 to 14, 16 and 17, as compared with Invention A-1, have different features similar to Different Features 1 to 3 above.

Then, it is the same as shown in (1) B. (A) and (B) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 2, in Inventions 7 to 14, 16 and 17.

C. In comparison of Invention 18 and Invention A-1, the two have different features similar to Different Features 1 and 2 above. Further, the two are different in the point that Invention 18 "forming a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure," whereas, in Invention A-1, it is unclear whether or not such a molten processed region is formed (hereinafter, referred to as Different Feature 4).

Further, Invention 31, as compared with Invention A-1, has different features similar to Different Features 1, 2, and 4 above.

Then, it is the same as shown in (1) B. (A) and (B) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 2 in Inventions 18 and 31.

D. In comparison of Invention 19 and Invention A-1, in addition to having a different feature similar to Different Feature 1, the two are different in the point that Invention 19 includes steps of "forming a modified region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region," whereas Invention A-1 moves a focal position upward from a bottom surface of the synthetic quartz glass that is the object to be processed to make minute cracks continue to cut (hereinafter referred to as Different Feature 5). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 5, also in Invention 19, a region (modified region) that is a starting point of cutting is formed inside the object to be processed, and a cutting mechanism is different from that of Invention A-1 in which cutting is performed by continuing cracks, so that for the same reasons as stated where Different Feature 2 was examined in (1) B. (B) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 5, in Invention A-1.

Further, since Inventions 20 to 28, as compared with Invention A-1, have different features similar to Different Features 1 to 5, concerning the judgment of Different Feature 1, for the same reasons as described in (1) B. (A) above, and concerning the judgment of Different Feature 5, for the same reasons as with Invention 19, it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 5 in Invention A-1.

E. In comparison of Invention 29 and Invention A-1, in addition to having different features similar to Different Features 1 and 4, the two are different in the point that Invention 29 includes steps of "forming a molten processed region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region," whereas Invention A-1 moves a focal position upward from a bottom surface of the synthetic quartz glass that is the object to be processed to make minute cracks continue to cut (hereinafter referred to as Different Feature 6). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 6, also in Invention 29, a region (molten processed region) that is a starting point of cutting is formed inside the object to be processed, and a cutting mechanism is different from that of Invention A-1 in which cutting is performed by continuing cracks, so that for the same reasons as stated where Different Feature 2 was examined in (1) B. (B) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6, in Invention A-1.

Further, since Invention 30, as compared with Invention A-1, has different features similar to Different Features 1, 4, and 6, concerning the judgment of Different Feature 1, for the same reasons as shown in (1) B. (A) above, and concerning the judgment of Different Feature 6, for the same reasons as for Invention 29, it is not easy to adopt the configurations of Different Feature 1 and Different Feature 6 in Invention A-1.

F. Therefore, it cannot be accepted that Inventions 2 to 31 could have been easily invented by a person skilled in the art, based on Invention A-1 and the matters described in Evidence A No. 2 to Evidence A No. 7.

(3) Closing on Reason for Invalidation 1

Therefore, regarding Inventions 1 to 31, Reason for Invalidation 1 advocated by the Demandant is groundless.

2. Examination on Reason for Invalidation 2

(1) Regarding Invention 1

A. Comparison with Invention A-4

Invention 1 and Invention A-4 will be compared.

"A focal point" of Invention A-4 corresponds to "a light-converging point" of Invention 1. Similarly, "a processed alteration layer 206" corresponds to "a modified region".

As an interpretation of "a wafer-shaped object to be processed made of a semiconductor material" of Invention 1, since the expression "made of a semiconductor material" modifies the object to be processed, in the description "a wafer-shaped object to be processed made of a semiconductor material," it is recognized that the object to be processed is configured by a semiconductor material. On the other hand, "a sapphire substrate 201" of Invention A-4 is a substrate of a semiconductor wafer, and becomes an object to be processed, but sapphire is not a semiconductor material. Then, when "a sapphire substrate 201" of Invention A-4 is compared with "a wafer-shaped object to be processed made of a semiconductor material" of Invention 1, they are identical up to "a wafer-shaped object to be processed".

In view of the above, Invention A and Invention A-4 have the following corresponding feature and different features.

(Corresponding Feature)

"An object to be processed cutting method comprising steps of: irradiating a wafer-shaped object to be processed with laser light with a light-converging point set within the object to be processed; and forming a modified region within the object to be processed".

(Different Feature 1)

In Invention 1, the object to be processed is "a semiconductor material," whereas, in Invention A-4, it is "a sapphire substrate 201".

(Different Feature 2)

When forming a modified region within the object to be processed, in Invention 1, it is formed by multiphoton absorption, whereas, in Invention A-4, it is unclear whether or not it is formed by multiphoton absorption.

(Different Feature 3)

In Invention 1, a cutting step is steps of "forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region," and the modified region is a starting point of cutting, whereas, in Invention A-4, a cutting step is steps of "forming a scribe line for controlling how to crack when a roller load is applied, by the processed alteration layer 206, in the inside of a substrate near a bottom surface of the substrate 201; then forming a groove portion 204; forming a scribe line 207 on a bottom surface of the groove portion 204; and after that, applying a load along the groove portion 204 by a roller to cut the semiconductor wafer". Although the substrate 201 is cut, it is unclear whether or not the scribe line by the processed alteration layer 206 is a starting point of cutting.

B. Examination on Different Features

(A) Different Feature 1 will be examined.

In Paragraph [0005] of Evidence A No. 4, it is described that "Nitride semiconductors laminated on sapphire, spinel, etc. have a heteroepitaxial structure. Nitride semiconductors have a large lattice constant irregularity with those of sapphire substrates. In addition, the sapphire substrate has a hexagonal crystal structure and does not have cleavage due to its nature. Furthermore, both sapphire and nitride semiconductors are extremely hard substances with a Mohs hardness of approximately 9," and in the subsequent Paragraph [0006], it is described that "Therefore, it has been difficult to cut them with a diamond scriber. Further, when a full cut was made with a dicer, cracks and chipping were likely to occur on the cutting surface, and it was not possible to cut cleanly". Therefore, although in Invention A-4, it is required to solve the problem that cutting is performed cleanly without generating cracks and chipping on a sapphire substrate with high Mohs hardness and no cleavage, in Invention A-4, adopting an object to be processed other than the sapphire substrate does not solve the above-mentioned problem, so that there is no motivation to change such a material. Therefore, in Invention A-4, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1.

(B) Different Feature 2 above will be examined.

On Page 3, upper left column, lines 1 to 6 of Evidence A No. 1, it is described that "All excimer lasers have wavelengths longer than 140 nm, so absorption should normally not occur. However, absorption occurs due to the above-mentioned multiphoton absorption, which causes the cleavage of a uniting bond or the generation of an exothermic effect, and fine cracks are generated inside," and the technical matter that cracks are generated inside a material by multiphoton absorption using laser is described.

Then, Invention A-4 radiates a laser beam and forms a processed alteration layer 206 which is a set of microscopic micro cracks inside the sapphire substrate 201.

In view of the above, since the technical matters described in Invention A-4 and Evidence A No. 1 are common in that cracks are generated inside the object to be processed, by using a laser beam, it can be said that it could have been easily conceived by a person skilled in the art to form the processed alteration layer 206 inside the sapphire substrate 201 by multiphoton absorption, in Invention A-4, by applying the technical matter of Evidence A No. 1 to Invention A-4.

(C) Different Feature 3 above will be examined.

In Invention A-4, the sapphire substrate is cut by "forming a scribe line for controlling how to crack when a roller load is applied, by the processed alteration layer 206, in the inside of a substrate near a bottom surface of the substrate 201; then forming a groove portion 204; forming a scribe line 207 on a bottom surface of the groove portion 204; and after that, applying a load along the groove portion 204 by a roller to cut the semiconductor wafer". In Invention A-4, there is not specification as to which side the roller should come to abut on, and there is no description on where a starting of cutting is. Therefore, in the cutting method of Invention A-4, although it can be inferred that the starting point of cutting occurs at any point, it cannot be said that the scribe line formed by the processed alteration layer 206 is necessarily the starting point of cutting, and it cannot be said that, as in Invention 1, there are performed steps of "forming a region that is a starting point of cutting, on the inner side from a laser light incident surface of the object to be processed by a predetermined distance; and generating cracks in a thickness direction of the object to be processed, starting from the region" in order to cut the semiconductor material. Rather, Invention A-4 has a groove portion 204 and a scribe line 207 on the bottom surface of the groove portion 204 for a sapphire substrate which is not cleavable, and considering that the scribe line formed by the processed alteration layer 206 is for controlling how to crack and that the roller applies a load along the groove portion, it can be said that it is natural to think that cracks are generated starting from the bottom surface of the groove portion 204, and the scribe line formed by the processed alteration layer 206 functions to control the cracks. Also, according to the descriptions of No. 5. (1) to (3) and (5) to (7), since there is no description on this step in Evidence A No. 1 to Evidence A No. 3 and Evidence A No. 5 to Evidence A No. 7, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3 above.

(D) Furthermore, the Demandant, in the oral proceedings statement brief dated August 9, 2019, alleges that "in Claim 1 of Evidence A No. 4, the configuration for separating a semiconductor wafer along a scribe line formed at a focal position of laser is described, and in Claim 4 depending therefrom, the configuration that the scribe line is a processed alteration layer formed within the substrate is described. In such a configuration, the groove is not an essential configuration, and there is disclosed an invention that exerts an effect without forming a groove". However, as mentioned in No. 5 (4) above, it is shown that the problem of Evidence A No. 4 can be solved by only providing a groove in the sapphire substrate, and only the sapphire substrate which is not cleavable provided with a groove and a scribe line is disclosed. Thus, it cannot be said that a configuration without a groove is disclosed. Further, in Evidence A No. 4, there is no Example of cutting without forming a groove, and it is not clear how to cut the sapphire substrate without forming a groove. Even if a sapphire substrate formed with no grooves is cut, it cannot be read from the description of Evidence A No. 4 that the starting point of cutting is always generated from the processed alteration layer inside the substrate.

Further, the Demandant, in the oral proceedings statement brief dated August 9, 2019, also alleges that "actually, in Paragraph [0022], it is described that 'according to the method of the present invention, a scribe line serving as a separation guide for a nitride semiconductor element can be formed at an arbitrary point other than a laser irradiation surface side by passing through a nitride semiconductor wafer without damaging a nitride semiconductor layer,' and it is specified that 'a separation guide' that is a starting point of cutting is a scribe line, not a groove". However, from the description of Paragraph [0022], it can be read that a scribe line can be formed at an arbitrary point other than a laser irradiation surface, but it cannot be read that "a separation guide" that is a starting point of cutting is a scribe line, not a groove.

Furthermore, the Demandant, in the oral proceedings statement brief dated September 9, 2019, alleges that as shown by FIG. 1, a schematic diagram showing a state in which a load is applied to the upper surface by a roller on a substrate having a vertically long cross-section gap inside near the lower surface, and FIG. 2, showing the results of the numerical simulation of the stress distribution, a break occurs from the point B toward the point A since the point B in FIGS. 1 and 2 is a singular point, and after that, it is considered that a break will occur from the remaining singular point C as the starting point toward the point D, and the starting point of cutting is not the lower surface, but the scribe line 206. Further, the Demandant, also in the written statement dated October 11, 2019, alleges that "stress is most concentrated at the end of the void inside the substrate, and this is the starting point of cutting". However, in Evidence A No. 4, there is only a description (Paragraph [0047]) of applying a load to the substrate by a roller along the groove portion (scribe line). Assuming that a groove portion (scribe line) exists, although it is understandable that a load is applied to the substrate by a roller along the groove, the case having no groove portion is not planned in the first place, no specific mode is shown on which surface and how to apply the load to the substrate. Therefore, it cannot be said that Evidence A No. 4 discloses that the starting point of cutting is the point B, which is a singular point; that is, the scribe line 206, as alleged by the Demandant. Also, FIG. 1 and FIG. 2 and the related descriptions thereof disclosed in the oral proceedings statement brief dated September 9, 2019 are not contents disclosed in Evidence A No. 4, but are described by the Demandant after the filing of the patent application and are based on the Demandant's interpretive opinion, so that it does not show the common general technical knowledge or well-known technology at the time of filing the patent application, and cannot serve as evidence when considering novelty and inventive step.

C. Advantageous effects

Further, Invention 1 is equipped with the configuration according to Different Feature 1 to Different Feature 3 above, and thus exerts the effect that "when the melt processing region is formed inside the object to be processed, it is difficult for unnecessary cracks that deviate from the line to cut to be generated at the time of cutting, so that cutting control becomes easy" as described in Paragraph [0042] of the specification of the patent, and the effect that "the semiconductor chip can be cut out from the semiconductor wafer without causing unnecessary cracking or melting of the line to cut" as described in Paragraph [0060] of the specification of the patent, which are advantageous effects as compared with Invention A-4.

D. In light of the above, according to (A) and (C) above, regardless of (B) above, it cannot be accepted that Invention 1 could have been easily invented by a person skilled in the art, based on Invention A-4 and the matters described in Evidence A No. 1 to Evidence A No. 3 and Evidence A No. 5 to Evidence A No. 7.

(2) Regarding Inventions 2 to 31

A. Inventions 2 to 6, and 15 include steps of "forming a region that is a starting point of cutting" in "a wafer-shaped object to be processed made of a semiconductor material" and "within the object to be processed" and "generating cracks in a thickness direction of the object to be processed, starting from the region," which are similar to Invention 1, so that Inventions 2 to 6, and 15 have different features similar to Different Features 1 and 3.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3, in Inventions 2 to 6, and 15.

B. In comparison of Invention 7 and Invention A-4, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 7 is equipped with the configuration of "radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof," whereas in Invention A-4, it is unclear whether or not a plurality of laser light sources are used (hereinafter, referred to as Different Feature 4).

Further, Inventions 8 to 14, 16 and 17, as compared with Invention A-4, have different features similar to Different Features 1 to 4 above.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3, in Inventions 7 to 14, 16 and 17.

C. In comparison of Invention 18 and Invention A-4, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 18 "forms a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, and a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure," whereas, in Invention A-4, it is unclear whether or not such a molten processed region is formed (hereinafter, referred to as Different Feature 5).

Further, Invention 31, as compared with Invention A-4, has different features similar to Different Features 1, 3, and 5 above.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3, in Inventions 18 and 31.

D. In comparison of Invention 19 and Invention A-4, in addition to having a different feature similar to Different Feature 1, the two are different in the point that Invention 19 includes steps of "forming a modified region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region," whereas although Invention A-4 cuts the substrate 201, it is unclear whether or not the scribe line by the processed alteration layer 206 is the starting point of cutting (hereinafter referred to as Different Feature 6). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 6, in Invention 19, a region (modified region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-4, it is unclear where the starting point of cutting is, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6, in Invention A-4.

Further, since Inventions 20 to 28, as compared with Invention A-1, have different features similar to Different Features 1 and 6, concerning the judgment of Different Feature 1, for the same reasons as described in (1) B. (A) above, and concerning the judgment of Different Feature 6, for the same reasons as for Invention 19, it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 6 in Invention A-4.

E. In comparison of Invention 29 and Invention A-4, in addition to having different features similar to Different Features 1 and 5, the two are different in the point that Invention 29 includes steps of "forming a molten processed region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region," whereas although Invention A-4 cuts the substrate 201, it is unclear whether or not the scribe line by the processed alteration layer 206 is the starting point of cutting (hereinafter referred to as Different Feature 7). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 7, also in Invention 29, a region (molten processed region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-4, it is unclear where the starting point of cutting is, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 7, in Invention A-4.

Further, since Invention 30, as compared with Invention A-4, has different features similar to Different Features 1, 5, and 7, concerning the judgment of Different Feature 1, for the same reasons as shown in (1) B. (A) above, and concerning the judgment of Different Feature 7, for the same reasons as for Invention 29, it is not easy to adopt the configurations of Different Feature 1 and Different Feature 7 in Invention A-4.

F. Therefore, it cannot be accepted that Inventions 2 to 31 could have been easily invented by a person skilled in the art, based on Invention A-4 and the matters described in Evidence A No. 1 to Evidence A No. 3, and Evidence A No. 5 to Evidence A No. 7.

(3) Closing on Reason for Invalidation 2

Therefore, regarding Inventions 1 to 31, Reason for Invalidation 2 advocated by the Demandant is groundless.

3. Examination on Reason for Invalidation 3

Evidence A No. 2 is Evidence A No. 1 in the trial decision of Invalidation No. 2005-80166, and since the same facts and evidence are targeted, it is highly probable that it falls under the prohibition of double jeopardy (Article 167 of the former Patent Act). Considering that the Demandant, in the oral proceedings statement brief dated August 9, 2019, alleges that Reason for Invalidation 3 is not for "the same facts and evidence" as the trial decision in 2005, and does not fall under the prohibition of double jeopardy (Article 167 of the former Patent Act), Reason for Invalidation 3 will be also examined.

(1) Regarding Invention 1

A. Comparison with Invention A-2

Invention 1 and Invention A-2 will be compared.

"A glass body" of Invention A-2 corresponds to "an object to be processed" of Invention 1. Hereinafter, similarly, "focusing," "laser," "a parting line," and "a breaking method" respectively correspond to "a light-converging point," "laser light," "a line to cut," and "a cutting method".

Further, since "a modified region" of Invention 1 is a region modified by laser and includes a crack region and the like, "microcracks" of Invention A-2 correspond to "a modified region" of Invention 1.

Furthermore, since "break open" of Invention A-2 means generating cracks in the thickness direction of the glass body, it corresponds to "generating cracks in a thickness direction" of Invention 1.

In light of the above, Invention 1 and Invention A-2 have the following corresponding feature and different features.

(Corresponding Feature)

"An object to be processed cutting method comprising steps of: irradiating an object to be processed with laser light with a light-converging point set within the object to be processed; forming a modified region within the object to be processed; and generating cracks in a thickness direction of the object to be processed, along a line to cut of the object to be processed".

(Different Feature 1)

In Invention 1, an object to be processed is "a wafer-shaped object to be processed made from a semiconductor material," whereas, in Invention A-2, it is a glass body.

(Different Feature 2)

When forming a modified region within the object to be processed, Invention 1 forms it by multiphoton absorption, whereas in Invention A-2, it is unclear whether or not it is formed by multiphoton absorption.

(Different Feature 3)

In Invention 1, a cutting step is steps of "forming a region that is a starting point of cutting," "on the inner side from a laser light incident surface of the object to be processed by a predetermined distance; and generating cracks in a thickness direction of the object to be processed, starting from the region," whereas, in Invention A-2, a cutting step is a step of "forming a breaking point in the inside of the glass body to break open the glass body," and it is unclear whether or not "a breaking point" is a starting point of cutting.

B. Examination on Different Features

(A) Different Feature 1 above will be examined.

According to the description A. "[Field of the Invention] The present invention relates to a method of forming (producing) a desired breaking point for breaking the glass wall of a glass body, in particular a break-open ampule or a tube, or for separating a glass pane by generating microcracks in the breaking zone" in Paragraph [0001] of Evidence A No. 2, and the description "[Problem to be Solved by the Invention] An object of the invention is to form a predetermined breaking point in the breaking zone of the break-open ampule in such a manner as to allow reproducible and safe opening of the break-open ampule. In particular, it is intended to avoid injuries which can occur when opening ampules which are difficult to break open and to preclude impairment to the medicament caused by opening the ampule" in Paragraph [0013], it is obvious that Invention A-2 is an invention that attempts to solve a problem peculiar to a glass object, particularly a break-open ampule.

Therefore, in Invention A-2, making an object to be processed to be a wafer-shaped one made from a semiconductor material has nothing to do with a problem peculiar to an ampule of "to form a predetermined breaking point in the breaking zone of the break-open ampule in such a manner as to allow reproducible and safe opening of the break-open ampule," so that there is no motivation for a person skilled in the art to change the object to be processed of Invention A-2 from a glass body to a wafer-shaped one made from a semiconductor material.

Therefore, in Invention A-2, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1.

(B) Different Feature 2 will be examined.

On Page 3, upper left column, lines 1 to 6 of Evidence A No. 1, it is described that "All excimer lasers have wavelengths longer than 140 nm, so absorption should normally not occur. However, absorption occurs due to the above-mentioned multiphoton absorption, which causes the cleavage of a uniting bond or the generation of exothermic effect, and fine cracks are generated inside," and the technical matter that cracks are generated inside a material by multiphoton absorption using laser, is described.

Then, Invention A-2 radiates laser in the inside of a glass body and forms microcracks in the inside of the glass body.

In view of the above, since the technical matters described in Invention A-2 and Evidence A No. 1 are common in that cracks are generated inside the object to be processed, by using a laser beam, it can be said that it could have been easily conceived by a person skilled in the art to form cracks in the inside of the glass body by multiphoton absorption, in Invention A-2, by applying the technical matter of Evidence A No. 1 to Invention A-2.

(C) Different Feature 3 above will be examined.

In Invention A-2, although a breaking point is formed in the inside of the glass body to break-open the glass body, it is unclear how to apply force on the glass body and how to break-open the glass body, and it is also unclear whether or not the breaking point becomes a starting point of cutting with this. Especially, in Evidence A No. 2, as an example thereof, only the breakage of the ampule neck is described, and the method of applying force in the breakage and the breaking mechanism is not described. Therefore, in Invention A-2, it cannot be said that the cutting step has steps of "forming a region that is a starting point of cutting, " " on the inner side from a laser light incident surface of the object to be processed by a predetermined distance " " and generating cracks in a thickness direction of the object to be processed, starting from the region". Further, about this step, according to the descriptions of No. 5 (1) and (3) to (7) above, it is not described in Evidence A No. 1 and Evidence A No. 3 to A No. 7, so that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3.

C. Advantageous Effects

Further, Invention 1 is equipped with the configuration according to Different Feature 1 and Different Feature 3 above, and thus exerts the effect that "when the melt processing region is formed inside the object to be processed, it is difficult for unnecessary cracks that deviate from the line to cut to be generated at the time of cutting, so that the cutting control becomes easy" as described in Paragraph [0042] of the specification of the patent, and the effect that "the semiconductor chip can be cut out from the semiconductor wafer without causing unnecessary cracking or melting of the line to cut" or the effect that "it is possible to improve the yield of a product (for example, a semiconductor chip, a piezoelectric device chip, a display device of a liquid crystal, etc.) manufactured by cutting an object to be processed," as described in Paragraph [0060] of the specification of the patent, which are advantageous as compared with Invention A-2.

D. In light of the above, from (A) and (C) above, regardless of (B) above, it cannot be accepted that Invention 1 could have been easily invented by a person skilled in the art, based on Invention A-2 and the matters described in Evidence A No. 1 and Evidence A No. 3 to A No. 7.

(2) Regarding Inventions 2 to 31

A. Inventions 2 to 6, and 15 include steps of "forming a region that is a starting point of cutting" in "a wafer-shaped object to be processed made of a semiconductor material" and "within the object to be processed" and "generating cracks in a thickness direction of the object to be processed, starting from the region," which are similar to the steps of Invention 1, so that Inventions 2 to 6, and 15 have different features similar to Different Features 1 and 3.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3 in Inventions 2 to 6, and 15.

B. In comparison of Invention 7 and Invention A-2, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 7 is equipped with the configuration of "radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof," whereas in Invention A-2, it is unclear whether or not a plurality of laser light sources are used (hereinafter, referred to as Different Feature 4).

Further, Inventions 8 to 14, 16 and 17, as compared with Invention A-2, have different features similar to Different Features 1 to 4 above.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3 in Inventions 7 to 14, 16, and 17.

C. In comparison of Invention 18 and Invention A-2, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 18 "forms a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure," whereas, in Invention A-2, it is unclear whether or not such a molten processed region is formed (hereinafter, referred to as Different Feature 5).

Further, Invention 31, as compared with Invention A-2, has different features similar to Different Features 1, 3, and 5 above.

Then, it is the same as shown in (1) B. (A) and (C) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 3 in Inventions 18 and 31.

D. In comparison of Invention 19 and Invention A-2, in addition to having a different feature similar to Different Feature 1, the two are different in the point that Invention 19 includes steps of "forming a modified region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region," whereas in Invention A-2, the cutting step is a step of "forming a breaking point in the inside of the glass body to break open the glass body," and it is unclear whether or not "a breaking point" is a starting point of cutting (hereinafter referred to as Different Feature 6). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 6, also in Invention 19, a region (modified region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-2, it is unclear where the starting point of cutting is, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6 in Invention A-2.

Further, since Inventions 20 to 28, as compared with Invention A-2, have different features similar to Different Features 1 and 6, concerning the judgment of Different Feature 1, for the same reasons as described in (1) B. (A) above, and concerning the judgment of Different Feature 6, for the same reasons as for Invention 19, it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 6 in Invention A-2.

E. In comparison of Invention 29 and Invention A-2, in addition to having different features similar to Different Features 1 and 5, the two are different in the point that Invention 29 includes steps of "forming a molten processed region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region," whereas in Invention A-2, the cutting step is a step of "forming a breaking point in the inside of the glass body to break open the glass body," and it is unclear whether or not "a breaking point" is a starting point of cutting (hereinafter referred to as Different Feature 7). Then, it is the same as shown in (1) B. (A) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 1. Further, concerning Different Feature 7, also in Invention 29, a region (molten processed region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-2, it is unclear where a starting point of cutting is, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 7 in Invention A-2.

Further, since Invention 30, as compared with Invention A-2, has different features similar to Different Features 1, 5, and 7, concerning the judgment of Different Feature 1, for the same reasons as shown in (1) B. (A) above, and concerning the judgment of Different Feature 7, for the same reasons as with Invention 29, it is not easy to adopt the configurations of Different Feature 1 and Different Feature 7 in Invention A-2.

F. Therefore, it cannot be accepted that Inventions 2 to 31 could have been easily invented by a person skilled in the art, based on Invention A-2 and the matters described in Evidence A No. 1 and Evidence A No. 3 to A No. 7.

(3) Closing on Reason for Invalidation 3

Therefore, regarding Inventions 1 to 31, Reason for Invalidation 3 advocated by the Demandant is groundless.

4. Examination on Reason for Invalidation 4

(1) Regarding Invention 1

A. Comparison with Invention A-5

Invention A-5 and Invention 1 will be compared.

"A thin plate-shaped object 10 to be processed including a silicon substrate" of Invention A-5 corresponds to "a wafer-shaped object to be processed made of a semiconductor material" of Invention 1. Hereinafter, similarly, "focusing" and "a very small region 13 which is altered, since optical damage or optical breakdown is produced" respectively correspond to "with a light-converging point set" and "a modified region".

In light of the above, Invention 1 and Invention A-5 have the following corresponding feature and different features.

(Corresponding Feature)
"Irradiating a wafer-shaped object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; and forming a modified region" " within the object to be processed".

(Different Feature 1)

When forming a modified region within the object to be processed, in Invention 1, it is formed by multiphoton absorption, whereas, in Invention A-5, it is unclear whether or not it is formed by multiphoton absorption.

(Different Feature 2)

Invention 1 relates to "an object to be processed cutting method comprising steps of: forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region," and the region that is a starting point of cutting is formed within the object to be processed to cut the object to be processed, whereas, Invention A-5 is "a mark making method for an object to be processed comprising" " making a mark in the inside of an object to be processed by a very small region," and although making a mark in the inside of the object to be processed, since it is not premised on cutting, it does not form a region that is a starting point of cutting, and it does not cut the object to be processed.

B. Examination on Different Features
(A) Different Feature 1 above will be examined.

On Page 3, upper left column, lines 1 to 6 of Evidence A No. 1, it is described that "All excimer lasers have wavelengths longer than 140 nm, so absorption should normally not occur. However, absorption occurs due to the above-mentioned multiphoton absorption, which causes the cleavage of a uniting bond or the generation of exothermic effect, and fine cracks are generated inside," and the technical matter that cracks are generated inside a material by multiphoton absorption using laser is described.

Then, Invention A-5 radiates a laser beam to the inside of an object 10 to be processed to produce optical damage in the inside of the object 10 to be processed.

In view of the above, since the technical matters described in Invention A-5 and Evidence A No. 1 are common in that damage is generated inside the object to be processed, by using a laser beam, it can be said that it could have been easily conceived by a person skilled in the art to produce optical damage in the inside of the object 10 to be processed by multiphoton absorption, in Invention A-5, by applying the technical matter of Evidence A No. 1 to Invention A-5.

(B) Different Feature 2 above will be examined.

Invention A-5 relates to a mark making method, not a cutting method. Further, in Evidence A No. 5, there are the description "therefore, it is possible to make marks over only a shorter range in the direction of the thickness of the object 10 to be processed, and hence cracks can be prevented from reaching the surface thereof" in Paragraph [0040] and the description that "since the generation of cracks due to the mark making can be prevented from reaching the surface thereof, it is possible to suppress the generation of dust due to waste of the object to be processed" in Paragraph [0071], and the cracks of the object to be processed are prevented from reaching the surface thereof due to making marks. In light of the above, there is a disincentive to change Invention A-5 to a cutting method of the object 10 to be processed, and it is not easy for a person skilled in the art to change the mark making method of Invention A-5 to a cutting method.

Further, Evidence A No. 1 describes a synthetic quartz glass cutting method by laser, Evidence A No. 2 describes a glass body breaking method by laser, Evidence A No. 4 describes a sapphire substrate cutting method by laser, and Evidence A No. 7 describes a semiconductor material cutting method by laser. However, Evidence A No. 5 can prevent the generation of cracks due to making marks from reaching the surface thereof, and even if using laser for cutting is a publicly known art according to Evidence A No. 1, A No. 2, A No. 4, and A No. 7, it should be said that there is a disincentive to apply it to Invention A-5 that suppress the generation of the cracks.

(C) The Demandant, in the oral proceedings statement brief dated August 9, 2019, about Reason for Invalidation 4, alleges that since Evidence A No. 1 and Evidence A No. 13 are applications by the same inventor and the same applicant, and Evidence A No. 1 relates to a transparent material cutting and processing method and Evidence A No. 13 relates to a transparent material marking method, in light of the common technical knowledge as of the filing, a person skilled in the art would recognize the marking method and the cutting method as subordinate concepts of laser processing inside materials, which method is suitable for laser processing inside the material is merely a matter that can be appropriately designed, such as adjusting the laser parameters, and there is no disincentive for a person skilled in the art to apply the laser processing inside the material used as a marking method to a cutting method.

However, as described above, since Invention A-5 is intended to prevent the generation of cracks due to mark making from reaching the surface of the object 10 to be processed; that is, to prevent the cracking of the object 10 to be processed, there is a disincentive to change the mark making method of Invention A-5 to a cutting method, and regardless of whether or not the mark making method and the cutting method are subordinate concepts of laser processing, it cannot be said that changing the mark making method to a cutting method is a matter that can be appropriately designed in Invention A-5.

C. Advantageous Effects

Further, Invention 1 is equipped with the configuration according to Different Feature 1 and Different Feature 2 above, and thus exerts the effect that "when the melt processing region is formed inside the object to be processed, it is difficult for unnecessary cracks that deviate from the line to cut to be generated at the time of cutting, so that the cutting control becomes easy" as described in Paragraph [0042] of the specification of the patent, and the effect that "the semiconductor chip can be cut out from the semiconductor wafer without causing unnecessary cracking or melting of the line to cut" or the effect that "it is possible to improve the yield of a product (for example, a semiconductor chip, a piezoelectric device chip, or a display device of a liquid crystal, etc.) manufactured by cutting an object to be processed," as described in Paragraph [0060] of the specification of the patent, which are advantageous as compared with Invention A-5.

D. In light of the above, from (B) above, regardless of (A) above, it cannot be accepted that Invention 1 could have been easily invented by a person skilled in the art, based on Invention A-5 and the matters described in Evidence A No. 1 to A No. 4 and Evidence A No. 6 to A No. 7.

(2) Regarding Inventions 2 to 31

A. Inventions 2 to 6, and 15 include steps of "forming a region that is a starting point of cutting" "within the object to be processed" and "generating cracks in a thickness direction of the object to be processed, starting from the region," which are similar to Invention 1, so that Inventions 2 to 6, and 15 have different features similar to Different Feature 2.

Then, it is the same as shown in (1) B. (B) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 2, in Inventions 2 to 6, and 15.

B. In comparison of Invention 7 and Invention A-5, the two have different features similar to Different Features 1 and 2 above. Further, the two are different in the point that Invention 7 is equipped with the configuration of "radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof," whereas in Invention A-5, it is unclear whether or not a plurality of laser light sources are used (hereinafter, referred to as Different Feature 3).

Further, Inventions 8 to 14, 16 and 17, as compared with Invention A-5, have different features similar to Different Features 1 and 2 above.

Then, it is the same as shown in (1) B. (B) above that it is not easy for a person skilled in the art to adopt the configurations of Different Feature 1 and Different Feature 2 in Inventions 7 to 14, 16 and 17.

C. In comparison of Invention 18 and Invention A-5, the two have different features similar to Different Feature 2 above. Further, the two are different in the point that Invention 18 "forms a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure," whereas, in Invention A-5, it is unclear whether or not such a molten processed region is formed (hereinafter, referred to as Different Feature 4).

Further, Invention 31, as compared with Invention A-5, has different features similar to Different Features 2 and 4 above.

Then, it is the same as shown in (1) B. (B) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 2 in Inventions 18 and 31.

D. In comparison of Invention 19 and Invention A-5, in addition to having a different feature similar to Different Feature 1, the two are different in the point that Invention 19 includes steps of "forming a modified region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region," whereas in Invention A-5, although a mark is made in the inside of the object to be processed, since it is not premised on cutting, it does not form a region that is a starting point of cutting, and it does not cut the object to be processed (hereinafter referred to as Different Feature 5). Then, concerning Different Feature 5, in Invention 19, a region (modified region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-5, although making a mark on the object to be processed, it does not cut the object to be processed, so that for the same reasons as stated where Different Feature 2 was examined in (1) B. (B) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 5 in Invention A-5.

Further, since Inventions 20 to 28, as compared with Invention A-5, have different features similar to Different Features 1 to 5, concerning the judgment of Different Feature 5, for the same reasons as for Invention 19, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 5 in Invention A-5.

E. In comparison of Invention 29 and Invention A-5, in addition to having different features similar to Different Features 1 and 4, the two are different in the point that Invention 29 includes steps of "forming a molten processed region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region," whereas in Invention A-5, although making a mark in the inside of the object to be processed, since it is not premised on cutting, it does not form a region that is a starting point of cutting, and it does not cut the object to be processed (hereinafter referred to as Different Feature 6). Further, concerning Different Feature 6, in Invention 29, a region (molten processed region) that is a starting point of cutting is formed inside the object to be processed, whereas in Invention A-5, although making a mark on the project to be processed, it does not cut the object to be processed, so that for the same reasons as stated where Different Feature 2 was examined in (1) B. (B) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6, in Invention A-5.

Further, since Invention 30, as compared with Invention A-5, has different features similar to Different Features 1, 4, and 6, concerning the judgment of Different Feature 6 for the same reasons as with Invention 29, it is not easy to adopt the configuration of Different Feature 6 in Invention A-5.

F. Therefore, it cannot be accepted that Inventions 2 to 31 could have been easily invented by a person skilled in the art, based on Invention A-5 and the matters described in Evidence A No. 1 to A No. 4 and Evidence A No. 6 to A No. 7.

(3) Closing on Reason for Invalidation 4

Therefore, regarding Inventions 1 to 31, Reason for Invalidation 4 advocated by the Demandant is groundless.

5. Examination on Reason for Invalidation 5

(1) Regarding Invention 1

A. Comparison with Invention A-7

Invention 1 and Invention A-7 will be compared.

"A laser beam" in Invention A-7 corresponds to "laser light" of Invention 1. Hereinafter, similarly, "focusing on" and "a material cutting method" respectively correspond to "with a light-converging point set" and "a material cutting method".

Further, since "a modified region" of Invention 1 is a region modified by laser and includes a crack region and the like, "voids" of Invention A-7 correspond to "a modified region" of Invention 1.

Furthermore, when "a material such as a glass, a plastic, a gemstone, or a semiconductor" of Invention A-7 is compared with "a wafer-shaped object to be processed made of a semiconductor material" of Invention 1, the two are identical up to "an object to be processed" made of "a semiconductor material".

Furthermore, "connecting the plurality of voids according to a predetermined path from the surface of the material with a sawing motion, thereby cutting the material" of Invention A-7 means cutting a material in the thickness direction of the material, and thus corresponds to "generating cracks in a thickness direction of the object to be processed" of Invention 1.

In light of the above, Invention 1 and Invention A-7 have the following corresponding feature and different features.

(Corresponding Feature)

"An object to be processed cutting method comprising steps of: irradiating an object to be processed made of a semiconductor material with laser light with a light-converging point set within the object to be processed; forming a modified region" " within the object to be processed " and "constituted by the modified region, " " generating cracks in the thickness direction of the object to be processed".

(Different Feature 1)

In Invention 1, the object to be processed made of a semiconductor material is "a wafer-shaped" one, whereas, in Invention A-7, it is unclear whether or not it has a wafer-shape.

(Different Feature 2)

When forming the modified region within the object to be processed, in Invention 1, it is formed by "multiphoton absorption, " whereas, in Invention A-7, it is formed by "optical breakdown. "

(Different Feature 3)

When cutting the object to be processed, Invention 1 includes steps of "forming a region that is a starting point of cutting, constituted by the modified region on the inner side from a laser light incident surface of the object to be processed by a predetermined distance along a line to cut of the object to be processed; and generating cracks in a thickness direction of the object to be processed, starting from the region," and forms a region that is a starting point of cutting within the object to be processed, whereas, in Invention A-7, it is made by "connecting the plurality of voids according to a predetermined path from the surface of the material with a sawing motion, thereby cutting the material," and it is unclear whether or not a region that is a starting point of cutting is formed.

B. Examination on Different Features

(A) Different Feature 1 will be examined

As described that "a load was applied by a roller along the groove portion (scribe line) to cut the semiconductor wafer, and separate the LED chip 210" in Paragraph [0047] of Evidence A No. 4, in the field of semiconductor manufacturing, it is a matter of well-known art that a wafer-shaped material is cut.

Since Invention A-7 relates to a technology of cutting a semiconductor material, it can be said that it could have been easily conceived by a person skilled in the art to use a wafer-shaped semiconductor material that is an object to be processed, by applying the above-mentioned well-known art.

(B) Different Feature 2 above will be examined.

On Page 3, upper left column, lines 1 to 6 of Evidence A No. 1, it is described that "All excimer lasers have wavelengths longer than 140 nm, so absorption should normally not occur. However, absorption occurs due to the above-mentioned multiphoton absorption, which causes the cleavage of a uniting bond or the generation of an exothermic effect, and fine cracks are generated inside," and the technical matter that cracks are generated inside a material by multiphoton absorption using laser is described.

Then, Invention A-7 radiates a laser beam and forms voids in the inside of the material by optical breakdown.

In light of the above, Invention A-7 and the technical matter described in Evidence A No. 1 are common in the point of generating breakdown inside the object to be processed using laser, so that it can be said that it could have been easily conceived by a person skilled in the art to form voids in the inside of the material by multiphoton absorption, in Invention A-7, by applying the above-mentioned technical matter of Evidence A No. 1 to Invention A-7.

(C) Different Feature 3 above will be examined.

Invention A-7 includes a step of "connecting the plurality of voids according to a predetermined path from the surface of the material with a sawing motion, thereby cutting the material," and it is recognized that the plurality of voids are connected from the surface of the material to cut the material. On the other hand, Invention 1 has steps of "forming a region that is a starting point of cutting, " " on the inner side from a laser light incident surface of the object to be processed by a predetermined distance " " and generating cracks in a thickness direction of the object to be processed, starting from the region," so that cracks are progressed from the starting point of cutting inside toward the outside, and it is different in cutting mechanism from Invention A-7 connecting the voids to cut the material. Further, as described in No. 5 (1) to (6) above, this step is not described in Evidence A No. 1 to A No. 6, so that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3 above in Invention A-7.

（ｃ），（ｄ）を繰り返す（鋸運動）　Repeating (c) and (d) (a sawing motion)

(D) The Demandant, in the oral proceedings statement brief dated August 9, 2019, about Reason for Invalidation 5, alleges that "as a result of such 'a sawing motion,' in order to form 'a completely cut groove,' cutting has to be performed starting from the location where the laser beam is focused inside the material (in the above figure (e), the second and subsequent lateral arrows from the top). That is, the above cited part discloses also that the starting point of cutting is within the object to be processed". However, in Evidence A No. 7, there is no explicit description about where the starting point of cutting arises as a result of a sawing motion. Also, there is no particular description suggesting that "the second and subsequent lateral arrows from the top" are a starting point of cutting. Then, the Demandant's allegation that Evidence A No. 7 discloses that the starting point of cutting is within the object to be processed cannot be accepted.

C. Advantageous Effects

Further, Invention 1 is equipped with the configuration according to Different Feature 1 to Different Feature 3 above, and thus exerts the effect that "when the melt processing region is formed inside the object to be processed, it is difficult for unnecessary cracks that deviate from the line to cut to be generated at the time of cutting, so that the cutting control becomes easy" as described in Paragraph [0042] of the specification of the patent, and the effect that "the semiconductor chip can be cut out from the semiconductor wafer without causing unnecessary cracking or melting of the line to cut" or the effect that "it is possible to improve the yield of a product (for example, a semiconductor chip, a piezoelectric device chip, a display device of a liquid crystal, etc.) manufactured by cutting an object to be processed," as described in Paragraph [0060] of the specification of the patent, which are advantageous as compared with Invention A-7.

D. In light of the above, from (C) above, regardless of (A) and (B) above, it cannot be accepted that Invention 1 could have been easily invented by a person skilled in the art, based on Invention A-7 and the matters described in Evidence A No. 1 to A No. 6.

(2) Regarding Inventions 2 to 31

A. Inventions 2 to 6, and 15 include steps of "forming a region that is a starting point of cutting" in "a wafer-shaped object to be processed made of a semiconductor material" and "within the object to be processed" and "generating cracks in a thickness direction of the object to be processed, starting from the region," which are similar to Invention 1, so that Inventions 2 to 6, and 15 have different features similar to Different Features 1 and 3.

Then, it is the same as shown in (1) B. (C) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3 in Inventions 2 to 6, and 15.

B. In comparison of Invention 7 and Invention A-7, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 7 is equipped with the configuration of "radiating each laser light emitted from a plurality of laser light sources with a light-converging point set within the object to be processed from different directions thereof," whereas in Invention A-7, it is unclear whether or not a plurality of laser light sources are used (hereinafter, referred to as Different Feature 4).

Further, Inventions 8 to 14, 16, and 17, as compared with Invention A-7, have different features similar to Different Features 1 to 4 above.

Then, it is the same as shown in (1) B. (C) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3 in Inventions 7 to 14, 16, and 17.

C. In comparison of Invention 18 and Invention A-7, the two have different features similar to Different Features 1 and 3 above. Further, the two are different in the point that Invention 18 "forms a molten processed region which is a region in which a monocrystal structure has changed into an amorphous structure, a region in which a monocrystal structure has changed into a polycrystal structure, or a region in which a monocrystal structure has changed into a structure including an amorphous structure and a polycrystal structure," whereas, in Invention A-7, it is unclear whether or not such a molten processed region is formed (hereinafter, referred to as Different Feature 5).

Further, Invention 31, as compared with Invention A-7, has different features similar to Different Features 1, 3, and 5 above.

Then, it is the same as shown in (1) B. (C) above that it is not easy for a person skilled in the art to adopt the configuration of Different Feature 3 in Inventions 18 and 31.

D. In comparison of Invention 19 and Invention A-7, in addition to having a different feature similar to Different Feature 1, the two are different in the point that Invention 19 includes steps of "forming a modified region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the modified region," whereas in Invention A-7, it is unclear whether or not a region that is a starting point of cutting is formed inside the material that is an object to be processed (hereinafter referred to as Different Feature 6). Then, concerning Different Feature 6, in Invention 19, a region (modified region) that is a starting point of cutting is formed inside the object to be processed, and it is different in cutting mechanism from Invention A-7 connecting the plurality of voids to cut the material, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6 in Invention A-7.

Further, since Inventions 20 to 28, as compared with Invention A-7, have different features similar to Different Features 1 to 6, concerning the judgment of Different Feature 6, for the same reasons as with Invention 19, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 6 in Invention A-7.

E. In comparison of Invention 29 and Invention A-7, in addition to having different features similar to Different Features 1 and 5, the two are different in the point that Invention 29 includes steps of "forming a molten processed region" "within the object to be processed" "and cutting the object to be processed by generating cracks in a thickness direction of the object to be processed, starting from the molten processed region," whereas in Invention A-7, it is unclear whether or not a region that is a starting point of cutting is formed inside the material that is an object to be processed (hereinafter referred to as Different Feature 7). Then, concerning Different Feature 7, in Invention 29, a region (molten processed region) that is a starting point of cutting is formed inside the object to be processed, and it is different in cutting mechanism from Invention A-7 connecting the plurality of voids to cut the material, so that for the same reasons as stated where Different Feature 3 was examined in (1) B. (C) above, it is not easy for a person skilled in the art to adopt the configuration of Different Feature 7 in Invention A-7.

Further, since Invention 30, as compared with Invention A-7, has different features similar to Different Features 1, 5, and 7, concerning the judgment of Different Feature 7, for the same reasons as with Invention 29, it is not easy to adopt the configuration of Different Feature 7 in Invention A-7.

F. Therefore, it cannot be accepted that Inventions 2 to 31 could have been easily invented by a person skilled in the art, based on Invention A-7 and the matters described in Evidence A No. 1 to A No. 6.

(3) Closing on Reason for Invalidation 5

Therefore, regarding Inventions 1 to 31, Reason for Invalidation 5 advocated by the Demandant is groundless.

No. 7 Closing

As described above, the patent according to Inventions 1 to 31 cannot be invalidated by the Demandant's allegation and the means of proof.

The costs in connection with the trial shall be borne by the Demandant under the provisions of Article 61 of the Code of Civil Procedure which is applied mutatis mutandis in the provisions of Article 169(2) of the Patent Act.

Therefore, the decision shall be made as described in the conclusion.

January 7, 2020

Chief administrative judge: KURITA, Masahiro
Administrative judge: OGAWA, Satoshi
Administrative judge: KEMMOKU, Shoji