

SPECIFICATION

Title of the Invention:

SCRIBING WHEEL AND METHOD FOR MANUFACTURING THE SAME

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a scribing wheel for scribing a brittle material substrate by pressure contact and rolling, and to a method for manufacturing the same.

10 2. Discussion of the Related Art

A conventional scribing wheel uses a disk made of cemented carbide or polycrystalline sintered diamond (referred to as PCD, hereinafter) as a base material. The PCD is one made by sintering diamond particles together
15 with cobalt or the like. A scribing wheel is one in which obliquely grinding down a circumferential edge from both sides of the disk serving as the base material forms a V-shaped blade edge in a circumferential surface. By rotatably and pivotally attaching the scribing wheel formed
20 in this manner to a scribing head or the like of a scribing machine and moving the scribing wheel along a surface of a brittle material substrate while pressing the scribing wheel against the brittle material substrate with a predetermined load, it is possible to perform a scribing
25 action while rolling the scribing wheel.

Japanese unexamined patent publication He14-224128 discloses a glass cutting blade that is for cutting a glass substrate and has a V-shaped blade edge. The surface of the V-shaped blade edge is coated with diamond in order to
5 prolong the life of the glass cutting blade. The blade edge surface of this glass cutting blade formed of ceramic compatible with diamond is coated with a diamond film, and the glass cutting blade is shaped by performing surface grinding treatment of the diamond film. It is disclosed
10 that, by using such a glass cutting blade, high hardness glass can be cut so as to exhibit a smooth cutting surface with the life of the blade kept long.

Also, Japanese unexamined patent publication 2013-220554 suggests a scribing wheel in which a diamond film is
15 grown on tapered surfaces serving as a blade edge of the scribing wheel having its circumferential portion formed to be V-shaped in sectional view. Both side areas of a ridge line of the V-shaped circumferential portion are ground.

By the way, in the case where a diamond film is
20 formed on tapered surfaces of a scribing wheel base material formed to be V-shaped in sectional view, in order to avoid the diamond film from adhering to a through hole and side walls, the scribing wheel base material 100 (briefly referred to as "wheel base material", hereinafter)
25 is held between a pair of spacers 101 and 102 as shown in

Fig. 1 (a) and the wheel base material 100 is kept in a film-forming furnace while the side walls of the wheel base material 100 are kept in contact with the spacers 101 and 102. Then, after the adhesion of the diamond film to the tapered surfaces of the wheel base material 100 is completed in the film-forming furnace, the spacers 101 and 102 are separated from the wheel base material 100, and the wheel base material 100 is cleaned. The adhesion of the diamond film is usually repeated plural times in order to obtain a desired thickness of the film, and therefore this work is repeated plural times.

However, when the diamond film is affixed to the tapered surfaces, even though the side surfaces of the wheel base material 100 are contacted with the spacers 101 and 102, the diamond film spills over around and adheres to the outer peripheral surfaces of the side surfaces, and therefore the film thickness of the outer peripheral surfaces of the side surfaces may increase by about several μm in some cases. And yet, once the wheel base material 100 is separated from the spacers 101 and 102, the wheel base material 100 cannot be held between the spacers 101 and 102 as originally held after cleaned. Therefore, when the diamond film is affixed again, the diamond film further spills over around the outer peripheral surfaces of the side surfaces, and the film thickness of the peripheral

portion may further increase and exceed a tolerance range in some cases.

A completed scribing wheel is inserted to a cut clearance of a scribing holder and it is rotatably held to be used. At this time, there has been a problem that, in the case where the diamond film adheres to the side surfaces, the increased film thickness may exceed a tolerance range of the clearance to which the scribing wheel is inserted and the scribing wheel cannot be held in the wheel holder in some cases. Further, there has been a problem that, if the thickness of the boundary region between the side surface and the tapered surface of the scribing wheel is large, even in the case where the scribing wheel can be held in the wheel holder, a sliding resistance at the time of using the scribing wheel following the rotation of the scribing wheel may be easily increased. Furthermore, there has been also a problem that only a peripheral portion around a through hole formed in side surfaces of the cut of the wheel holder is annularly worn away and the wheel holder is also damaged.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above problems, and an essential object of the present invention is to provide a scribing wheel and a

manufacturing method thereof, preventing deterioration of a yield caused by adhesion of a diamond film on side surfaces of a wheel base material while preventing a sliding resistance from increasing when using the scribing wheel.

5 The scribing wheel of the present invention comprises a scribing wheel base material that is formed with a ridge line along a circumferential portion thereof and has a blade edge including the ridge line and tapered surfaces of both sides from said ridge line; a diamond film formed on
10 the tapered surfaces of said scribing wheel base material; and annular grooves formed in annular areas corresponding to boundary regions between side surfaces and the tapered surfaces having the diamond film formed thereon in both sides of said scribing wheel base material.

15 The method of the present invention for manufacturing a scribing wheel that is formed with a ridge line along a circumferential portion of a disk and has a blade edge including the ridge line and tapered surfaces of both sides from the ridge line, the method comprises grinding the both
20 sides of side surfaces along a circumference of a disk-shaped scribing wheel base material in a manner of mutually and obliquely cutting from the both sides of the side surfaces to thereby form a blade edge portion including the tapered surfaces and the ridge line at the circumferential
25 portion; forming a diamond film on the tapered surfaces of

the scribing wheel base material; and cutting off annular areas corresponding to boundary regions between the side surfaces and the tapered surfaces having the diamond film formed thereon, thereby removing the diamond film on the
5 annular areas of the side surfaces and forming annular grooves.

In the method for manufacturing the scribing wheel, the annular grooves of the side surfaces of the scribing wheel base material may be formed by irradiating the
10 annular areas with laser beams.

In the method for manufacturing the scribing wheel, the diamond film may be formed on the tapered surfaces of a plurality of scribing wheel base materials by alternately contacting the plurality of scribing wheel base materials
15 each of which has a blade edge portion formed thereon with spacers that are in contact with the entire side surfaces of each of the scribing wheel base materials.

In the method for manufacturing the scribing wheel, the diamond film may be formed on the tapered surfaces of a
20 plurality of scribing wheel base materials each of which has a blade edge portion formed thereon by mutually contacting the side surfaces of the scribing wheel base materials in a face-to-face state, and outside both ends of the scribing wheel base materials, contacting a pair of
25 spacers with entire outer both side surfaces of the both

sides of the scribing wheel base materials.

In the method for manufacturing the scribing wheel, the annular grooves of the scribing wheel base material may be formed by irradiating the side surfaces of the scribing
5 wheel base material with laser beams in parallel to the side surfaces of the scribing wheel base material.

In the method for manufacturing the scribing wheel, the annular grooves of the scribing wheel base material may be formed by irradiating the side surfaces of the scribing
10 wheel base material with laser beams perpendicularly to the side surfaces of the scribing wheel base material.

According to the present invention having such a specific feature as mentioned above, even in the case where the diamond film adheres to the side surface area
15 corresponding to the boundary region between a tapered surface of the diamond film and the side surface, since the diamond film formed on the side surface area has been removed, it is possible to prevent deterioration of a yield caused by a change in thickness of the scribing wheel due
20 to the adhesion of the diamond film. Moreover, since there is no diamond film affixed to the side surface of the scribing wheel, the sliding resistance can be reduced in the case of using the scribing wheel attached to a wheel holder. Therefore, there can be obtained an effect of
25 preventing a damage of the wheel holder.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 (a) and (b) are a schematic views showing an
adhesion process of a diamond film when manufacturing a
5 scribing wheel;

Figs. 2 (a) and (b) are front and side views,
respectively, showing a manufacturing process of the
scribing wheel according to embodiment 1 of the present
invention;

10 Fig. 3 is a schematic view showing an adhesion
process of a diamond film onto a scribing wheel base
material according to embodiment 1 of the present
invention;

Figs. 4 (a) and (b) are enlarged sectional views each
15 showing a boundary region between a side surface and a
tapered surface of the scribing wheel before and after
applying laser beams;

Figs. 5 (a) and (b) are front and side views,
respectively, showing laser beam irradiation to the
20 scribing wheel base material according to the embodiment of
the present invention;

Figs. 6 (a) and (b) are front and side views,
respectively, showing the scribing wheel after applying
laser beams according to the present embodiment; and

25 Fig. 7 is a side view showing laser beam irradiation

to the scribing wheel base material according to another embodiment of the present invention;

Figs. 8 (a) and (b) are schematic views each showing an adhesion process of a diamond film onto a scribing wheel
5 base material according to another embodiments; and

Figs. 9 (a), (b) and (c) are side views each showing laser beam irradiation to the scribing wheel base material according to another embodiment of the present invention.

10 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 2 (a) and (b) are respectively a front view and a side view, showing a manufacturing process of a scribing wheel according to embodiment 1 of the present invention. At a time of manufacturing the scribing wheel, for example,
15 as shown in Fig. 2 (a), a through hole 11 is first formed to be used as a shaft hole in a center of a disk 10 that is to be used as a cemented carbide scribing wheel base material. Next, a shaft of such as a motor (not shown) is inserted through this through hole 11, and while the disk
20 10 is being rotated as a rotating shaft about a center axis of the through hole 11, the entire circumference of the disk 10 is obliquely ground with respect to the rotating shaft from both of the front and back sides of the disk 10. Thus, the disk 10 is formed to be V-shaped in vertical
25 section view as shown in Fig. 2 (b) and this disk 10 is

used as a scribing wheel base material 12 while the V-shaped portion is used as a blade edge. Note that the V-shaped slant surfaces formed in this manner are referred to as tapered surfaces 13 and 14, and the side surfaces of the disk 10 are denoted by reference numerals 15 and 16.

Next, the following describes a procedure of forming a diamond film onto the tapered surfaces 13 and 14. First, the V-shaped tapered surfaces 13 and 14 are previously made to be rough surfaces such that the diamond film can be easily affixed thereto. Then, as shown in Fig. 3, the scribing wheel base material 12 is held between a pair of spacers 21 and 22, and these members 12, 21 and 22 are fixed at the upper and lower positions by a column member 23 passing through these members. A diameter of a side surface (upper and lower surfaces in Fig. 3) of each of the spacers 21 and 22 is made slightly larger than that of each of a diameter of the side surfaces 15 and 16 of the scribing wheel base material 12. Thus, each of the side surfaces 15 and 16 of the scribing wheel base material 12 can be fully made to contact with each of the side surfaces of the spacers 21 and 22. After a pre-treatment process under this condition, these members 12, 21 and 22 are put into a film forming furnace and a diamond film 17 is formed on the tapered surfaces 13 and 14 of the scribing wheel base material 12. Next, after the scribing wheel base

material 12 and the pair of spacers 21 and 22 are separated, these members are cleaned by such as ultrasonic cleaning.

In the case where a necessary film thickness is not obtained by film forming only once, the necessary film
5 thickness may be obtained by repeating the film forming mentioned above and the film forming process of the diamond film on the side surfaces of the scribing wheel base material multiple times.

When the diamond film is affixed to the tapered
10 surfaces 13 and 14 of the scribing wheel base material 12 in the film forming furnace, the diamond particles also spill over around the outermost peripheral annular portions of the side surfaces 15 and 16 and slightly adhere thereto and form annular convex portions. Fig. 4 (a) is a
15 sectional view showing a partially enlarged outer peripheral portions where the tapered surface 13 and the side surface 15 intersect, showing that the diamond film 17 is affixed to the outer peripheral portions of the tapered surface 13 and the side surface 15.

20 Next, in order to remove the diamond film spilling over around and adhering to the side surface 15, laser beams are applied to the annular area 15a that corresponds to a boundary region between the side surface 15 and the V-shaped tapered surface 13, of the scribing wheel base
25 material 12 after forming the diamond film 17, as shown in

Figs. 5 (a) and (b). As a laser source, it is preferable to use a laser source that generates a laser beam of a short pulse width, for example, 10 nanosecond or shorter in order to reduce thermal influence to the diamond film and the scribing wheel base material. A hatching portion shown in Fig. 5 (a) indicates an area that is irradiated with laser beams. By applying laser beams, not only the diamond film 17 affixed to the side surface 15, but also the annular area 15a of cemented carbide which constitutes the scribing wheel base material 12 is slightly removed, for example, about 5 μm depth, in an annular shape. This results in that an annular groove 15b is formed as shown in Fig. 4 (b) showing a sectional view of a small circular portion in Fig. 5 (b). Accordingly, even in the case where the diamond film 17 is slightly affixed to the side surface 15, the excessive diamond film can be completely removed from the side surface 15 after applying laser beams.

Further, in order to remove the diamond film spilling over around and adhering to the side surface 16, the scribing wheel base material 12 is reversed as shown in Figs. 5 (a) and (b), and laser beams are applied to an annular area 16a that corresponds to a boundary region between the side surface 16 and the tapered surface 14, similarly. Thus, the excessive diamond film 17 affixed to the annular area 16a is removed, and a corresponding

portion of the side surface 16 of the scribing wheel base material irradiated with laser beams is annularly removed to be a concave of about 5 μm depth, which results in forming an annular groove 16b. It is preferable that each of the annular grooves 15b and 16b is formed to have a width in a range of 100 μm to 200 μm so as to be able to surely remove the convex portions of the side surfaces 15 and 16. In the present embodiment, the width is made about 150 μm .

Thereafter, a tip portion having the diamond film affixed is ground by a grinding material such as a grinding stone such that the tip end is sharpened. The grinding may have two steps of rough grinding and finishing grinding, and the tip end may have an obtuse angle to be larger than that of the original diamond film 17 by, for example, about 5°. Figs. 6 (a) and (b) are respectively front and side views, showing the scribing wheel completed in this way.

Thus, by removing the diamond film affixed to the side surfaces 15 and 16, the annular convex portions on the side surfaces are removed. Therefore, frictions at the boundary region between the side surfaces of a wheel holder and the tapered surfaces of the scribing wheel base material are reduced and the sliding resistance can be improved.

Note that, although laser beams are applied

perpendicularly to the side surfaces of the scribing wheel to thereby delete the annular convex portion formed of the diamond film affixed to the side surface in this embodiment, laser beams may be applied in parallel to the side surfaces
5 of the scribing wheel as shown in Fig. 7. Also, the diamond film affixed to the side surfaces may be removed using a grindstone instead of laser beams.

Further, although the scribing wheel base material is held via a pair of spacers when the diamond film is affixed
10 to the tapered surfaces of the scribing wheel base material in this embodiment, in the case where the diamond film is affixed to a plurality of scribing wheel base materials at the same time, the scribing wheel base materials 12 and the spacers 31, 32, ... and the like may be alternately
15 contacted as shown in Fig. 8 (a) to form the diamond film.

Further, in the case where the diamond film is affixed to a plurality of scribing wheel base materials at the same time, the spacers 31 and 32 may be placed only on the both ends as shown in Fig. 8 (b) to form the diamond
20 film by holding the plurality of scribing wheel base materials 12 between the spacers with the side surfaces of the scribing wheel base materials 12 which are mutually contacted in a face-to-face state. In this case, by applying laser beams in parallel to the side surfaces as
25 shown in Figs. 9 (a) and (b), removal of the diamond film

affixed to the side surfaces and separation of each of the scribing wheel base materials can be performed at the same time. Here, Fig. 9 (c) is a partially enlarged view showing a boundary region between the side surface and the tapered surface, which is shown as a small circle in Fig. 9 (b).

In addition, although the tip portion together with the diamond film affixed thereto is ground after removing the diamond film affixed to the side surfaces in this embodiment, the diamond film affixed to the side surfaces may be removed after grinding the tip end of the diamond film.

What is claimed is:

1. A scribing wheel comprising:

5 a scribing wheel base material that is formed with a ridge line along a circumferential portion thereof and has a blade edge including the ridge line and tapered surfaces of both sides from said ridge line;

a diamond film formed on the tapered surfaces of said scribing wheel base material; and

10 annular grooves formed in annular areas corresponding to boundary regions between side surfaces and the tapered surfaces having the diamond film formed thereon in both sides of said scribing wheel base material.

15 2. A method for manufacturing a scribing wheel that is formed with a ridge line along a circumferential portion of a disk and has a blade edge including the ridge line and tapered surfaces of both sides from the ridge line, the method comprising:

20 grinding the both sides of side surfaces along a circumference of a disk-shaped scribing wheel base material in a manner of mutually and obliquely cutting from the both sides of the side surfaces to thereby form a blade edge portion including the tapered surfaces and the ridge line
25 at the circumferential portion;

forming a diamond film on the tapered surfaces of the scribing wheel base material; and

cutting off annular areas corresponding to boundary regions between the side surfaces and the tapered surfaces
5 having the diamond film formed thereon, thereby removing the diamond film on the annular areas of the side surfaces and forming annular grooves.

3. The method for manufacturing the scribing wheel
10 according to claim 2, wherein the annular grooves of the side surfaces of the scribing wheel base material are formed by irradiating the annular areas with laser beams.

4. The method for manufacturing the scribing wheel
15 according to claim 2, wherein the diamond film is formed on the tapered surfaces of a plurality of scribing wheel base materials by alternately contacting the plurality of scribing wheel base materials each of which has a blade
edge portion formed thereon with spacers that are in
20 contact with the entire side surfaces of each of the scribing wheel base materials.

5. The method for manufacturing the scribing wheel
according to claim 2, wherein the diamond film is formed on
25 the tapered surfaces of a plurality of scribing wheel base

materials each of which has a blade edge portion formed thereon by mutually contacting the side surfaces of the scribing wheel base materials in a face-to-face state, and outside both ends of the scribing wheel base materials,
5 contacting a pair of spacers with entire outer both side surfaces of the both sides of the scribing wheel base materials.

6. The method for manufacturing the scribing wheel
10 according to claim 3, wherein the annular grooves of the scribing wheel base material are formed by irradiating the side surfaces of the scribing wheel base material with laser beams in parallel to the side surfaces of the scribing wheel base material .

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7. The method for manufacturing the scribing wheel according to claim 3, wherein the annular grooves of the scribing wheel base material are formed by irradiating the side surfaces of the scribing wheel base material with
20 laser beams perpendicularly to the side surfaces of the scribing wheel base material.