PROCESSING DISK FOR PROCESSING A SUBSTRATE

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ABSTRACT
A processing disk (10) for processing a substrate (22), including a carrying body (11) having an accommodation region (13) and a processing region (14) and including a processing section (17) having one or more segments (12) that are connected to a connection region (24) of the carrying body (11), wherein a cooling opening (25) is provided in at least one segment (12) and/or in at least one connection region (24) of the carrying body (11) for a segment (12).
PROCESSING DISK FOR PROCESSING A SUBSTRATE

[0001] The present invention relates to a processing disk for processing a substrate.

[0002] The term “processing disk” subsumes all processing disks for processing a substrate using grinding, cutting, and similar processing methods. The processing disks may be designed as flat or pot-shaped processing disks, and include a support body and a processing section made of one or multiple segments which are connected to the support body. The processing disks may have multiple segments or a single, annular segment. Depending on the respective processing method of a processing disk, the segments are designated as grinding segments or cutting segments.

BACKGROUND

[0003] A processing disk designed as a grinding disk for surface processing of a mineral, coated, or other substrate is known from EP 0 865 878 A1. The grinding disk is designed as pot-shaped and includes a support body having a reception region and a grinding region as well as a processing section including multiple grinding segments. The grinding segments are connected to a connection region of the support body on a backside facing away from the substrate to be processed. Soldering and welding, among others, are used as processing methods for connecting the grinding segments. In order to exhaust removed material, the grinding disk has exhaust openings in the support body, via which removed material is exhausted by an exhaust system.

[0004] During the surface processing using the grinding disk, the grinding segments heat up due to friction with the substrate to be processed. In order to increase the lifespan of the grinding segments and to support the machining process, the grinding disk is cooled during processing. The coolant flows via the intermediate spaces between the grinding segments and the exhaust openings in the support body into the inner region of the grinding disk. The grinding segments are cooled on the one hand by the coolant and on the other hand emit heat to the cooled support body.

[0005] The known processing disk has the disadvantage that the lifespan of the segments is limited, despite addition of a coolant via the intermediate spaces between the cutting segments. In addition, cooling is impeded due to small intermediate spaces between the segments.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a processing disk for processing a substrate having an increased lifespan of the segments. In addition, the processing speed during the processing should be increased.

[0007] According to the present invention, a cooling opening is provided at least partially in at least one segment and/or in at least one connection region of the support body to a segment. Cooling openings, which are provided in the connection region of the support body, in the segment, or in the support body and in the segment, improve the heat dissipation from the segments during the processing of a substrate. Due to the improved heat dissipation, the lifespan of the segments and the processing speed during processing are increased.

[0008] The at least one cooling opening is preferably provided completely at least one segment and/or in at least one connection region of the support body. If the cooling opening is situated completely in the segment or in the segment and in the connection region, then the contact surface for the coolant with the segment is enlarged and the cooling effect is increased. The coolant is liquid or gaseous, air being primarily used as the coolant.

[0009] In a first variant, the cooling opening is formed in the support body, the cooling opening being designed as a through opening or as a blind opening. The formation of the cooling opening in the support body has the advantage of easy producibility. The support body is, for example, formed as a steel body and the cooling opening is created in the support body by drilling, milling, stamping, or comparable manufacturing methods.

[0010] A cooling opening passing through the support body, which is designated as a through opening, has the advantage that the coolant contacts the backside of the segments and the heat is released from the segment directly to the coolant. The size and geometry of the cooling opening are selected in such a way that a secure fastening of the segment to the connection region of the support body is ensured and the shear forces necessary for approving the processing disk are maintained. The through opening has a further advantage; it reduces the connection surface between the segment and the support body and thereby increases the contact pressure during welding. The higher contact pressure results in a better connection between the segment and the support body.

[0011] A cooling opening that does not pass completely through the support body, which is designated as a blind opening, has the advantage that the connection surface between the support body and the segments is not reduced by the cooling opening. The blind opening in the support body is suitable for processing disks in which the fastening of the segments on the support body is critical.

[0012] In a second variant, the cooling opening is formed in the support body and in the segment. The formation of the cooling opening in the support body and in the segment enlarges the contact surface between the segment and the coolant and thereby increases the heat transmission from the segment to the coolant. The larger the contact surface between the segment and the coolant, the better the cooling effect for the segment and the higher the lifespan of the segments.

[0013] The cooling opening is preferably formed as a through opening in the support body and as a through opening in the segment. A cooling opening passing completely through the support body and the segment enlarges the contact surface between the segment and the coolant and improves the cooling effect. The coolant flows through the entire segment and transports the heat away from the segment. In addition, removed material may be evacuated via the cooling openings.

[0014] The cooling opening is alternatively formed as a through opening in the support body and as a blind opening in the segment. A cooling opening not passing completely through the segment has the advantage that the entire cross-sectional area of the segment is available for the processing.

[0015] In a third variant, the cooling opening is formed as a through opening in the segment. The through opening in the segment reduces the connection surface between the segment and the support body and thereby increases the contact pressure during welding. The higher contact pressure results in a better connection between the segment and the support body.

[0016] The cooling opening amounts to up to 80% of the cross-sectional area of the segment in a preferred embodiment. The larger the contact surface between the segment and
the coolant, the better the cooling effect for the segment and the longer the lifespan of the segments. In order to ensure a secure fastening of the segments to the support body and to achieve the prescribed shear forces, the connection surface between the segment and the support body amounts to at least 20% of the cross-sectional area of the segments.

In a further preferred embodiment, the cooling opening is filled with a heat conducting material, the heat conductivity of the material being higher than the heat conductivity of the support body. Copper, resin, and aluminum are suitable as materials for support bodies made of steel. Filling the cooling opening with a heat conducting material is suitable for processing disks, whose stability is to be increased. In order to improve the cooling effect with regard to processing disks without cooling openings, a material is selected whose heat conductivity is higher than the heat conductivity of the support body.

Exemplary embodiments of the present invention will be subsequently described based on the drawings. These do not necessarily represent the exemplary embodiments to scale; rather, the drawings are carried out in schematic and/or slightly distorted form where this is useful to the explanation. Reference is made to the relevant prior art in view of additions from the teachings directly recognizable from the drawing. It is thereby taken into consideration that multiple modifications and changes affecting the shape and detail of a specific embodiment may be carried out without departing from the general concept of the present invention. The features of the present invention disclosed in the description, the drawings, and also in the claims may be essential for the refinement of the present invention, individually as well as in any arbitrary combination. In addition, the scope of the present invention includes all combinations of at least two of the features disclosed in the description, the drawings, and/or the claims. The general concept of the present invention is not limited to the exact form or detail of the preferred specific embodiment described and shown in the following, or limited to a subject matter which would be limited in comparison to the subject matter claimed in the claims. With regard to the dimensional ranges cited, values lying within the listed limits are disclosed as limiting values and should be arbitrarily applicable and claimable.

BRIEF DESCRIPTION OF THE DRAWINGS

For the sake of simplicity, the same reference numerals are subsequently used for identical or similar parts, or for parts having identical or similar functions.

FIGS. 1A through C show a first specific embodiment of a processing disk according to the present invention designed as a grinding disk including a support body and multiple grinding segments in a view from below onto the grinding segments (FIG. 1A), in a section through the grinding disk along line I-I in FIG. 1A (FIG. 1B), and in a top view onto the support body (FIG. 1C); and

FIGS. 2A, B show a second specific embodiment of a processing disk according to the present invention including a support body and multiple grinding segments in a view from below onto the grinding segments (FIG. 2A) and in a section through the grinding disk along line II-II in FIG. 2A (FIG. 2B).

DETAILED DESCRIPTION

FIGS. 1A through C show a first specific embodiment of a processing disk according to the present invention for processing a mineral or coated substrate. The processing disk is designed as a pot-shaped grinding disk 10. Grinding disk 10 includes a support body 11 and multiple grinding segments 12 which are connected to support body 11. Grinding segments 12 are, for example, soldered or welded to support body 11 or fastened on support body 11 with the aid of similar processing methods.

FIG. 1A shows grinding disk 10 in a view from below onto grinding segments 12. Support body 11 of grinding disk 10 includes a reception region 13, a processing region 14 designed as a grinding region, and a transition region 15 connecting the reception and grinding regions 13, 14 formed by the pot shape of grinding disk 10; in the case of flat processing disks, the transition region is eliminated. Reception region 13 of support body 11 is used to fix grinding disk 10 on a drive shaft of a tool. A central opening 16 for the drive shaft is provided in reception region 13.

Grinding segments 12 are connected to support body 11 in grinding region 14. Cutting segments 12 are designated collectively as processing section 17 (FIG. 1B). Grinding disk 10 has a processing section 17 including seven triangular-shaped grinding segments 12, the sides of the grinding segments 12 being curved outward. To distinguish the grinding segments and further elements in the figures, an indicator “·” is used. The number of grinding segments 12 and the geometry of grinding segments 12 are adapted to the diameter of grinding disk 10 and to the substrate to be processed. In addition to triangular-shaped grinding segments 12, L-shaped grinding segments, U-shaped grinding segments, and rectangular grinding segments having curved lateral surfaces are known. Grinding segments 12 have in each case two grooves 19 on a front side 18 facing away from grinding region 14 of support body 11. Grooves 19 are used to facilitate exhaustion of removed material.

Grinding region 14 has multiple exhaust openings 21, which are situated in the circumferential direction of grinding disk 10 and have essentially the same distance to each other. During grinding with grinding disk 10, material removed from the substrate being processed is exhausted via exhaust openings 21. Exhaust openings 21 are shaped as ovals for grinding disk 10 and are displaced relative to transition region 15 of support body 11. In order to ensure a good exhaustion, exhaust openings 21 should be preferably large. On the other hand, support body 11 must have a sufficient stability in grinding region 14.

FIG. 1B shows a section through grinding disk 10 and first grinding segment 12.1 along line I-I in FIG. 1A during processing of a substrate 22. The connection between support body 11 and grinding segments 12 is described using the example of first grinding segment 12.1 and applies analogously for the six further grinding segments 12.2 through 12.7 of processing section 17, which are constructed identically to first grinding segment 12.1.

First grinding segment 12.1 is connected to support body 11 on a back side 23 facing away from front side 18. Support body 11 has a connection region 24.1 at which grinding segment 12.1 is fastened to support body 11. The entire region of support body 11, to which first grinding segment 12.1 abuts, is designated as a connection region; the connection region does not only include the connection surface.

An opening 25.1, which is designated as a cooling opening, is provided in connection region 24.1 of support body 11. Cooling opening 25.1 is designed in support body 11 as a through opening which passes completely through sup-
port body 11. A coolant flows via through opening 25.1 through support body 11 to grinding segment 12.1 and cools the grinding segments 12.1 on back side 22. The coolant is liquid or gaseous, air being primarily used as the coolant.

[0029] FIG. 1C shows grinding disk 10 in a top view onto support body 11. Seven oval-shaped exhaust openings 21.1 through 21.7 and seven circular cooling openings 25.1 through 25.7 are provided in grinding region 14 of support body 11. Circular cooling openings 25.1 through 25.7 are situated in connection regions 24.1 through 24.7 of support body 11 and exhaust openings 21.1 through 21.7 are situated in grinding region 14 between connection regions 24.1 through 24.7.

[0030] The coolant flows into cooling openings 25 and cools grinding segments 12 on backside 22. The heat from grinding segments 12 is released directly to the coolant. The cooling of grinding segments 12 improves with the increasing size of cooling opening 25. The size of cooling openings 25 is thereby limited in that grinding segments 12 are connected to support body 11 on backside 22. Therefore, the size of cooling openings 25 is selected in such a way that, in addition to a good cooling, a secure fastening of grinding segments 12 on support body 11 is ensured and the prescribed shear forces are achieved for the approval of processing disk 10.

[0031] Alternatively to cooling openings 25 shown in FIGS. 1A through 1C, which as through openings pass through connection region 24 of support body 11, the cooling openings may be designed in support body 11 as blind openings. Blind openings do not reduce the connection surface between support body 11 and grinding segments 12; however, the cooling effect is lower for blind openings than for through openings.

[0032] Grinding disk 10 has seven triangular grinding segments 12.1 through 12.7 and seven circular cooling openings 25.1 through 25.7 in connection regions 24.1 through 24.7 of support body 11. Alternatively, the grinding disk may have different grinding segments with differently shaped cooling openings, the cooling openings may be situated at different positions in the connection region with identically constructed grinding segments, or the geometry of the cooling openings may differ with identically constructed grinding segments. The geometry of cooling openings 25 is adapted to the geometry of grinding segments 12, to the substrate to be processed, etc. A circle, a triangle, an octagon, a star shape, or an ellipse, among others, are suitable as the geometry for cooling openings 25.

[0033] FIGS. 2A, B show a second specific embodiment of a processing disk 30 according to the present invention for surface processing of a mineral or coated substrate. Processing disk 30 is designed like processing disk 10 as a pot-shaped grinding disk.

[0034] Grinding disk 30 includes a support body 31 and multiple grinding segments 32, which are connected to support body 31. Grinding disk 30 differs from grinding disk 10 from FIGS. 1A through 1C in the cooling openings, which are provided in support body 31 and grinding segments 32.

[0035] FIG. 2A shows grinding disk 30 in a view from below onto grinding segments 32. Support body 31 of grinding disk 30 includes, like support body 11 of grinding disk 10, grinding region 14, transition region 15, and reception region 13 including central opening 16. Grinding segments 32 are designed as triangular, and grinding segments 32 each have two grooves 19 on the front side 18 facing away from grinding region 14.

[0036] One cooling opening 33 is assigned to each grinding segment 32. Cooling openings 33 are designed as circular through openings, which pass completely through support body 31 and grinding segments 32. The coolant flows on the upper side of support body 31 into cooling openings 33, flows through support body 31 and grinding segments 32, and is exhausted by the exhaust system together with the removed material.

[0037] FIG. 2B shows grinding disk 30 in a section through grinding disk 30 and first grinding segment 32.1 along line II-II in FIG. 2A during the processing of substrate 22. The connection between support body 31 and grinding segments 32 and the arrangement of cooling openings 33 in support body 31 and grinding segments 32 is described by way of first grinding segment 32.1 as an example, and applies analogously for all further grinding segments 32.2 through 32.7.

[0038] Support body 31 has a connection region 34.1, at which grinding segment 32.1 is connected to support body 31. Cooling opening 33.1 is in two parts formed from one through opening 35.1 in support body 31 and one through opening 36.1 in grinding segment 32.1. Cooling opening 33 passing completely through support body 31 and grinding segment 32.1 has the advantage that the cooling effect is improved by the large contact surface between the coolant and grinding segment 32.1.

[0039] The cross-sectional area of cooling openings 33 is limited in that the connection surface for fastening grinding segment 32 is reduced by the cross-section of cooling opening 33. Prescribed shear forces must be achieved for approval of the grinding disk. For this purpose, a certain connection surface between support body 31 and grinding segment 32 is necessary. The size of the cross-sectional area of cooling openings 33 is selected in such a way that in addition to a good cooling, a secure fastening of grinding segment 32 on support body 31 is ensured and the prescribed shear forces are achieved.

[0040] Alternatively to the through openings 35.36 in support body 31 and in grinding segment 32 shown in FIG. 2A, B, the cooling openings may be designed in support body 31 as through openings and in grinding segment 32 as blind openings.

What is claimed is:

1. 1-11. (canceled)
2. A processing disk for processing a substrate comprising:
   a support body including a reception region and a processing region; and
   a processing section including one or multiple segments, the segments being connected to a connection region of the support body, a cooling opening being provided at least partially in at least one segment or in at least one connection region of the support body to a segment.
3. The processing disk as recited in claim 12 wherein the cooling opening is provided completely in the at least one segment or in the at least one connection region of the support body.
4. The processing disk as recited in claim 12 wherein the cooling opening is formed in the support body.
5. The processing disk as recited in claim 14 wherein the cooling opening in the support body is designed as a through opening.
6. The processing disk as recited in claim 14 wherein the cooling opening in the support body is designed as a blind opening.
17. The processing disk as recited in claim 14 wherein the cooling opening is formed in the support body and in the segment.

18. The processing disk as recited in claim 17 wherein the cooling opening is designed as a through opening in the support body and as a through opening in the segment.

19. The processing disk as recited in claim 17 wherein the cooling opening is designed as a through opening in the support body and as a blind opening in the segment.

20. The processing disk as recited in claim 12 wherein the cooling opening is designed as a through opening in the segment.

21. The processing disk as recited in claim 12 wherein the cooling opening amounts to up to 80% of the cross-sectional area of the segments.

22. The processing disk as recited in claim 12 wherein the cooling opening is filled with a heat conducting material, the heat conductivity of the material being higher than the heat conductivity of the support body.