

Versatile holder for the surface treatment of rod-shaped substrates

The present invention relates to a holder for the surface treatment of rod-like substrates. A holder according to the present invention is particularly well suited for the surface treatment of cutting tools of the variety bar blade.

State of the art

Surfaces of many objects are nowadays treated in order to achieve certain properties at the surface.

Surfaces of components and tools are nowadays often significantly improved by coatings for particular applications.

The choice of the right substrate holder plays a very important role in any surface treatment process. Therefore expedient substrate holders for specific surface treatment processes are being developed that take into account the nature of the substrate surface to be treated, as well as other substrate properties (such as, for example substrate shape, -dimension and -composition).

A nowadays usual surface treatment of substrates is the coating. Thereby layers are coated with special properties to certain substrate surfaces. By coating improved properties are imparted to the substrate surfaces, which enable the use of these substrates in certain applications or a power increase of these substrates in a particular application.

For example, the cutting surfaces of cutting tools are normally (at least partially) coated with wear protection coatings to increase the cutting performance of these tools.

Therefore specific substrate holders are developed.

For example, the patent document DE60002579T2 discloses a hollow substrate holder, which is used for carrying a drill set for depositing a ceramic coating on portions of the drills, which extend from the tips thereof. This substrate holder comprises:

- at least one perforated outer wall provided with an array of openings into which the drills are inserted so that the aforementioned parts protrude from the holder
- a support wall within the hollow interior of the holder for the or each perforated outer wall parallel to the outer wall and spaced by the latter and provided with a corresponding array of openings, in order to arrange the inserted drills substantially in parallel with their shafts,
- a stop means within the hollow interior of the holder which is spaced from the or each support wall inwardly so as to position the tips of drills of the same diameter, which essentially protrude the same extent from the outer wall, the hollow interior of the holder and the positioning of the drills are such that the part of each drill within the outer wall is shielded from the external environment, but is exposed to the atmosphere in the interior of the holder.

However, the above-mentioned support has the disadvantage that it lacks versatility, and therefore can not be applied for the coating of different kinds of rod-like substrates at the same time, but only for the coating of substrates (in this case drills) having substantially the same length and same diameter.

object of the present invention

It is an object of the present invention to provide a versatile holder for the surface treatment of rod-like substrates with at least two areas with different cross section, whereby one of these areas includes an end having a cross section smaller than the cross section of the at least another area. The holding must allow that at least the end of smaller cross section can be coated in the same way independently of the entire substrate length.

The holder according to the present invention should also allow the rod-shaped substrates fastened in the holder to be subjected to a plurality of surface treatment processes, without the need of the substrates to be discharged from the holder and then reloaded into the same or into a different holder. Thereby, the amount of handling and risk of damage to the substrates are reduced.

In particular, to enable a holder according to the present invention should enable cleaning, pre-treatment, coating and post-treatment of blades according to the application requirements.

Description of the Invention

Figures 1 to 9 are intended as a contribution to better understanding but not to limit the present invention:

Figure 1: Substrate body 10 having a surface to be treated in the substrate body area B_{Q1} and a not to be treated surface in the substrate body area B_{Q2} .

Figure 2: Holder according to an embodiment of the present invention having an array of support elements 9 to accept rod-shaped substrate bodies, which support elements 9 are attached to a front wall 3 with an array of openings (5), so that one support element 9 is attached at each opening 5, and wherein at each opening 5 a retaining element 11 is present for stopping the substrate body. The support elements shown in Figure 2 are, for example, rectangular profiles with recesses 30, which should facilitate cleaning of the substrate body 10 (not shown in the Figure 2) during a cleaning process.

Figure 3: Arrangement of support elements 9, wherein the support elements 9 are arranged with an inclination angle α to the horizontal and arranged parallel in the vertical plane.

Figure 4: Holder according to an embodiment of the present invention with an additional perforated wall as a supporting wall 13.

Figure 5: Holder according to an embodiment of the present invention with connecting elements 15 for fixing the position of the front wall 3 in relation to the support wall 13. At the same time, an arrangement of support elements 9 is shown in Figure 5, in which the supporting elements 9 are arranged incisive in the horizontal plane and thus the distance between the support elements in the horizontal plane

with respect to the areas closer to the support elements 9 that are closer to the front cover 3, is greater with regard to the areas of the supporting members 9 arranged distant from front cover 3.

Figure 6: a) front cover mask 17 with an array of apertures 5'' and a retaining element 11 at each opening 5'', and b) holder with a front cover mask 17. In the holder of Figure 6b, the front cover mask 17 is attached to the front wall 3 by connecting elements 8, for example screws, so that the substrate body 10 using the retaining elements 11 of the front cover mask 17 are stopped in a manner that the area of the substrate body with its surface to be treated protrudes from the holder through the openings 5' or 5''. The distance between the front cover mask 17 and the front wall 3 is selected so that no beam particles can remain trapped between the front wall 3 and the front cover mask 17, if for example, the surface to be treated is subjected of a granulate-beaming surface treatment.

Figure 7: Holder according to an embodiment of the present invention with connecting elements 15 in the form of walls, such that the holder is constructed in the form of a compartment cartridge 20. In addition, a cover 40 is shown, which is intended for example in a coating process to prevent not to be treated areas of the substrate body from being coated. Therefore, such a cover 40 is referred to in the present invention in particular as a coating protective cover 40.

Figure 8: Holder arrangement with two holders, each holder according to an embodiment of the present invention, one arranged on top of the other, a) with a coating protective cover 40, for example for carrying out a coating process, and b) without coating protective cover 40, for example for carrying out a cleaning or granulate-beaming process.

Figure 9: Holder according to one embodiment of the present invention with a transport protection cover (50).

The object of the present invention is achieved by providing a holder with an open design, as described in claim 1.

The present invention relates to a holder (such as the holder shown for example in Figure 2) for the attachment of rod-shaped substrates 10 (such as the substrate shown for example in Figure 1) with at least two areas, B_{Q1} and B_{Q2} , with different cross sections $Q1$ and $Q2$, wherein one of the areas includes an end having a cross section smaller than the cross section of the at least other area, for example $Q1 < Q2$, wherein the holder comprises at least one perforated wall, which is provided with an array of openings and is used as the front wall 3, into which the rod-shaped substrates can be inserted, wherein:

- at each opening 5 of the front wall 3 a support element 9 (i.e. a U-profile or a rectangular profile) is arranged positioned from the opening level upwards obliquely, preferably with an inclination angle to the horizontal α (as in Figure 3) greater than 2° , where the substrate can be arranged at least partially, and
- at least one guide element 11 is provided at each opening 5 of the front wall 3, to stop the substrate at the at least one location between the area with the smaller cross-section B_{Q1} and the at least other area B_{Q2} .

The substrate is thereby inserted into the holder in such a way that the end of the substrate in the range of smaller cross section B_{Q1} lies under the other end of the substrate. Thanks to this holder structure the substrates can be inserted through the supporting elements into the holder towards the front wall, so that the substrates are pressed by the force of gravity towards the retaining elements and be stopped by the retaining elements in such a way, that at least the end of the substrate in the region of smaller cross section B_{Q1} will protrude through the opening 5 of the front wall 3 from the holder.

According to one embodiment of the present invention, the supporting members 9 have two ends and at least one support element is disposed so that one end of the supporting member is strut onto an opening 5 of the front wall 3 (as shown in Figure 2). Preferably, the support elements 9 are welded to the openings.

A further preferred variant of the holder according to the present invention comprises at least a second perforated wall, which serves as a supporting wall 13 for the supporting elements 9. This supporting wall 13 is also provided with an array of openings $5'$, through which the substrates can be inserted into the holder. The arrangement of openings $5'$ in the support wall 13 is preferably the same as the arrangement of openings 5 in the front wall 3. In this way, for example, the remote end from the front wall 3 of the supporting member 9 can be strut onto an opening $5'$ of the support wall 13 (as shown in Figure 4). Preferably the support wall 13 is disposed substantially in parallel from the front wall 3 and the arrangement of the openings $5'$ of the support wall 13 is at least slightly above that of the front wall 3, so that the supporting elements 9 may rest as already mentioned above in an inclination angle α to the horizontal, while keeping the end of a support element 9 arranged at the front end wall 3 located below the portion of the support wall 13 of the support element 9. Preferably, the areas of the support elements 9 arranged at the openings $5'$ of the support wall 13 are welded onto the openings $5'$.

In a further preferred variant of a holder according to the present invention, the retaining elements 11 are made as part of a front cover mask 17 with an array of openings $5''$ (as shown for example in Figure 6a) so that the front cover mask may be secured for example by means of connecting elements 18 onto the front wall. The connecting elements 18 can be, for example, screws which can serve as detachable connections (as shown in Figure 6b).

Because of the open design of the holders according to the present invention, they enable the cleaning of the substrates held in the holders in cleaning baths.

Preferably, the position of the front wall 3 in relation to the position of the support wall 13 in the holder is fixed by composite elements 15 (as shown in Figure 5).

In addition, such a holder with an open design according to the present invention may also be used for the mechanical surface treatment of the parts of the substrates which protrude from the holder through the openings 5, $5''$ of the front wall 3 and the front cover mask 17 (at least the end or the peak in the area B_{Q1}). In the sense of mechanical surface treatment within the scope of the present invention is in particular meant the procedure of granulate-beaming processes.

In a preferred variant of a holder according to the present invention, particularly well suited for cleaning, coating and other surface treatments, such as granulate-beaming (e.g. as a pre- and/or post-treatment of the surface to be coated) of cutting tools of the variety blades, the composite elements 15 may be walls (as shown in Figure 7) so that it is prevented that parts of the body of the substrates are undesirable coated of its sides. This variant, in the context of the present invention, is called compartment cartridge 20.

In order to ensure that only the desired surfaces of the substrates or in the examples of blades the tip portion of the substrates (at least the end of the area B_{Q1}) can be efficiently coated by physical vapor deposition, the holder is equipped according to the present invention with a coating protective cover 40 which shades the regions of the substrate that does not protrude through an opening 5 of the front wall 3. Thereby an unwanted coating of parts of the body not to be coated of the substrate (which may be otherwise be coated from above, below and/or behind) is prevented.

In the compartment cartridge 20, the blades 10 (not shown in Fig. 7) can be set in a matrix arrangement, as shown in Figure 7, as set of blades (i.e. 1 set of 16-22 blades). By a symmetrical structure of the holder, the front cover mask 17 can be mounted in four positions and can be moved vertically, so that at each mounting position of the front cover mask 17 the blades can be kept at a different location. This allows a front cover mask 20 to be used more varied and thus the same front cover mask 17, mounted just in a different position, can be used for the surface treatment of blades with other dimensions and/or geometry.

The above-mentioned inclination angle α of the profiles in relation to the horizontal shall be selected large enough so that the blades do not move through any vibration of the holder back towards the rear portion of the holder. However, the angle should not be selected that large that the surfaces to be coated of the substrates can be shaded such that the coating of these surfaces is impaired. For example, in various versions of a holder according to the present invention, an angle between 5° to 20° from the horizontal (as outlined in Figure 3) has proved to be particularly well suited.

The rectangular sections 9 were "maximum" provided with openings 30, as shown for example in Figure 6b, to achieve an optimum cleaning result.

By the expression "Maximum provided with openings 30" it is meant that the openings 30" are spread in case of the illustrated rectangular profiles 9' such that the largest area of the blades that are held in the rectangular profiles is exposed. At least the profiles must be provided with openings so that at least more than 50% of the area of the blades can have direct contact with the detergent during a cleaning process. Preferably, the profiles will be provided with opening so that the profiles do not lose mechanical stability so as to be deformed by the normal use of the holder.

Another way to build "quasi rectangular profiles", which are provided with a maximum of openings, would be the use of profiles which have a U-shape in cross-section instead of a rectangular shape. In this case, the U-profiles according to the present invention would be positioned such in the holder, that the upper surface of bar blades located in the holder is completely free.

In addition, the distance between the front cover mask 17 and the compartment cartridge 20 has been provided in order to prevent a fixing of particles from a blasting medium between the front cover mask 17 and the rest of the compartment cartridge 20. Preferably, this distance is greater or equal to 0.5 mm. For example, very good results in different beam processes were achieved with a distance of 0.8 mm. But it also has to be considered that this distance must not be so large that undesired surfaces of the substrates could be coated too.

Thus, the use of a holder according to the present invention is possible as well for performing beam processes such as microjets, for treating the surface both before and after the coating. This results in a consistent quality of the complete coating services, but without the increased handling expenses caused by using several holders (sorting of the substrates to be treated, charging into a first holder, discharging, transportation, re-sorting, recharging into a second holder, etc.). This also reduces the risk of damaging the blades during processing.

As well the construction of the compartment cartridge 20 is designed so that the blades 10 are arranged conically in a spherical arrangement. Thus the blades 10 are arranged further spaced, resulting in a more uniform distribution of the coating layer on the surface to be coated by all blades (both external and internal placed blades) (see Figure 6b). With this spherical arrangement of the rectangular profiles, in which the distance between the blades 10 in the rear area B_{Q2} is reduced, the distance between the to be coated blade tips B_{Q1} can be increased, which has a positive influence on the film thickness distribution.

For the use of a holder according to the present invention in a vacuum coating process, in which at least one target is used as the solid material source for the production of the coating, whereby for example blades with a rectangular or similar cross section are coated, having at least one to be coated surface, the blades 10 should preferably be arranged in the profiles 9 so that the surface rotates toward the target in order to allow a higher deposition on the surface and that not to be coated surfaces of the blades B_{Q2} shall be covered with a protective coating 40 (as shown in Figure 7).

Preferably the material that is used for the construction of a holder according to the present invention is selected which does not affect the use of the holder for all process steps, for example steel 1.4301. This material has a sufficient mechanical strength, is suitable for vacuum, non-magnetic, and resistant against the conditions employed during cleaning processes (chemicals and temperatures).

Treatment processes such as cleaning and the microjet may for example, as shown in Figure 8b, be carried out in at least a twin-pack (A + B). This reduces the cost of handling also.

To prevent the coating of undesired surface areas of the blades, i.e. B_{Q2} , the compartment cartridge 20 is covered with the protective coating 40, as shown in Figure 8b. Also trees with at least a twin-pack (A + B) can be constructed as well for the coating, as shown in Figure 8b.

According to the invention the same holder can be used for the implementation of all process steps (e.g. cleaning, microjet or granulate-beaming and coating; possibly

stripping, if it is for example a chemical or electrochemical stripping process), without losing any quality of the treatment of the surface.

During transportation of the substrates from one process step to another in a holder according to the present invention, however, it could happen that the portions of the substrates, which protrude from the support may be damaged. Therefore, these substrate regions will preferably be covered during transport. For example a transport protection cover 50 may therefore be used, as shown in Figure 9.

Claims

1. Holder for fastening at least one rod-like substrate body (10) with variable section along the substrate body and a surface to be treated, which is located in a area B_{Q1} of the substrate body (10) comprising an end of the substrate body (10) and a smaller cross-section than the rest of the substrate body (10), wherein the holder comprises at least one perforated wall as a front wall (3), which is provided with at least one opening (5), preferably having an array of openings (5), characterized in that the holder comprises at least one support element (9) and a retaining element (11), which are arranged at an opening (5), wherein:

- the support element (9) is constructed and/or secured in such a way to the opening (5), preferably welded, that the substrate body may be at least partially disposed oblique at an inclination angle α to the horizontal alongside in the support element (9), and

- the retaining element (11) constructed and/or secured in such a way to the opening (5), preferably by using a connecting element, that the retaining element (11) can stop the substrate body at a position between the area B_{Q1} and the remainder of the substrate body in such a way that the area B_{Q1} projects through the opening (5) from the holder.

2. Holder according to claim 1, characterized in that the angle of inclination α to the horizontal is greater than 2° , preferably $5^\circ \leq \alpha \leq 20^\circ$.

3. Holder according to at least one of the preceding claims 1 to 2, characterized in that the supporting member (9) is elongate and has two ends, one end of the support element (9) being close to the front wall (3) or on the front wall (3) and the other end distant from the front wall (3), and preferably the support element (9) is a U-profile or a rectangular profile or a 5-corner profile.

4. Holder according to claim 3, characterized in that the holder comprises at least two support elements (9) for attachment of at least two substrate members (10) which are arranged parallel in the vertical plane and/or incisive in the horizontal plane, wherein the distance in the horizontal plane between the support elements (9) is greater with respect to the close to the front wall (3) lying areas compared to the distant from the front wall (3) areas, thereby also the distance in the horizontal plane between the substrate members (10) is greater with respect to the close to the front wall (3) lying areas compared to the distant from the front wall (3) areas.

5. Holder according to at least one of the preceding claims 3 to 4, characterized in that the holder comprises at least a second perforated wall, distant by a spacing from the front wall (3), is provided with at least one opening (5'), preferably with an array of openings (5''), and being arranged as a supporting wall (13) for the supporting members (9) in the holder such that at least a part of one of the support elements (9) is supported by an opening (5'), preferably, the part of the support element (9) supported by the opening (5') is fastened, preferably welded, with the opening (5').

6. Holder according to claim 5, characterized in that the number of openings in the array of openings (5') of the supporting wall (13) corresponds to the number of

openings in the array of openings (5) of the front wall (3), and the support wall (13) is arranged in the holder in such a way that each supporting member (9) at the same time is supported by an opening (5) and an opening (5').

7. Holder according to claim 6, characterized in that the supporting wall (13) in the holder is arranged parallel with respect to the front wall (3) and/or the array of openings (5') is designed such that

- in the vertical plane, each opening of the arrangement of openings (5') is arranged above the opening of the corresponding array of openings (5), and/or- in the horizontal plane, the distance between the openings of the array of openings (5') in the support wall (13) is smaller than the distance between the openings of the array of openings (5) in the front wall (3).

8. Holder according to at least one of the preceding claims 1 to 7, characterized in that the retaining elements (11) are made in the form of a front cover mask (17) having an array of openings (5''), which preferably corresponds with the arrangement of openings (5) of the front wall (3) and which is secured to the front wall (3) by means of connecting elements (18), preferably with screws.

9. Holder according to at least one of the preceding claims 5 to 8, characterized in that the holder comprises composite elements (15), with the aid of which the position of the front wall (3) in relation to the position of the support wall (13) is secured.

10. Holder according to claim 9, characterized in that the composite elements (15) are walls which form together with the rest of the holder a compartment cartridge (20).

11. Holder according to at least one of the preceding claims 1 to 10, characterized in that the holder is loaded with at least one substrate body (10) in such a way that the area B_{Q1} of the substrate body (10) is projecting through one of the openings (5) of the front wall (3) of the holder and thereby as well the surface to be treated of the substrate.

12. Holder according to claim 11, characterized in that the holder comprises a cover as a coating protective cover (40) which shade the spaces of the substrate body (10) which do not protrude through the opening (5) of the front wall (3).

13. Holder according to at least one of the preceding claims 11 to 12, characterized in that the holder comprises a cover as a transport protection cover (50), which covers the areas of the substrate body (10) protruding through the opening (5) of the front wall (3).

14. Method for the surface treatment of at least one substrate body (10), characterized in that the method comprises performing at least one surface treatment process, wherein the substrate body (10) being arranged in a holder according to at least one of the preceding claims 11 to 13.

15. Method according to claim 14, characterized in that the method comprise at least one of the following process steps a to d:

a. cleaning of the substrate body, for example in a cleaning bath,

b. pretreating the surface to be treated of the substrate body, for example in a granulate-beaming process,

c. coating the surface to be treated of the substrate body in a coating process, preferably at a PVD process,

d. post-treating of the surface to be treated of the substrate body, for example in a granulate-beaming process, wherein the substrate body are first sorted and charged into a holding apparatus according to at least one of the preceding claims 1 to 11 and preferably:

- the substrate body is always kept in the same holder such that no discharging from and recharging into the holder between the process steps is necessary,

- the substrate body being transported in the same holder from one to the other process step, and preferably the surfaces to be treated of the substrate body projecting outwards of the front wall (3) of the holder are covered with a transport protection cover (50) so that a damage to the surfaces to be treated is avoided,

- if appropriate for the implementation of the coating process, the not to be treated surfaces of the substrate body not projection outwards from the front wall (3) being shaded by a protection cover (40) according to claim 12 such that a coating of the surfaces not to be treated is avoided.