

SPINDLE FOR WAFER CARRYING MANIPULATOR

TECHNICAL FIELD

The present invention relates to the field of wafer carrying manipulators, and in particular, to a spindle for a wafer carrying manipulator.

BACKGROUND

A wafer carrying manipulator is an automated device used in semiconductor manufacture for carrying and processing the delicate and critical wafers. Wafers are basis materials for semiconductor chip fabrication and required to be carried and processed in various manufacturing steps, thus a specially designed and precisely operated manipulator is needed to perform these tasks.

A spindle for driving the manipulator to perform motions of a plurality of degrees of freedom in the conventional art has a complicated inner structure, and a plurality of coaxial driving shafts bring great inconvenience in an assembling process thereof.

SUMMARY

An object of the present invention relates to a spindle for a wafer carrying manipulator to solve a technical problem that a spindle structure for driving a manipulator in the conventional art brings great inconvenience in an assembling process thereof.

An aspect of the present invention provides a spindle for a wafer carrying manipulator for driving an end effector to carry a wafer, the spindle includes:

a plurality of driving shafts being arranged coaxially, different driving shafts being connected to different parts of the end effector and rotating around a same axis, such that different parts of the end effector have independent degrees of motion freedom;

a plurality of driving motors for driving the driving shafts to rotate around a housing relatively;

a plurality of bearings having inner and outer sides abutting against the driving shafts and the housing respectively; and

a plurality of circular gratings for recording rotation angle data of the driving shafts.

In a preferred embodiment, at least one of the plurality of driving shafts is formed by at least two sub-shaft bodies detachably connected along a same axis, at least one of the sub-shaft bodies has a step structure, and the step structure and an opposite end portion of another adjacent sub-shaft body form an annular chamber for mounting a device.

5 In a more preferred embodiment, the driving shaft is formed by a first shaft body, a second shaft body, and a third shaft body detachably connected;

the second shaft body has the step structure, and an end portion of the first shaft body and a first end of the step structure adjacent to the first shaft body form a first chamber for mounting one of the plurality of circular gratings; an end portion of the third shaft body and
10 a second end of the step structure adjacent to the third shaft body form a second chamber for mounting one of the plurality of bearings.

In a preferred embodiment, bolt holes are arranged along an axial direction on the circular gratings, and at least a first circular grating of the plurality of circular gratings is mounted in the first chamber through bolts penetrating through the bolt holes and connected
15 with the step structure of the second shaft body.

In a preferred embodiment, at least a second circular grating of the plurality of circular gratings sleeves an outer wall of one of the plurality of driving shafts through a bracket, a cross section of the bracket is L-shaped, and the bracket has a mounting end for carrying the second circular grating and a fixed end which is perpendicular to the mounting end and is
20 connected with the driving shaft.

In a preferred embodiment, a wedge-shaped hole is arranged along a radial direction on the fixed end, and the wedge-shaped hole is connected with one of the plurality of driving shafts in cooperation with a wedge-shaped screw.

In a preferred embodiment, a body is arranged in the housing, the body is configured to
25 limit motions of the plurality of driving shafts in the axial direction, and the body is slidably connected with the housing under driving of a jacking mechanism.

In a preferred embodiment, the jacking mechanism includes a jacking motor, a jacking shaft and a jacking base, and the jacking shaft is a lead screw and rotates under driving of the jacking motor, such that the jacking base in thread fit with the jacking shaft pushes the
30 body to ascend and descend.

In a preferred embodiment, a sliding rail is arranged on an inner side of the housing in a length direction, a part of the body is made by an integral forming process, and at least two sliding blocks arranged in the length direction are connected with the sliding rail.

The present invention has the following advantages.

5 (1) In the present invention, the first driving shaft is configured to be formed by three sub-shaft bodies detachably and coaxially connected, and the step structure is arranged on an outer wall of the second shaft body in the middle, such that chambers are formed between the step structure and end surfaces of the adjacent sub-shaft bodies, and then, a space for mounting the bearing and the circular grating is provided at a position at a top
10 portion of the housing, and the top portion has a complex structure.

(2) In the present invention, at least one of the circular gratings sleeves the outer wall of the second driving shaft through the bracket, thereby avoiding a position conflict with the bearing when one circular grating is mounted at the end portion of the second driving shaft.

(3) In the present invention, at least one of the bodies is manufactured by adopting the
15 integral forming process, such that at least two sliding blocks can be arranged on an outer side of the same body along the length direction on a guide rail, and therefore, the assembling difficulty is lowered while an operation is stable.

BRIEF DESCRIPTION OF THE DRAWINGS

20 The present invention is further described below with reference to the drawings and embodiments:

FIG. 1 is a sectional view of a spindle for a wafer carrying manipulator according to an embodiment of the present invention;

FIG. 2 is a schematic diagram of a driving shaft according to an embodiment of the
25 present invention;

FIG. 3 is an enlarged view at A in FIG. 1, wherein a bearing and a circular grating are not shown;

FIG. 4 is an enlarged view at A in FIG. 1;

FIG. 5 is an enlarged view at B in FIG. 1;

30 FIG. 6 is an enlarged view at C in FIG. 1; and

FIG. 7 is a sectional view of a spindle for a wafer carrying manipulator according to an embodiment of the present invention.

In the drawings: 1 - housing; 2 - bearing; 3 - circular grating; 4 - first driving shaft; 41 - first shaft body; 42 - second shaft body; 43 - third shaft body; 5 - second driving shaft; 6 - first chamber; 7 - second chamber; 8 - bracket; 81 - mounting end; 82 - wedge-shaped screw; 83 - fixed end; 9 - driving motor; 10 - guide rail; 11 - jacking mechanism; 111 - jacking motor; 112 - jacking shaft; 113 - jacking base; 12 - body; 13 - sliding block; 14 - third driving shaft; 15 - fourth driving shaft.

10 DETAILED DESCRIPTION

For convenience of understanding of the present invention, a usage of the present invention is described firstly: a spindle for a wafer carrying manipulator is configured to drive an end effector to carry a wafer.

The end effector has a plurality of mechanical arms, joints are arranged at ends of the mechanical arms, and each joint is in independent transmission connection with the spindle for the wafer carrying manipulator, such that the spindle for the wafer carrying manipulator can independently control each mechanical arm to move, thereby realizing a complex wafer carrying action.

The present invention is further described below in detail with reference to specific embodiments.

Referring to FIG. 1 and FIG. 2, a spindle for a wafer carrying manipulator is configured to have a columnar structure, and includes a housing 1 arranged outside, and a body 12 arranged inside the housing 1 in a length direction, and the body 12 is arranged coaxially with the housing 1. A plurality of driving shafts are coaxially mounted in the body 12 along the length direction, an output end of each driving shaft is in transmission connection with a different joint, and each driving shaft rotates around a same axis through a correspondingly provided driving motor 9, so as to drive the mechanical arm of the corresponding joint to rotate.

As shown in FIG. 6, each driving motor 9 includes a stator 91 and a rotor 92 coaxially arranged, the stator 91 is fixedly mounted on the body 12, and the rotor 92 is fixedly

connected with each driving shaft.

Each driving shaft is connected with the body 12 through a bearing 2, and a circular grating 3 is provided for recording rotation angle data of the driving shaft. As shown in FIG. 2, in the present embodiment, four driving shafts are provided, including a first driving shaft 4, a second driving shaft 5, a third driving shaft 14, and a fourth driving shaft 15 which are coaxially arranged from outside to inside.

Since the first driving shaft 4 is located at a top portion of the housing 1 and near the junction with the end effector. In order to facilitate mounting of the bearing 2 and the circular grating 3, in the present embodiment, as shown in FIG. 3 and FIG. 4, the first driving shaft 4 is configured to have a plurality of sub-shaft bodies detachably connected, and the bearing 2 or the circular grating 3 is clamped between the plurality of sub-shaft bodies.

Specifically, the first driving shaft 4 is formed by a first shaft body 41, a second shaft body 42, and a third shaft body 43 detachably connected by bolts. The middle of the second shaft body 42 has a step structure, and a top end of the second shaft body abuts against the first shaft body 41, such that a first chamber 6 for mounting the circular grating 3 is formed between an end surface of the step structure close to the first shaft body 41 and a bottom end of the first shaft body 41. A second chamber 7 for mounting the circular grating 3 is formed between another end surface of the step structure close to the third shaft body 43 and a top end of the third shaft body 43.

In the present embodiment, four circular gratings 3 are provided and connected to the first driving shaft 4 to the fourth driving shaft 15 respectively for detecting rotation angle data thereof. The circular gratings 3 have bolt holes arranged along an axial direction, and a first circular grating of the circular gratings 3 is arranged in the first chamber 6 and connected with the step structure of the second shaft body 42 through a bolt penetrating through the bolt hole in the first circular grating.

Since a bottom end of the second driving shaft 5 is close to the bearing 2, there is no space for mounting the circular grating 3, and therefore, as shown in FIG. 5, a second circular grating for detecting the rotation angle data of the second driving shaft 5 is mounted on an outer wall of the middle of the second driving shaft 5 through a bracket 8.

Specifically, a section of the bracket 8 is configured to be L-shaped, a horizontal part thereof is configured as a mounting end 81 for carrying the circular grating 3, a vertical part thereof is configured as a fixed end 83 and provided with a wedge-shaped hole in a radial direction, and the vertical part and the second driving shaft 5 are fixed in cooperation with a wedge-shaped screw 82.

Furthermore, as shown in FIG. 7, in the present embodiment, the body 12 can also ascend and descend in the axial direction relative to the housing 1, and therefore, a jacking mechanism 11 is further provided, and a guide rail 10 and a pair of sliding blocks 13 are provided between the body 12 and the housing 1. The guide rail 10 extends from one end of the housing 1 to the other end of the housing 1 and has a length direction parallel to the axial direction of the body 12. A plurality of bodies 12 are provided, at least one of the bodies 12 is made by adopting an integral forming process, the body 12 limits positions of the two driving motors 9 along the length direction of the housing 1, the two sliding blocks 13 are arranged on an outer side of the body 12 along the length direction, and the body is in sliding fit with the guide rail 10 through the two sliding blocks 13. The jacking mechanism 11 is provided below the body 12, and the jacking mechanism 11 drives the body 12 to drive the first driving shaft 4, the second driving shaft 5, the third driving shaft 14 and the fourth driving shaft 15 to be overall jacked along the axial direction of the housing 1. The jacking mechanism 11 includes a jacking motor 111, a jacking shaft 112 and a jacking base 113, and the jacking shaft 112 is configured as a lead screw and rotates under driving of the jacking motor 111, such that the jacking base 113 in thread fit with the jacking shaft 112 pushes the body 12 to ascend and descend.

In the present embodiment, the spindle for a wafer carrying manipulator belongs to a four-shaft manipulator and then corresponds to four driving shafts and four driving motors 9, the stator 91 of each driving motor 9 is mounted on the bodies 12, and in a traditional structure, four bodies 12 are provided, spliced and assembled, a flatness requirement of each body 12 is high, and the pair of sliding blocks 13 cannot be mounted on the same body 12 due to a height limitation of the single bodies 12, thereby affecting mounting precision and rigidity of a whole device. In the present embodiment, three bodies 12 are provided, and the body 12 on which the two middle stators 91 are mounted are configured as an integral

structure, namely a single piece, such that a mounting height is sufficient, it is possible to mount the pair of sliding blocks 13 on the same single body 12, and the stability is higher, and the rigidity is higher.

In other embodiments, two bodies 12 may be provided, the two upper stators are
5 mounted on one same body 12, the two lower stators are mounted on the other body 12, and at this point, each body 12 has a sufficient mounting height for mounting a pair of sliding blocks 13.

When in use, joints of the plurality of mechanical arms of the end effector are in transmission connection with top ends of the first driving shaft 4, the second driving shaft 5,
10 the third driving shaft 14 and the fourth driving shaft 15 respectively. The first driving shaft 4, the second driving shaft 5, the third driving shaft 14 and the fourth driving shaft 15 are driven by the corresponding driving motors 9 to rotate around respective axes, so as to drive the corresponding mechanical arms of the end effector connected to the top ends of the mechanical arms to swing.

15 The above-mentioned embodiments are merely illustrative of the technical concepts and features of the present invention, and are intended to enable those skilled in the art to understand the contents of the present invention and implement the present invention, and not to limit the protection scope of the present invention.

What is claimed is:

1. A spindle for a wafer carrying manipulator, for driving an end effector to carry a wafer, the spindle comprising:

5 a plurality of driving shafts being arranged coaxially, different driving shafts being connected to different parts of the end effector and rotating around a same axis, such that different parts of the end effector have independent degrees of motion freedom;

a plurality of driving motors (9) for driving the driving shafts to rotate around a housing (1) relatively;

10 a plurality of bearings (2) having inner and outer sides abutting against the driving shafts and the housing (1) respectively; and

a plurality of circular gratings (3) for recording rotation angle data of the driving shafts;

wherein at least one of the plurality of driving shafts is formed by at least two sub-shaft
15 bodies detachably connected along a same axis, at least one of the sub-shaft bodies has a step structure, and the step structure and an opposite end portion of another adjacent sub-shaft body form an annular chamber for mounting a device;

the at least one of the plurality of driving shafts is formed by a first shaft body (41), a second shaft body (42), and a third shaft body (43) detachably connected;

20 the second shaft body (42) has the step structure, and an end portion of the first shaft body (41) and an adjacent end of the step structure form a first chamber (6) for mounting one of the plurality of circular gratings (3); an end portion of the third shaft body (43) and an adjacent end of the step structure form a second chamber (7) for mounting one of the plurality of bearings (2);

25 bolt holes are arranged along an axial direction on the circular gratings, and at least one of the plurality of circular gratings (3) is mounted in the first chamber (6) through bolts penetrating through the bolt holes and connected with the step structure of the second shaft body (42);

at least one of the circular gratings (3) sleeves an outer wall of one of the plurality of
30 driving shafts through a bracket (8), a cross section of the bracket (8) is L-shaped, and the

bracket has a mounting end (81) for carrying the circular grating (3) and a fixed end (83) which is perpendicular to the mounting end (81) and is connected with the driving shaft.

2. The spindle for wafer carrying manipulator of claim 1, wherein a wedge-shaped hole is arranged along a radial direction on the fixed end, and the wedge-shaped hole is
5 connected with one of the plurality of driving shafts in cooperation with a wedge-shaped screw (82).

3. The spindle for wafer carrying manipulator of claim 1, wherein a body (12) is arranged in the housing (1), the body (12) is configured to limit motions of the plurality of driving shafts in the axial direction, and the body (12) is slidably connected with the
10 housing (1) under driving of a jacking mechanism (11).

4. The spindle for wafer carrying manipulator of claim 3, wherein the jacking mechanism (11) comprises a jacking motor (111), a jacking shaft (112) and a jacking base (113), and the jacking shaft (112) is a lead screw and rotates under driving of the jacking motor (111), such that the jacking base (113) in thread fit with the jacking shaft (112) pushes
15 the body (12) to ascend and descend.

5. The spindle for wafer carrying manipulator of claim 3, wherein a sliding rail is arranged on an inner side of the housing (1) in a length direction, a part of the body (12) is made by an integral forming process, and at least two sliding blocks (13) arranged in the length direction are connected with the sliding rail.

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