

CLAIMS

Claim 1: A spindle assembly for transferring wafers in a multi-station process module, comprising:

a hub body, the hub body configured to be rotated about a center axis;

5 a plurality of end effectors, each end effector having a first end configured for connection to the hub body and a second end configured to support a wafer;

a plurality of covers;

a plurality of fastener assemblies;

10 wherein the first end of each end effector is clamped between a respective cover and a respective outer portion of the hub body by a respective fastener assembly, the respective fastener assembly including a wave spring that provides a consistent clamping force.

Claim 2: The spindle assembly of claim 1, wherein the respective fastener assembly includes a barrel nut that extends through the respective cover and the respective
15 outer portion of the hub body, and a screw that connects to the barrel nut.

Claim 3: The spindle assembly of claim 2, wherein the wave spring surrounds the barrel nut.

Claim 4: The spindle assembly of claim 3, wherein the wave spring decouples torque applied to the screw from clamping force applied by the fastener assembly to the
20 respective cover and the respective outer portion of the hub body.

Claim 5: The spindle assembly of claim 1, wherein a lip of the respective cover is configured to fit into an undercut portion of the hub body.

Claim 6: The spindle assembly of claim 1, wherein the plurality of fastener assemblies are composed of an Inconel material.

25 **Claim 7:** The spindle assembly of claim 1, wherein the hub body includes a plurality of slot-shaped holes facilitating connection of the hub body to a rotating spindle shaft assembly.

Claim 8: A spindle assembly for transferring wafers in a multi-station process module, comprising:

30 a hub body, the hub body configured to be rotated about a center axis;

a plurality of end effectors, each end effector having a first end configured for connection to the hub body, the hub body having recesses configured to receive the first ends of the end effectors, each end effector having a second end configured to support a wafer during transfer in the multi-station process module;

a plurality of covers, each cover disposed over one of the first ends of the end effectors, each cover being fastened to the hub body by at least two fastener assemblies, so that the first end of each end effector is clamped between one of the covers and the hub body;

5 wherein each fastener assembly includes a wave spring that provides a substantially consistent clamping force.

Claim 9: The spindle assembly of claim 8, wherein the each fastener assembly includes a barrel nut that extends through one of the covers and the hub body, and a screw that connects to the barrel nut.

10 **Claim 10:** The spindle assembly of claim 9, wherein the wave spring surrounds the barrel nut.

Claim 11: The spindle assembly of claim 10, wherein the wave spring decouples torque applied to the screw from clamping force applied by the fastener assembly to the one of the covers and the hub body.

15 **Claim 12:** The spindle assembly of claim 8, wherein each cover includes a lip that is configured to fit into an undercut portion of the hub body.

Claim 13: The spindle assembly of claim 8, wherein the fastener assemblies are composed of an Inconel material.

20 **Claim 14:** The spindle assembly of claim 8, wherein the hub body includes a plurality of slot-shaped holes facilitating connection of the hub body to a rotating spindle shaft assembly.