Nozzle tip adapter, nozzle assembly as well as nozzle

The invention concerns a nozzle tip adapter for mounting a nozzle tip to a substrate processing device, a nozzle assembly for a substrate processing device as well as a nozzle for supplying a liquid to a substrate.

In known substrate processing devices for nano- and microfabrication, it is necessary to dispense a liquid onto the substrate. The substrate may be a wafer or the like. The fluid may be developer, water, solvent, or any aqueous solution and is supplied to the substrate via a nozzle. Usually, the liquid is dispensed for a defined dispense period so that a predefined amount of liquid is dispensed. However, at the end of dispense period, a rest of the liquid remains in the nozzle and may drip onto the substrate in an uncontrolled manner.

In substrate processing devices of the state of the art, it is known to prevent the nozzle from dripping after a dispense period by reversing the flow of the liquid to pull back excess liquid from the nozzle.

However, due to air bubbles and the like in the liquid, dripping cannot be prevented completely with this approach.

Summary

It is thus the object of the invention to provide a nozzle tip adapter, a nozzle assembly and a nozzle for a substrate processing device that reliably prevents dripping after the liquid has been dispensed.

For this purpose, according to a first aspect of the present disclosure, a nozzle tip adapter for mounting a nozzle tip to a substrate processing device is provided, comprising a suction duct, a supply duct and a base body with a device end and a substrate end, wherein the suction duct and the supply duct are provided in the base body. The base body has a nozzle tip recess at its substrate end for receiving the nozzle tip and a projecting portion extending into the nozzle

tip recess, wherein the suction duct extends through the projecting portion and the supply duct opens into the nozzle tip recess, wherein the suction duct is being at least partially surrounded by the supply duct.

downstream end. In this case, the downstream end of the projecting portion is the most downstream portion of the nozzle tip adapter.

In an example of the present disclosure, the base body comprises a device protrusion at the device end for fixing the nozzle tip adapter to the substrate processing device. The device protrusion may be threaded. By this means, the nozzle tip adapter can easily be mounted between the nozzle tip and the substrate processing device.

In particular, the nozzle tip recess and the device protrusion have the same size and/or complementary shape. This way, it can be assured that the nozzle tip adapter may be mounted between the nozzle tip and the device without changes to the nozzle tip or the device.

In another example, the nozzle tip adapter has a suction port, preferably at the peripheral surface or the device end of the base body, and the suction duct originates from the suction port. The nozzle has further a supply port, preferably at the peripheral surface or at the device end, and the supply duct originates from the supply port. The peripheral surface is the surface between the two ends of the base body and the supply duct may extend through the device protrusion. Further, the suction port may be threaded or a coupling. By providing a suction port, excess liquid that may drip from the nozzle can easily be diverted away from the nozzle outlet. For example, the supply port may be located at the device end and the suction port may be located at the peripheral surface, or vice versa. Further, it is possible that both, the suction port and the supply port, are located at the same surface of the base body, for example the peripheral surface or the end face of the device end.

According to a second aspect, the present disclosure further provides a nozzle tip assembly for a substrate processing device, comprising a nozzle tip adapter according to the first aspect and a nozzle tip. The nozzle tip comprises a nozzle body with a connection end and a discharge end, a fastening protrusion provided at the connection end, a liquid chamber being open towards the connection end and extending at least into the fastening protrusion, and an outlet having an orifice at the discharge end and being fluidly connected to the liquid chamber, preferably at the downstream end of the liquid chamber.

The fastening protrusion of the nozzle tip is received in the nozzle tip recess at the nozzle tip adapter, the projecting portion of the nozzle tip

adapter extending into the liquid chamber of the nozzle tip. The nozzle tip may be a puddle or a spray nozzle, in particular a fan spray nozzle. The nozzle assembly provides a duct for supplying the liquid and another duct for diverting the liquid from the liquid chamber and away from the outlet. This way, it can be prevented that liquid drips from the outlet or the liquid chamber onto the substrate after a dispense period has ended.

For example, the supply duct of the nozzle tip adapter opens into the liquid chamber, and the upstream end of the liquid chamber and/or the suction duct of the nozzle tip adapter opens into the liquid chamber at the downstream end of the projecting portion. Thus, the suction duct and the supply duct merge at the downstream end of the projecting portion close to the downstream end of the liquid chamber to reliably divert any liquid away from the nozzle in a controlled manner after a dispense period.

In an example, the outlet has a diameter, the distance between the downstream end of the projecting portion and the orifice being at least 0.5 times the diameter of the outlet. For example, the distance is maximum 5 times the diameter of the outlet, preferably between 1 and 3 times the diameter. This way, the distance between the downstream end of the projecting portion and the orifice is small enough to ensure that all of the liquid in the outlet is diverted into the other duct.

For improved performance, the outlet and the suction duct in the projecting portion are coaxial.

In an example, a channel is being formed between the periphery of the projecting portion of the nozzle tip adapter and the inner walls of the liquid chamber, and the supply duct of the nozzle tip adapter opens into the channel. The channel may have a width between 0.25 mm and 1.0 mm and may be an elongation of the supply duct. In this way, the supply duct is formed with minimal material needed.

For further improving the performance, the channel and the suction duct merge at the downstream end of the liquid chamber.

According to a third aspect, the present disclosure further provides a nozzle for supplying a liquid to a substrate, having a main body with a device end and a discharge end, the main body

comprising: a suction duct, a supply duct, a liquid chamber forming portions of the supply duct, an outlet having a smaller diameter than the diameter of the liquid chamber, having an orifice at the discharge end, and being fluidly connected to the liquid chamber, preferably at the downstream end of the liquid chamber, and a projecting portion extending into the liquid chamber. The suction duct extends through the projecting portion and opens into the liquid chamber at the downstream end of the liquid chamber and merges with the supply duct upstream of the outlet. The suction duct is being at least partially surrounded by the supply duct.

The suction duct may extend through the axial length of the projecting portion and may open at the downstream end of the projecting portion. In this way, the suction duct and the supply duct are merged as far downstream as possible.

The main body and the projecting portion are immovably fixed to one another. In particular, the main body and the projecting portion are formed as a single piece. This simplifies handling of the nozzle.

For example, the main body comprises a device protrusion at the device end for fixing the nozzle to a substrate processing device. The device protrusion may be threaded. By this means, the nozzle tip adapter can easily be mounted between the nozzle tip and the substrate processing device. The device protrusion may be threaded.

In an example of the present disclosure, the nozzle has a suction port, preferably at the peripheral surface or the device end of the main body, and the suction duct originates from the suction port. The nozzle has a supply port as well, preferably at the peripheral surface or at the device end, and the supply duct originates from the supply port. The peripheral surface extends between the two ends of the main body. The supply duct may extend through the device protrusion. Further, the suction port may be threaded or a coupling. By providing a suction port, excess liquid in the nozzle outlet that may drip from the nozzle can easily be diverted. For example, the supply port may be located at the

device end and the suction port may be located at the peripheral surface, or vice versa. Further, it is possible that both, the suction port and the supply port, are located at the same surface of the base body, for example the peripheral surface or the end face of the device end.

In an example, the distance between the downstream end of the projecting portion and the orifice being at least 0.5 times the diameter of the outlet. For example, the distance is maximum 5 times the diameter of the outlet, preferably between 1 and 3 times the diameter. This way, the distance between the downstream end of the projecting portion and the orifice is small enough to ensure that all of the liquid in the outlet is diverted into the other duct.

For improved performance, the outlet and the suction duct in the projecting portion are coaxial.

In another example, a channel is being formed between the periphery of the projecting portion and the inner walls of the liquid chamber. The channel may have a width between 0.25 mm and 1.0 mm. Thus, the space needed for providing the channel can be minimized.

Further features and advantages of the invention will be apparent from the following description of the embodiments and the attached drawings to which reference is made. In the drawings,

- Figure 1 shows a cross section of a nozzle tip assembly according to a first embodiment of the invention with a nozzle tip adapter according to a first embodiment of the invention,
- Figure 2 shows a cross section of the nozzle tip adapter of Figure 1,
- Figure 3 shows another cross section of the nozzle tip adapter of Figure 1 across the line III-III,
- Figure 4 shows a nozzle according to another embodiment of the invention in a cross section,
- Figure 5 shows a cross section of a nozzle tip assembly according to a second embodiment of the invention with a nozzle tip adapter according to a second embodiment of the invention,
- Figure 6 shows a cross section of the nozzle tip adapter of Figure 5,
- Figure 7 shows another cross section of the nozzle tip adapter of Figure 5 across the line VII-VII, and

Claims

1. Nozzle tip adapter for mounting a nozzle tip to a substrate processing device, comprising a suction duct, a supply duct, and a base body with a device end and a substrate end, wherein the suction duct and the supply duct are provided in the base body,

the base body having a nozzle tip recess at its substrate end for receiving the nozzle tip and a projecting portion extending into the nozzle tip recess,

wherein the suction duct extends through the projecting portion and the supply duct opens into the nozzle tip recess,

wherein the suction duct is being at least partially surrounded by the supply duct.

2. Nozzle tip adapter according to claim 1, characterized in that the suction duct extends through the axial length of the projecting portion and opens at the downstream end of the projecting portion.

3. Nozzle tip adapter according to claim 1 or 2, characterized in that the projecting portion extends in an axial direction of the base body through the nozzle tip recess and protrudes from the nozzle tip recess with its downstream end.

4. Nozzle tip adapter according to any of the preceding claims, characterized in that the base body comprises a device protrusion at the device end for fixing the nozzle tip adapter to the substrate processing device.

5. Nozzle tip adapter according to claim 4, characterized in that the nozzle tip recess and the device protrusion have the same size and/or complementary shape.

6. Nozzle tip adapter according to any of the preceding claims, characterized in that the nozzle tip adapter has a suction port, preferably at the peripheral surface or the device end of the base body, and the suction duct originates from the suction port as well as a supply port, preferably at the

peripheral surface or at the device end, and the supply duct originates from the supply port.

7. Nozzle assembly for a substrate processing device comprising a nozzle tip adapter according to any one of the preceding claims and a nozzle tip,

the nozzle tip comprising:

a nozzle body with a connection end and a discharge end,

a fastening protrusion provided at the connection end,

a liquid chamber being open towards the connection end and extending at least into the fastening protrusion, and

an outlet having an orifice at the discharge end and being fluidly connected to the liquid chamber, preferably at the downstream end of the liquid chamber,

wherein the fastening protrusion of the nozzle tip is received in the nozzle tip recess of the nozzle tip adapter, the projecting portion of the nozzle tip adapter extending into the liquid chamber of the nozzle tip.

8. Nozzle assembly according to claim 7, characterized in that the supply duct of the nozzle tip adapter opens into the liquid chamber at the upstream end of the liquid chamber and/or in that the suction duct of the nozzle tip adapter opens into the liquid chamber at the downstream end of the projecting portion.

9. Nozzle assembly according to claim 7 or 8, characterized in that the outlet has a diameter, the distance between the downstream end of the projecting portion and the orifice being at least 0.5 times the diameter of the outlet.

10. Nozzle assembly according to any one of claims 7 to 9, characterized in that the outlet and the suction duct in the projecting portion are coaxial.

11. Nozzle assembly according to any one of claims 7 to 10, characterized in that a channel is being formed between the periphery of the projecting portion of the nozzle tip adapter and the inner walls of the liquid chamber, and wherein the supply duct of the nozzle tip adapter opens into the channel.

12. Nozzle assembly according to any one of claims 7 to 11, characterized in that the channel and the suction duct merge at the downstream end of the liquid chamber.

13. Nozzle for supplying a liquid to a substrate, having a main body with a device end and a discharge end, the main body comprising:

a suction duct,

a supply duct,

a liquid chamber forming portions of the supply duct,

an outlet having a smaller diameter than the diameter of the liquid chamber, having an orifice at the discharge end, and being fluidly connected to the liquid chamber, preferably at the downstream end of the liquid chamber, and

a projecting portion extending into the liquid chamber,

wherein the suction duct extends through the projecting portion and opens into the liquid chamber at the downstream end of the liquid chamber and merges with the supply duct upstream of the outlet,

wherein the suction duct is being at least partially surrounded by the supply duct.

14. Nozzle according to claim 13, characterized in that the suction duct extends through the axial length of the projecting portion and opens at the downstream end of the projecting portion.

15. Nozzle according to claim 13 or 14, characterized in that the main body comprises a device protrusion at the device end for fixing the nozzle to a substrate processing device.

16. Nozzle according to any one of the claims 13 to 15, characterized in that the nozzle has a suction port, preferably at the peripheral surface or the device end of the main body, and the suction duct originates from the suction port as well as a supply port, preferably at the peripheral surface or at the device end, and the supply duct originates from the supply port.

17. Nozzle according to any one of the claims 13 to 16, characterized in that a distance between the downstream end of the projecting portion and the orifice being at least 0.5 times the diameter of the outlet.

18. Nozzle according to any one of the claims 13 to 17, characterized in that the outlet and the suction duct in the projecting portion are coaxial.

19. Nozzle according to any one of the claims 13 to 18, characterized in that a channel is being formed between the periphery of the projecting portion and the inner walls of the liquid chamber.