Claims

1. A method for treating substrates comprising the following method steps:
forming a liquid film on a local surface area of the substrate to be treated using a nozzle unit which comprises at least one elongated nozzle arrangement and an ultrasonic or megasonic transducer arrangement arranged adjacent thereto, said ultrasonic or megasonic transducer arrangement being formed by a plurality of transducers, said plurality having transducers of different resonance frequencies;
bringing at least one part of the ultrasonic or megasonic transducer arrangement into contact with the liquid film; and
introducing ultrasound or megasound into the formed liquid film using the ultrasonic or megasonic transducer arrangement, wherein the transducers are excited individually and/or in groups using different intensities and/or frequencies.

2. The method in accordance with Claim 1, characterised in that the liquid film is formed between a substantially closed base structure of the nozzle unit and the surface area of the substrate to be treated.

3. The method in accordance with Claim 1 or 2, characterized by the production of a relative movement between the nozzle unit and the substrate for the purposes of depositing the liquid film on different surface areas of the substrate and for introducing the ultrasound into these areas.

4. The method in accordance with Claim 3, characterised in that the speed of the relative movement between the nozzle unit and the substrate is varied.

5. The method in accordance with Claim 4, characterised in that the speed of the relative movement is altered in dependence on the position of the nozzle unit relative to the substrate.

6. The method in accordance with any of the preceding Claims, characterised in that the introduction of the ultrasound into the liquid film is varied during the treatment.

7. The method in accordance with Claim 6, characterised in that the introduction of the ultrasound is altered in dependence on the position of the nozzle unit relative to the substrate.

8. The method in accordance with Claim 6 or 7, characterised in that the intensity and/or the frequency of the ultrasound introduced into the liquid film is altered in at least a sub region of the transducer arrangement.

9. The method in accordance with any of the Claims 6 to 8, characterised in that the angle of incidence of the ultrasound on the substrate is varied by an inclined positioning of the transducer arrangement with respect to a surface of the substrate.

10. The method in accordance with Claim 7, characterised in that the angle of incidence of the ultrasound with re-

spect to the surface of the substrate is varied between 105° and 75°.

11. The method in accordance with any one of the preceding Claims, characterised in that the transducers are arranged along a row or in the form of a matrix.

12. The method in accordance with any of the preceding Claims, characterised in that the liquid film is formed substantially along a straight line over the entire width of the substrate, and the ultrasound is introduced into the liquid film substantially along a straight line over the entire width of the substrate.

13. The method in accordance with any of the preceding Claims, characterised in that the introduction of the ultrasound is controlled in different manners over the width of the substrate.

14. The method in accordance with any of the preceding Claims, characterised in that the composition of the liquid forming the liquid film is controlled.

15. The method in accordance with any of the preceding Claims, characterised in that the nozzle arrangement consists of a plurality of nozzles which are controlled in different manners.

16. The method in accordance with Claim 14 or 15, characterised in that locally different liquids and/or differing quantities of liquid are applied to the substrate for the purposes of forming the liquid film.

17. The method in accordance with any of the preceding Claims, characterised in that the liquid film is applied by means of at least two nozzle arrangements which are arranged on opposite sides of the transducer arrangement.

18. The method in accordance with Claim 17, characterised in that different liquids are supplied to the nozzles arranged on opposite sides of the transducer arrangement.

19. The method in accordance with any of the preceding Claims, characterised in that an average spacing of from 0.2 to 2.0 mm and in particular of from 0.7 to 1.4 mm is maintained between the transducer arrangement and the surface of the substrate to be treated during the treatment process.

20. The method in accordance with Claim 19, characterised in that the average distance is varied during the treatment.

21. The method in accordance with any of the preceding Claims, characterised in that the liquid forming the liquid film contains a developer or an etching agent.

22. The method in accordance with any of the preceding Claims, characterised in that the liquid film contains a rinsing and/or a cleaning fluid.

23. The method in accordance with any of the preceding Claims, characterised in that at least one of the transducers is controlled at least on occasion during the process of introducing the ultrasound into the liquid film in such a manner that it works as a sensor.

24. An apparatus for treating substrates with a liquid and ultrasound or megasound, said apparatus comprising:
a nozzle unit including at least one elongated nozzle arrangement for producing a liquid film on the substrate and a transducer arrangement arranged adjacent to the nozzle arrangement for introducing ultrasound or megasound into a liquid film disposed on the substrate, wherein the transducer arrangement is formed by a plurality of ultrasonic or megasonic transducers, said plurality of transducers having transducers of different resonance frequencies, and wherein the at least one nozzle arrangement and the transducer arrangement point in substantially the same direction;
a moving device for the substrate and/or the nozzle unit for positioning them adjacent to a surface of the substrate in such a manner that the at least one nozzle arrangement and the ultrasonic or megasonic transducer arrangement are directed toward the surface of the substrate at a defined distance therefrom, and the transducer arrangement contacts a liquid film formed on the surface of the substrate; and
a control device for exciting the plurality of transducers individually and/or in groups.

25. The apparatus accordance with Claim 24, characterized by a control device for controlling the moving device in such a manner that the nozzle arrangement and the ultrasonic transducer arrangement are moved over the surface of the substrate at a defined distance therefrom.

26. The apparatus in accordance with Claim 24 or 25, characterized by at least one further elongated nozzle arrange-

ment, wherein the transducer arrangement is arranged between the at least two elongated nozzle arrangements.

27. The apparatus in accordance with Claim 26, characterised in that at least one of the elongated nozzle arrangements is directed towards a central plane of the transducer arrangement.

28. The apparatus in accordance with any of Claims 24 to 27, characterised in that the transducers in the plurality thereof are arranged adjacent to one another, in a row or in the form of a matrix.

29. The apparatus in accordance with any of the Claims 24 to 28, characterized by a control device for varying the frequency and/or the energy applied to the transducers.

30. The apparatus in accordance with any of the Claims 24 to 29, characterized by a device for setting an angle between a surface of the transducer arrangement and a surface of the substrate.

31. The apparatus in accordance with Claim 30, wherein the angle is adjustable between 0 and ±15°.

32. The apparatus in accordance with any of the Claims 24 to 31, characterised in that the defined average distance is adjustable between 0.2 and 2 mm, and in particular between 0.7 and 1.4 mm.

33. The apparatus in accordance with any of the Claims 24 to 32, characterized by a device for supplying liquid to the at least one nozzle arrangement.

34. The apparatus in accordance with Claim 33, characterized by a control device for supplying different liquids to different nozzle arrangements and/or different outlet nozzles of the nozzle arrangement(s).

35. The apparatus in accordance with any of the Claims 24 to 34, characterised in that the at least one nozzle arrangement and the transducer arrangement are disposed in/on a common main body and form a substantially closed base structure.

36. The apparatus in accordance with Claim 35, characterised in that the substantially closed base structure protrudes relative to the remainder of the base structure in the region of the transducer arrangement.

37. The apparatus in accordance with any of the Claims 24 to 36, characterised in that at least one nozzle arrangement and the transducer arrangement extend substantially parallel to one another.

38. The apparatus in accordance with any of the Claims 24 to 37, characterized by a control device for controlling the transducers to serve as a sensor for ultrasound or megasound or as generators for ultrasound or megasound.

39. A nozzle unit including at least one elongated nozzle arrangement, an ultrasonic or megasonic transducer arrangement arranged adjacent to the nozzle arrangement, said ultrasonic or megasonic transducer arrangement being formed by a plurality of transducers, said plurality having transducers of different resonance frequencies,

wherein the nozzle arrangement and the transducer arrangement point substantially in the same direction and form a substantially closed base structure of the nozzle unit, and a control device for exciting the plurality of transducers individually and/or in groups.

40. The nozzle unit in accordance with Claim 39, characterized by at least one further elongated nozzle arrangement, wherein the transducer arrangement is arranged between the at least two elongated nozzle arrangements.

41. The nozzle unit in accordance with Claim 39 or 40, characterised in that at least one elongated nozzle arrangement is directed towards a central plane of the transducer arrangement.

42. The nozzle unit in accordance with any of Claims 39 to 41, characterised in that the transducers in the plurality thereof are arranged adjacent to one another, in a row or in the form of a matrix.

43. The nozzle unit in accordance with any of the Claims 39 to 42, characterised in that the transducer arrangement and at least one nozzle arrangement are substantially parallel to one another.

44. A method for treating substrates comprising the following method steps:
forming a liquid film on a local surface area of the substrate by means of a nozzle unit having at least one elongated nozzle arrangement, wherein different liquids are applied over the longitudinal extent of the nozzle arrangement; and

introducing ultrasound or megasound into the liquid film by means of an ultrasonic or megasonic transducer arrangement, which is formed by a plurality of transducers, said plurality having transducers of different resonance frequencies, wherein the transducers are excited individually and/or in groups using different intensities and/or frequencies.

45. The method in accordance with Claim 44 in combination with the features of one or more of Claims 1 to 23.

Claims

1. A method for treating substrates comprising the following steps:

forming a liquid film on a local surface area of the substrate to be treated using a nozzle unit which comprises at least one elongated nozzle arrangement and an ultrasonic or megasonic transducer arrangement arranged adjacent thereto, said ultrasonic or megasonic transducer arrangement being formed of a plurality of transducers, said plurality of transducers having different resonance frequencies;

bringing at least one part of the ultrasonic or megasonic transducer arrangement into contact with the liquid film; and

introducing ultrasound into the liquid film using the ultrasonic or megasonic transducer arrangement, wherein the transducers are controlled individually and/or in groups using different intensities and/or frequencies, and the introduction of the ultrasound into the liquid film is varied during the treatment in dependence on the position of the nozzle unit relative to the substrate.

2. The method in accordance with Claim 1, characterised in that the liquid film is formed between a substantially closed base structure of the nozzle unit and the surface area of the substrate to be treated.

3. The method in accordance with Claim 1 or 2, characterized by the production of a relative movement between the nozzle unit and the substrate for the purposes of depositing the liquid film on different surface areas of the substrate and for introducing the ultrasound into the surface areas.

4. The method in accordance with Claim 3, characterised in that the speed of the relative movement between the nozzle unit and the substrate is varied.

5. The method in accordance with Claim 4, characterised in that the speed of the relative movement is altered in dependence on the position of the nozzle unit relative to the substrate.

6. The method in accordance with any one of Claims 1 to 5, characterised in that the intensity and/or the frequency of the ultrasound introduced into the liquid film is altered in at least a sub region of the transducer arrangement.

7. The method in accordance with any one of Claims 1 to 6, characterised in that the angle of incidence of the ultrasound on the substrate is varied by inclination of the transducer arrangement with respect to a surface of the substrate.

8. The method in accordance with Claim 7, characterised in that the angle of incidence of the ultrasound with respect to the surface of the substrate is varied between 105° and 75°.

9. The method in accordance with any one of Claims 1 to 8, characterised in that the transducers are arranged along a row or in the form of a matrix.

10. The method in accordance with any one of Claims 1 to 9, characterised in that the liquid film is formed substantially along a straight line over the entire width of the substrate, and the ultrasound is introduced into the liquid film substantially along a straight line over the entire width of the substrate.

11. The method in accordance with any one of Claims 1 to 10, characterised in that the introduction of the ultrasound is controlled in different manners over the width of the substrate.

12. The method in accordance with any one of Claims 1 to 11, characterised in that the composition of the liquid forming the liquid film is controlled.

13. The method in accordance with any one of Claims 1 to 12, characterised in that the nozzle arrangement consists of a plurality of nozzles which are controlled in different manners.

14. The method in accordance with Claim 12 or 13, characterised in that locally different liquids or differing quantities of liquid are applied to the substrate for the purposes of forming the liquid film.

15. The method in accordance with any one of Claims 1 to 14, characterised in that the liquid film is formed by means of at least two nozzle arrangements which are arranged on opposite sides of the transducer arrangement.

16. The method in accordance with Claim 15, characterised in that different liquids are supplied by the nozzles arranged on opposite sides of the transducer arrangement.

17. The method in accordance with any one of Claims 1 to 16, characterised in that an average distance of from 0.2 to 2.0 mm and in particular of from 0.7 to 1.4 mm is maintained between the transducer arrangement and the surface of the substrate to be treated during the treatment.

18. The method in accordance with Claim 17, characterised in that the average distance is varied during the treatment.

19. The method in accordance with any one of Claims 1 to 18, characterised in that the liquid forming the liquid film contains a developer or an etching agent.

20. The method in accordance with any one of Claims 1 to 19, characterised in that the liquid film contains a rinsing and/or a cleaning fluid.

21. The method in accordance with any one of Claims 1 to 20, characterised in that at least one of the transducers is controlled at least on occasion during the introduction of the ultrasound into the liquid film in such a manner that the at least one of the transducers works as a sensor.

22. An apparatus for treating substrates with a liquid and ultrasound or megasound, said apparatus comprising:

a nozzle unit including an elongated nozzle arrangement for forming a liquid film on the substrate and a transducer arrangement arranged adjacent to the nozzle arrangement for introducing ultrasound or megasound into a liquid film on the substrate,

wherein the transducer arrangement is formed of a plurality of ultrasonic or megasonic transducers, said plurality of transducers having different resonance frequencies, and wherein the at least one nozzle arrangement and the transducer arrangement point in substantially the same direction;

a moving device for the substrate and/or the nozzle unit for positioning the nozzle unit with respect to a surface of the substrate in such a manner that the at least one nozzle arrangement and the ultrasonic or megasonic transducer arrangement are adjusted to a distance defined on the surface of the substrate, and the transducer arrangement contacts a liquid film formed on the surface of the substrate; and

a control device for controlling the plurality of transducers individually or in groups and for varying frequency and/or energy applied to the transducers.

23. The apparatus in accordance with Claim 22, characterized by a control device for controlling the moving device in such a manner that the nozzle arrangement and the transducer arrangement are moved over the surface of the substrate at a defined distance along an upper surface of the substrate.

24. The apparatus in accordance with Claim 22 or 23, characterized by at least one further elongated nozzle arrangement wherein the transducer arrangement is arranged between the at least two elongated nozzle arrangements.

25. The apparatus in accordance with Claim 24, characterised in that at least one of the elongated nozzle arrangements is directed towards a central plane of the transducer arrangement.

26. The apparatus in accordance with any one of Claims 22 to 25, characterised in that the plurality of transducers are arranged adjacent to one another, in a row or in the form of a matrix.

27. The apparatus in accordance with any one of Claims 22 to 26, characterized by a device for adjusting an angle between a surface of the transducer arrangement and a surface of the substrate.

28. The apparatus in accordance with Claim 27, wherein the angle is adjustable between 0° and ±15°.

29. The apparatus in accordance with any one of Claims 22 to 28, characterised in that the defined average distance is adjustable between 0.2 mm and 2 mm, and in particular between 0.7 mm and 1.4 mm.

30. The apparatus in accordance with any one of Claims 22 to 29, characterized by a device for supplying liquid to the at least one nozzle arrangement.

31. The apparatus in accordance with Claim 30, characterized by a control device for supplying different liquids to different nozzle arrangements or different outlet nozzles of the nozzle arrangement.

32. The apparatus in accordance with any one of Claims 22 to 31, characterised in that the at least one nozzle arrangement and the transducer arrangement are disposed on a common main body and form a substantially closed base structure.

33. The apparatus in accordance with Claim 32, characterised in that the substantially closed base structure protrudes beyond a region of the nozzle arrangement in the region of the transducer arrangement.

34. The apparatus in accordance with any one of Claims 22 to 33, characterised in that the at least one nozzle arrangement and the transducer arrangement extend substantially parallel to one another.

35. The apparatus in accordance with any one of Claims 22 to 34, characterized by a device for controlling the transducers as an ultrasonic sensor or megasonic sensor or as an ultrasonic transmitter or a megasonic transmitter.