CLAIMS:

1. A substrate processing apparatus, comprising:

a control mechanism;

a clamp mechanism, configured to hold a substrate;

a spray head mechanism, including a liquid nozzle configured to dispense liquid to a front surface of the substrate positioned on the clamp mechanism;

a rotary drive mechanism, configured to drive the clamp mechanism to rotate;

a heating mechanism, including a heating plate arranged under the substrate, the heating plate having at least two cavities along the radial direction, and each cavity being distributed on a different radius, the bottom of each cavity being provided with a fluid inlet hole, and the top of each cavity being provided with fluid outlet holes, the fluid inlet hole being connected to a fluid delivery pipe;

wherein the substrate processing apparatus is configured such that, during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a local area above the substrate, the control mechanism controls the thermal energy of the fluid in a cavity on the radius corresponding to said local area, thereby increasing the temperature of a local region of the substrate under the liquid nozzle, and before dispensing liquid to the front surface through the liquid nozzle, preheating the whole substrate by jetting fluid through the heating mechanism with a first thermal energy to a whole back surface of the substrate.

2.The substrate processing apparatus according to claim 1, wherein the heating mechanism further includes a fluid delivery unit and a heater set on the fluid delivery unit to heat the fluid in the fluid delivery unit.

3. The substrate processing apparatus according to claim 1, wherein the heating plate includes a first chuck and a second chuck, wherein the first chuck is positioned above the second chuck, and the second chuck is matched with the first chuck;

wherein the first chuck has the at least two cavities in the radial direction, and the cavities are respectively distributed at different radii along the radial direction of the first chuck, the bottom of each cavity is provided with the fluid inlet hole, and the top of each cavity is provided with the fluid outlet holes;

the interior of the second chuck is provided with first fluid delivery channels equal to the number of cavities, the first fluid delivery channels are connected to the cavities through the fluid inlet holes.

4. The substrate processing apparatus according to claim 3, wherein the heating plate is evenly divided into n equal parts according to center angle, where n is an integer greater than or equal to 2.

5.The substrate processing apparatus according to claim 4, wherein the number of cavities in each equal part is equal, and the cavities are distributed on different radii.

6.The substrate processing apparatus according to claim 1, wherein the at least two cavities are circular arc shape and arranged in concentric circles.

7.The substrate processing apparatus according to claim 1, wherein the fluid flowing through the cavities is gas or liquid.

8.The substrate processing apparatus according to claim 1, wherein the density of the fluid outlet holes opened on each cavity of the heating plate is the same.

9.The substrate processing apparatus according to claim 1, wherein the fluid delivery pipes connected to each cavity are respectively connected to the same fluid delivery main pipe, an on-off valve and a heater are respectively installed on each fluid delivery pipe, a mass flow controller is installed on the fluid delivery main pipe;

the on-off valve is configured to open or close the fluid flowing through the fluid delivery pipe;

the mass flow controller is configured to monitor and adjust the flow rate of fluid passing through the fluid delivery main pipe;

the heater is configured to heat the fluid in each fluid delivery pipe.

10.The substrate processing apparatus according to claim 9, wherein the control mechanism is configured to:

open the on-off valves;

control the heater to heat the thermal energy of the fluid passing through the fluid delivery pipe to a first thermal energy, the fluid with the first thermal energy heats the substrate to a first temperature through the fluid outlet holes of each cavity;

during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a certain area above the substrate, control the heater to heat the fluid in the cavity on the radius corresponding to said certain area to a second thermal energy, the fluid with the second thermal energy heats the substrate region corresponding to said certain area to a second temperature through the fluid outlet holes of the cavity on the radius corresponding to said certain area.

11.The substrate processing apparatus according to claim 1, wherein each fluid delivery pipe connected to each cavity is equipped with an on-off valve, a mass flow controller, and a heater; wherein,

the on-off valve is configured to open or close the fluid passing through the fluid delivery pipe;

the mass flow controller is configured to monitor and adjust the flow rate of fluid passing through each fluid delivery pipe;

the heater is configured to heat the fluid in the fluid delivery pipe.

12.The substrate processing apparatus according to claim 11, wherein the control mechanism is configured to:

open the on-off valves;

control the heater to heat the thermal energy of the fluid passing through the fluid delivery pipe to a first thermal energy, the fluid with the first thermal energy heats the substrate to a first temperature through the fluid outlet holes of each cavity;

during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a certain area above the substrate, adjust the flow rate of the fluid in the cavity on the radius corresponding to said certain area by controlling the mass flow controller and/or adjust the temperature of the fluid in the cavity on the radius corresponding to said certain area by controlling the heater to make the fluid in the cavity on the radius corresponding to said certain area reaches a second thermal energy, and the fluid with the second thermal energy heats the substrate region corresponding to said certain area to a second temperature through the fluid outlet holes of the cavity on the radius corresponding to said certain area.

13.The substrate processing apparatus according to claim 1, wherein each fluid delivery pipe connected to each cavity is connected to two fluid delivery branch pipes, each fluid delivery branch pipe is connected to a fluid delivery main pipe, an on-off valve is installed on each fluid delivery branch pipe, and a mass flow controller and a heater are installed on each fluid delivery main pipe; wherein,

the on-off valve is configured to open or close the fluid passing through the fluid delivery branch pipes;

the mass flow controller is configured to monitor and adjust the flow rate of fluid passing through each fluid delivery main pipe;

the heater is configured to heat the fluid in each fluid delivery main pipe.

14.The substrate processing apparatus according to claim 13, wherein the control mechanism is configured to:

adjust the flow rate of fluid by controlling the mass flow controllers and/or adjust the fluid temperature by controlling the heaters to make the thermal energy of the fluid flowing through the first fluid delivery main pipe to reach a first thermal energy and the thermal energy of the fluid flowing through the second fluid delivery main pipe to reach a second thermal energy;

open the on-off valves on the first fluid delivery branch pipes, the fluid with the first thermal energy heats the substrate to a first temperature through the fluid outlet holes of each cavity;

during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a certain area above the substrate, close the on-off valve on the first fluid delivery branch pipe connected to the cavity on the radius corresponding to said certain area and simultaneously open the on-off valve on the second fluid delivery branch pipe connected to the cavity on the radius corresponding to said certain area, the fluid with the second thermal energy in the second fluid delivery main pipe heats the substrate region corresponding to said certain area to a second temperature through the fluid outlet holes of the cavity on the radius corresponding to said certain area.

15.The substrate processing apparatus according to claim 1, wherein each fluid delivery pipe connected to each cavity is connected to three fluid delivery branch pipes, each fluid delivery branch pipe is connected to a fluid delivery main pipe, each fluid delivery branch pipe is equipped with an on-off valve, and each fluid delivery main pipe is equipped with a mass flow controller, a heater is disposed on fluid delivery main pipes connected to the first fluid delivery branch pipe and the second fluid delivery branch pipe; wherein,

the on-off valves are configured to open or close the fluid passing through the fluid delivery branch pipes;

the mass flow controllers are configured to monitor and adjust the flow rate of fluid passing through each fluid delivery main pipe;

the heaters are configured to heat the fluid in each fluid delivery main pipe.

16.The substrate processing apparatus according to claim 15, wherein after taking the substrate from the clamp mechanism, close the on-off valves set on the first fluid delivery branch pipe and the second fluid delivery branch pipe, open the on-off valve set on the third fluid delivery branch pipe, and supply low-temperature fluid into the fluid delivery main pipe connected to the third fluid delivery branch pipe, the low-temperature fluid passes through each cavity to cool the heating plate.

17.The substrate processing apparatus according to claim 1, wherein each fluid delivery pipe connected to each cavity is connected to three fluid delivery branch pipes, a first fluid delivery branch pipe is connected to a first fluid delivery main pipe, a second fluid delivery branch pipe is connected to a second fluid delivery main pipe, and a third fluid delivery branch pipe is connected to a third fluid delivery main pipe, each fluid delivery branch pipe is equipped with an on-off valve, and each fluid delivery main pipe is equipped with a mass flow controller and a heater; wherein,

the on-off valves are configured to open or close the fluid passing through the fluid delivery branch pipes;

the mass flow controllers are configured to monitor and adjust the flow rate of fluid passing through each fluid delivery main pipe;

the heaters are configured to heat the fluid in each fluid delivery main pipe.

18.The substrate processing apparatus according to claim 17, wherein the control mechanism is configured to:

adjust the flow rate of fluid by controlling the mass flow controllers and/or adjust the temperature of fluid by controlling the heaters to make the thermal energy of the fluid in the first fluid delivery main pipe reach a first thermal energy, the thermal energy of the fluid in the second fluid delivery main pipe reach a second thermal energy, and the thermal energy of the fluid in the third fluid delivery main pipe reach a third thermal energy;

open the on-off valves on the first fluid delivery branch pipes connected to each fluid delivery pipe, the fluid with the first thermal energy heats the substrate to a first temperature through the fluid outlet holes of each cavity;

during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a certain area above the substrate, close the on-off valve on the first fluid delivery branch pipe connected to the cavity on the radius corresponding to said certain area, and simultaneously open the on-off valve on the second fluid delivery branch pipe connected to the cavity on the radius corresponding to said certain area, the fluid with the second thermal energy in the second fluid delivery main pipe heats the substrate region corresponding to said certain area to a second temperature through the fluid outlet holes of the cavity on the radius corresponding to said certain area;

at the same time, open the on-off valve on the third fluid delivery branch pipe connected to another cavity adjacent to the cavity on the radius corresponding to said certain area in the radial direction away from the center of the heating plate, the fluid with the third thermal energy in the third fluid delivery main pipe heats the substrate region corresponding to said another cavity to a third temperature through the fluid outlet holes of said another cavity;

the first temperature is lower than the third temperature, and the third temperature is lower than the second temperature.

19.A substrate processing method, comprising:

holding a substrate on a clamp mechanism;

driving the clamp mechanism to rotate the substrate;

dispensing liquid to a front surface of the substrate through a liquid nozzle of a spray head mechanism, during the process of the liquid nozzle moving from the center of the substrate to the edge of the substrate along the radial direction of the substrate, when the liquid nozzle moves to a local area above the substrate, jetting fluid with a second thermal energy to a back surface of the substrate to heat a local region of the substrate corresponding to said local area, raising the temperature of the local region of the substrate below the liquid nozzle; and

before dispensing liquid to the front surface through the liquid nozzle, preheating the whole substrate by jetting fluid through the heating mechanism with a first thermal energy to the whole back surface of the substrate.

20.The substrate processing method according to claim 19, wherein while jetting fluid with the second thermal energy to the bottom of the substrate to heat the substrate region corresponding to said certain area, re-preheating the substrate region corresponding to an area adjacent to said certain area in the radial direction away from

the center of the substrate by jetting fluid with a third thermal energy to the bottom of the substrate.

21.The substrate processing method according to claim 19, wherein the fluid is gas or liquid.

22.The substrate processing method according to claim 19, wherein controlling the temperature and/or flow rate of the fluid with the second thermal energy to locally heat the substrate region corresponding to said certain area, the local temperature of the substrate below the liquid nozzle is increased.

23.The substrate processing method according to claim 19, further comprising: cooling a heating plate by supplying low-temperature fluid after taking the substrate from the clamp mechanism.

24.The substrate processing apparatus according to claim 3, further comprising:

a heating element setting between the first chuck and the second chuck to heat the fluid in the at least two cavities.

25.The substrate processing apparatus according to claim 24, further comprising:

a cooling mechanism, the cooling mechanism including a cooling part, wherein the cooling part is arranged on the first chuck and used for reducing the temperature of the first chuck.

26.The substrate processing apparatus according to claim 25, further comprising a sealing layer disposed on the upper surface of the first chuck.

27.The substrate processing apparatus according to claim 26, wherein the cooling part is a cooling groove opened on the upper surface of the first chuck.

28.The substrate processing apparatus according to claim 26, wherein the cooling part is a cooling pipe, the upper surface of the first chuck is provided with an accommodating groove, the cooling pipe is set in the accommodating groove, and each of the cavities is correspondingly provided with the cooling pipe.

29.The substrate processing apparatus according to claim 25, wherein the cooling part is a cooling cavity, and the cooling cavity is set inside the first chuck.

30.The substrate processing apparatus according to claim 25, wherein the first chuck is covered with a protective layer.

31.The substrate processing apparatus according to claim 25, wherein the cooling part is a cooling pipe, and an accommodating cavity is set inside the first chuck, and the cooling pipe is set in the accommodating cavity, and each of the cavities is correspondingly provided with the cooling pipe.

32.The substrate processing apparatus according to claim 25, wherein the first chuck is made of metal material;

the second chuck is made of non-metal material.

33.The substrate processing apparatus according to claim 24, further comprising:

a cooling mechanism, the cooling mechanism including a cooling part, wherein the cooling part is disposed on the second chuck, and is used for reducing the temperature of the second chuck.

34.The substrate processing apparatus according to claim 33, wherein the cooling part is a cooling cavity, and the cooling cavity is set inside the second chuck.

35.The substrate processing apparatus according to claim 34, wherein the first chuck is made of non-metal material;

the second chuck is made of metal material.

36.The substrate processing apparatus according to claim 24, further comprising a thermal insulation layer being arranged between the second chuck and the heating element.

37.The substrate processing apparatus according to claim 25 or 33, wherein an inlet of the cooling part is connected to at least one inlet pipe for delivering liquid into the cooling part, and the inlet pipe is equipped with a cooler for cooling the liquid flowing through the inlet pipe;

an outlet of the cooling part is connected to at least one outlet pipe for discharging the liquid from the cooling part.

38.The substrate processing apparatus according to claim 37, wherein the inlet of the cooling part is further connected to at least one inlet gas pipe for delivering gas into the cooling part;

the outlet of the cooling part is connected to at least one outlet gas pipe for discharging the gas from the cooling part.

39.The substrate processing apparatus according to claim 38, wherein an on-off valve is arranged on the inlet pipe, the outlet pipe, the inlet gas pipe and the outlet gas pipe respectively.

40.The substrate processing apparatus according to claim 39, wherein the control mechanism is further configured to control the cooling mechanism to reduce the temperature of the first chuck or the second chuck.

41.The substrate processing apparatus according to claim 40, wherein the control mechanism is further configured to:

open the on-off valves on the inlet pipe and the outlet pipe after the process of heating and drying the substrate is completed;

control the cooler to cool the temperature of the liquid flowing through the inlet pipe, and the cooled liquid enters the cooling part to cool the cooling part for a time period T1 to lower the overall temperature of the first chuck or second chuck to room temperature, and then close the cooler and the on-off valves on the inlet pipe and the outlet pipe.

42.The substrate processing apparatus according to claim 41, wherein the control mechanism is further configured to:

close the cooler and the on-off valves on the inlet pipe and the outlet pipe, and then open the on-off valves on the inlet gas pipe and the outlet gas pipe; control the gas to flow through the cooling part for a time period T2 to dry the cooling part, then close the on-off valves on the inlet gas pipe and the outlet gas pipe.

43.The substrate processing apparatus according to claim 42, wherein the gas supplied into the cooling part is dry gas.