

WHAT IS CLAIMED IS:

1. A substrate processing apparatus, comprising:

- a process chamber configured to accommodate a substrate;
- a vaporizer configured to vaporize a liquid precursor to generate a reaction gas and deliver a processing gas containing the reaction gas and a carrier gas, the vaporizer including:
 - a vaporization vessel in which the liquid precursor is vaporized;
 - a liquid precursor introduction part configured to introduce the liquid precursor into the vaporization vessel;
 - a carrier gas introduction part configured to introduce the carrier gas into the vaporization vessel; and
 - a heater configured to heat the liquid precursor introduced into the vaporizing vessel;
- a carrier gas flow rate controller configured to control a flow rate of the carrier gas supplied to the vaporizer;
- a liquid precursor flow rate controller configured to control a flow rate of the liquid precursor supplied to the vaporizer;
- a processing gas supply pipe configured to introduce the processing gas delivered from the vaporizer into the process chamber;
- a processing gas temperature sensor configured to detect a temperature of the processing gas delivered from the vaporizer into the processing gas supply pipe;
- a controller configured to control the heater to adjust a temperature of the heater, based on the temperature of the processing gas detected by the processing gas temperature sensor; and
- a gas concentration sensor configured to detect a gas concentration of the reaction gas contained in the processing gas delivered from the vaporizer into the processing gas supply pipe.

2. The apparatus of Claim 1, wherein the controller is further configured to acquire the gas concentration of the reaction gas detected by the gas concentration sensor and determine a vaporization state of the liquid precursor supplied into the vaporization vessel based on the acquired gas concentration of the reaction gas.
3. The apparatus of Claim 2, wherein when a state in which the acquired gas concentration of the reaction gas is a value equal to or less than a predetermined ratio of a predetermined concentration value as a reference continues for a predetermined period of time, the controller is configured to determine that a vaporization failure of the liquid precursor supplied into the vaporization vessel has occurred.
4. The apparatus of Claim 2, wherein when it is determined that a vaporization failure of the liquid precursor supplied into the vaporization vessel has occurred, the controller is configured to control a display device to notify a user that the vaporization failure has occurred.
5. The apparatus of Claim 2, wherein when it is determined that a vaporization failure of the liquid precursor supplied into the vaporization vessel has occurred, the controller is configured to control a memory device to record occurrence of the vaporization failure.
6. The apparatus of Claim 1, wherein the controller is further configured to acquire the gas concentration of the reaction gas detected by the gas concentration sensor and perform at least one of the operations to (a) control the heater to adjust a temperature of the heater based on the acquired gas concentration of the reaction gas, (b) control the carrier gas flow rate controller to adjust a supply amount of the carrier gas, and (c) control the liquid precursor flow rate controller to adjust a supply amount of the liquid precursor.

7. The apparatus of Claim 1, wherein a gas concentration of the reaction gas detected by the gas concentration sensor is acquired, and when a state in which the acquired gas concentration of the reaction gas is a value equal to or less than a predetermined ratio of a predetermined concentration value as a reference continues for a predetermined period of time, it is configured to perform at least one of the operations to (a) control the carrier gas flow rate controller to increase a supply amount of the carrier gas, and (b) control the liquid precursor flow rate controller to decrease a supply amount of the liquid precursor.
8. The apparatus of Claim 1, wherein the controller is further configured to acquire the gas concentration of the reaction gas detected by the gas concentration sensor, and when a state in which the acquired gas concentration of the reaction gas is a value equal to or larger than a predetermined ratio of a predetermined concentration value as a reference continues for a predetermined period of time, to control the liquid precursor flow rate controller to reduce the supply amount of the liquid precursor.
9. The apparatus of Claim 1, wherein the processing gas contains a hydrogen peroxide gas as the reaction gas.
10. The apparatus of Claim 1, wherein the liquid precursor is a hydrogen peroxide solution.
11. The apparatus of Claim 10, wherein the processing gas contains a hydrogen peroxide gas as the reaction gas.
12. The apparatus of Claim 1, wherein the controller is further configured to control the heater such that the temperature of the heater is 220 degrees C or lower.

13. A method of manufacturing a semiconductor device, comprising:
processing a substrate using a substrate processing apparatus, the substrate processing apparatus including:
- a process chamber configured to accommodate the substrate;
 - a vaporizer configured to vaporize a liquid precursor to generate a reaction gas and deliver a processing gas containing the reaction gas and a carrier gas, wherein the vaporizer includes a vaporization vessel in which the liquid precursor is vaporized, and a heater configured to heat the liquid precursor introduced into the vaporizing vessel;
 - a processing gas supply pipe configured to introduce the processing gas delivered from the vaporizer into the process chamber;
 - a processing gas temperature sensor that detects a temperature of the processing gas delivered from the vaporizer into the processing gas supply pipe; and
 - a gas concentration sensor configured to detect a gas concentration of the reaction gas contained in the processing gas delivered from the vaporizer into the processing gas supply pipe,
- wherein the act of processing the substrate comprises:
- loading the substrate into the process chamber;
 - generating the processing gas by supplying the liquid precursor and the carrier gas from the liquid precursor introduction part into the vaporizer and heating the liquid precursor supplied into the vaporizer by the heater to vaporize the liquid precursor;
 - introducing the processing gas generated in the vaporizer into the processing chamber through the processing gas supply pipe;
 - adjusting a temperature of the heater based on the temperature of the processing gas detected by the processing gas temperature sensor; and
 - acquiring the gas concentration of the reaction gas detected by the gas concentration sensor and determine a vaporization state of the liquid precursor supplied

into the vaporization vessel based on the acquired gas concentration of the reaction gas.

14. A computer-readable recording medium storing a program that causes a computer to perform a predetermined process in a substrate processing apparatus, the substrate processing apparatus comprising:

- a process chamber configured to accommodate the substrate;

- a vaporizer configured to vaporize a liquid precursor to generate a reaction gas and deliver a processing gas containing the reaction gas and a carrier gas, wherein the vaporizer includes a vaporization vessel in which the liquid precursor is vaporized, and a heater configured to heat the liquid precursor introduced into the vaporizing vessel;

- a processing gas supply pipe configured to introduce the processing gas delivered from the vaporizer into the process chamber;

- a processing gas temperature sensor that detects a temperature of the processing gas delivered from the vaporizer into the processing gas supply pipe; and

- a gas concentration sensor configured to detect a gas concentration of the reaction gas contained in the processing gas delivered from the vaporizer into the processing gas supply pipe,

wherein the predetermined process comprises:

- loading the substrate into the process chamber;

- generating the processing gas by supplying the liquid precursor and the carrier gas from the liquid precursor introduction part into the vaporizer and heating the liquid precursor supplied into the vaporizer by the heater to vaporize the liquid precursor;

- introducing the processing gas generated in the vaporizer into the processing chamber through the processing gas supply pipe;

- controlling at least one of operations to (a) adjust a temperature of the heater, (b) adjust a supply amount of the carrier gas supplied into the vaporizer and (c) adjust a

supply amount of the liquid precursor supplied into the vaporizer based on the temperature of the processing gas detected by the processing gas temperature sensor; and

acquiring the gas concentration of the reaction gas detected by the gas concentration sensor and determine a vaporization state of the liquid precursor supplied into the vaporization vessel based on the acquired gas concentration of the reaction gas.