CLAIMS

[Claim 1] A method of creating a polishing-rate responsiveness profile indicating a distribution of responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the method comprising:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

pressing the workpiece against the polishing pad to polish the workpiece, while a predetermined pressure is maintained in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the polished workpiece;

multiplying the pressing-pressure responsiveness profile by the predetermined pressure and a polishing-rate coefficient to create a virtual polishing-rate profile;

determining the polishing-rate coefficient that minimizes a difference between the polishing-rate profile and the virtual polishing-rate profile; and

multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient to create the polishing-rate responsiveness profile.

[Claim 2] The method according to claim 1, wherein the pressure chamber comprises a plurality of pressure chambers, and the polishing-rate coefficient comprises a plurality of polishing-rate coefficients corresponding to the plurality of pressure chambers, respectively.

[Claim 3] The method according to claim 1 or 2, further comprising determining a correction factor that eliminates the difference between the polishing-rate profile and the

virtual polishing-rate profile,

wherein multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient to create the polishing-rate responsiveness profile comprises multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient and the determined correction factor to create the polishing-rate responsiveness profile.

[Claim 4] A method of creating a polishing-rate responsiveness profile indicating a distribution of responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the method comprising:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

pressing the workpiece against the polishing pad to polish the workpiece, while a predetermined pressure is maintained in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the polished workpiece;

adding a polishing-rate offset to a value determined by multiplying the pressing-pressure responsiveness profile by the predetermined pressure and a polishing-rate coefficient to create a virtual polishing-rate profile;

determining the polishing-rate coefficient and the polishing-rate offset that minimize a difference between the polishing-rate profile and the virtual polishing-rate profile; and

adding the determined polishing-rate offset to a value determined by multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient

to create the polishing-rate responsiveness profile.

[Claim 5] The method according to claim 4, wherein the pressure chamber comprises a plurality of pressure chambers, and the polishing-rate coefficient comprises a plurality of polishing-rate coefficients corresponding to the plurality of pressure chambers, respectively.

[Claim 6] The method according to claim 4 or 5, further comprising determining a correction factor that eliminates the difference between the polishing-rate profile and the virtual polishing-rate profile,

wherein multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient to create the polishing-rate responsiveness profile comprises adding the determined polishing-rate offset to a value determined by multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient and the determined correction factor to create the polishing-rate responsiveness profile.

[Claim 7] A method of creating a polishing-rate responsiveness profile indicating a distribution of responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the method comprising:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

pressing the workpiece against the polishing pad to polish the workpiece, while a predetermined pressure is maintained in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the polished workpiece; and

creating the polishing-rate responsiveness profile based on the pressing-pressure responsiveness profile, the predetermined pressure, and the polishing-rate profile,

wherein creating the pressing-pressure responsiveness profile comprises:

performing simulation to create a first pressing-pressure responsiveness profile indicating a distribution of the pressing pressure changed in response to a change from a first pressure to a second pressure in the pressure chamber;

performing simulation to create a second pressing-pressure responsiveness profile indicating a distribution of the pressing pressure changed in response to a change from a third pressure to a fourth pressure in the pressure chamber; and

creating the pressing-pressure responsiveness profile based on the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile.

[Claim 8] The method according to claim 7, wherein creating the pressing-pressure responsiveness profile based on the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile comprises creating the pressing-pressure responsiveness profile by interpolation or extrapolation using the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile.

[Claim 9] The method according to claim 7, wherein creating the pressing-pressure responsiveness profile based on the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile comprises inputting the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile into a model constructed by machine learning, and outputting the pressing-pressure responsiveness profile from the model.

[Claim 10] The method according to any one of claims 1 to 9, wherein the

polishing-rate profile comprises one selected from a plurality of polishing-rate profiles created by polishing a plurality of workpieces, and

the plurality of polishing-rate profiles are obtained by:

pressing the plurality of workpieces one by one against the polishing pad to polish the plurality of workpieces with different pressures set in the pressure chamber for each of the plurality of workpieces; and

creating the plurality of polishing-rate profiles indicating distributions of polishing rate of the plurality of polished workpieces.

[Claim 11] The method according to any one of claims 1 to 10, further comprising optimizing a polishing condition for other workpiece using the polishing-rate responsiveness profile.

[Claim 12] The method according to claim 11, wherein optimizing the polishing condition for the other workpiece comprises:

creating a current film-thickness profile of the other workpiece, while the other workpiece is polished; and

determining the pressure in the pressure chamber for minimizing a difference between the current film-thickness profile and a target film-thickness profile based on the polishing-rate responsiveness profile.

[Claim 13] The method according to claim 11, wherein optimizing the polishing condition for the other workpiece comprises:

creating a film-thickness profile before the polishing of the workpiece and a film-thickness profile after the polishing of the workpiece which has been used to create the polishing-rate profile; and

determining the pressure in the pressure chamber based on the film-thickness profile before the polishing, the film-thickness profile after the polishing, a target film-

thickness profile, and the polishing-rate responsiveness profile.

[Claim 14] A polishing method comprising:

optimizing a polishing condition for a workpiece using the polishing-rate responsiveness profile created by the method according to any one of claims 1 to 13; and

pressing the workpiece against the polishing pad with the elastic membrane to polish the workpiece under the optimized polishing condition.

[Claim 15] A computer-readable storage medium storing a program to cause a computer to create a polishing-rate responsiveness profile indicating a distribution of responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the program being configured to cause the computer to perform the steps of:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the workpiece polished by pressing the workpiece against the polishing pad while a predetermined pressure is maintained in the pressure chamber;

multiplying the pressing-pressure responsiveness profile by the predetermined pressure and a polishing-rate coefficient to create a virtual polishing-rate profile;

determining the polishing-rate coefficient that minimizes a difference between the polishing-rate profile and the virtual polishing-rate profile; and

multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient to create the polishing-rate responsiveness profile.

[Claim 16] A computer-readable storage medium storing a program to cause a

computer to create a polishing-rate responsiveness profile indicating a distribution of responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the program being configured to cause the computer to perform the steps of:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the workpiece polished by pressing the workpiece against the polishing pad while a predetermined pressure is maintained in the pressure chamber; and

creating the polishing-rate responsiveness profile based on the pressing-pressure responsiveness profile, the predetermined pressure, and the polishing-rate profile,

wherein creating the pressing-pressure responsiveness profile comprises:

performing simulation to create a first pressing-pressure responsiveness profile indicating a distribution of the pressing pressure changed in response to a change from a first pressure to a second pressure in the pressure chamber;

performing simulation to create a second pressing-pressure responsiveness profile indicating a distribution of the pressing pressure changed in response to a change from a third pressure to a fourth pressure in the pressure chamber; and

creating the pressing-pressure responsiveness profile based on the first pressing-pressure responsiveness profile and the second pressing-pressure responsiveness profile.

[Claim 17] A computer-readable storage medium storing a program to cause a computer to create a polishing-rate responsiveness profile indicating a distribution of

responsiveness of a polishing rate to a pressure change in a pressure chamber when a workpiece for use in manufacturing of semiconductor devices is pressed against a polishing pad with an elastic membrane forming the pressure chamber therein, the program being configured to cause the computer to perform the steps of:

performing simulation to calculate a pressing-pressure responsiveness profile indicating a distribution of pressing pressure, which is to be applied from the workpiece to the polishing pad, changed in response to a change in unit pressure in the pressure chamber;

creating a polishing-rate profile indicating a distribution of polishing rate of the workpiece polished by pressing the workpiece against the polishing pad while a predetermined pressure is maintained in the pressure chamber;

adding a polishing-rate offset to a value determined by multiplying the pressing-pressure responsiveness profile by the predetermined pressure and a polishing-rate coefficient to create a virtual polishing-rate profile;

determining the polishing-rate coefficient and the polishing-rate offset that minimize a difference between the polishing-rate profile and the virtual polishing-rate profile; and

adding the determined polishing-rate offset to a value determined by multiplying the pressing-pressure responsiveness profile by the determined polishing-rate coefficient to create the polishing-rate responsiveness profile.