What is claimed is:

1. A polishing method comprising:

polishing a substrate by pressing the substrate against a polishing surface of a polishing pad, while regulating a temperature of the polishing surface by a heat exchanger;

calculating a target polishing rate required for an actual polishing time to coincide with a target polishing time, the actual polishing time being a time duration from start of polishing the substrate until a film thickness of the substrate reaches a target thickness;

determining a target temperature of the polishing surface that can achieve the target polishing rate based on a relational expression indicating a correlation between polishing rate and temperature of the polishing surface; and

during polishing of the substrate, changing a temperature of the polishing surface to the target temperature by the heat exchanger.

wherein the relational expression is a relational expression produced by:

polishing one of sample substrates on the polishing surface of the polishing pad while keeping the temperature of the polishing surface constant by the heat exchanger;

calculating a polishing rate of the one sample substrate;

repeating polishing of one of the sample substrates and calculation of a polishing rate of the one sample substrate, while changing the sample substrate to be polished from one to another of the plurality of sample substrates and while changing the temperature of the polishing surface to another temperature by the heat exchanger, thereby obtaining a plurality of polishing rates corresponding to a plurality of temperatures of the polishing surface; and

determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.

2. The polishing method according to claim 1, wherein calculating the target polishing rate comprises:

calculating a remaining film thickness by subtracting the target thickness from a film thickness of the substrate at a present point in time;

calculating a remaining time by subtracting an elapsed time from the target polishing time, the elapsed time being a period of time from start of polishing the substrate to the present point in time; and

dividing the remaining film thickness by the remaining time, thereby calculating the target polishing rate.

~~3. The polishing method according to claim 1 or 2, wherein determining the target temperature of the polishing surface comprises determining the target temperature of the polishing surface corresponding to the target polishing rate based on a relational expression indicating a correlation between polishing rate and temperature of the polishing surface.~~

~~4. The polishing method according to claim 3, wherein the relational expression is a relational expression produced by:~~

~~polishing one of sample substrates on the polishing surface of the polishing pad while keeping the temperature of the polishing surface constant by the heat exchanger;~~

~~calculating a polishing rate of the one sample substrate;~~

~~repeating polishing of one of the sample substrates and calculation of a polishing rate of the one sample substrate, while changing the sample substrate to be polished from one to another of the plurality of sample substrates and while changing the temperature of the polishing surface to another temperature, thereby obtaining a plurality of polishing rates corresponding to a plurality of temperatures of the polishing surface; and~~

~~determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.~~

~~5. The polishing method according to claim 3, wherein the relational expression is a relational expression produced by:~~

~~polishing a sample substrate on the polishing surface of the polishing pad while measuring a temperature of the polishing surface;~~

~~calculating a plurality of polishing rates of the sample substrate corresponding to a plurality of temperatures of the polishing surface, respectively; and~~

~~determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.~~

3~~6~~. A polishing method comprising:

polishing a substrate by pressing the substrate against a polishing surface of a polishing pad, while regulating a temperature of the polishing surface by a heat exchanger;

calculating a target polishing rate required for an actual polishing time to coincide with a target polishing time, the actual polishing time being a time duration from start of polishing the substrate until a film thickness of the substrate reaches a target thickness; and

during polishing of the substrate, adjusting a temperature of the polishing surface by the heat exchanger such that a current polishing rate of the substrate is maintained at the target polishing rate,

wherein the temperature of the polishing surface is adjusted within a temperature range that does not exceed a predetermined upper limit temperature, the upper limit temperature being determined based on a temperature of the polishing surface that maximizes a polishing rate of the substrate.

4~~7~~. The polishing method according to claim 3~~6~~, wherein calculating the target polishing rate comprises:

calculating a remaining film thickness by subtracting the target thickness from a film thickness of the substrate at a present point in time;

calculating a remaining time by subtracting an elapsed time from the target polishing time, the elapsed time being a period of time from start of polishing the substrate to the present point in time; and

dividing the remaining film thickness by the remaining time, thereby calculating the target polishing rate.

~~8. The polishing method according to claim 6, wherein adjusting the temperature of the polishing surface is performed within a temperature range that does not exceed a predetermined upper limit temperature, the upper limit temperature being determined based on a temperature of the polishing surface that maximizes a polishing rate of the substrate.~~

5~~9~~. A polishing apparatus comprising:

a polishing table for supporting a polishing pad;

a polishing head configured to polish a substrate by pressing the substrate against a polishing surface of the polishing pad;

a heat exchanger having a heating flow passage and a cooling flow passage therein, the heat exchanger being arranged above the polishing table;

a pad-temperature measuring device configured to measure a temperature of the polishing surface;

a fluid supply system having a heating-fluid supply pipe and a cooling-fluid supply pipe coupled to the heating flow passage and the cooling flow passage, respectively;

a film-thickness sensor attached to the polishing table; and

an operation controller having a memory and a processing device, the memory storing a program therein, the processing device being configured to perform an arithmetic operation according to an instruction contained in the program,

the operation controller being configured to

calculate a target polishing rate required for an actual polishing time to coincide with a target polishing time, the actual polishing time being a time duration from start of polishing the substrate until a film thickness of the substrate reaches a target thickness,

determine a target temperature of the polishing surface that can achieve the target polishing rate, and

operate the fluid supply system during polishing of the substrate to change a temperature of the polishing surface to the target temperature by the heat exchanger,

the operation controller stores, in the memory, a relational expression indicating a correlation between polishing rate and temperature of the polishing surface, and the operation controller is configured to determine the target temperature of the polishing surface corresponding to the target polishing rate based on the relational expression,

the relational expression is a relational expression produced by:

polishing one of sample substrates on the polishing surface of the polishing pad while keeping the temperature of the polishing surface constant by the heat exchanger;

calculating a polishing rate of the one sample substrate;

repeating polishing of one of the sample substrates and calculation of a polishing rate of the one sample substrate, while changing the sample substrate to be polished from one to another of the plurality of sample substrates and while changing the temperature of the polishing surface to another temperature by the heat exchanger, thereby obtaining a plurality of polishing rates corresponding to a plurality of temperatures of the polishing surface; and

determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.

6~~10~~. The polishing apparatus according to claim 5~~9~~, wherein the operation controller is configured to:

calculate a remaining film thickness by subtracting the target thickness from a film thickness of the substrate at a present point in time;

calculate a remaining time by subtracting an elapsed time from the target polishing time, the elapsed time being a period of time from start of polishing the substrate to the present point in time; and

divide the remaining film thickness by the remaining time to calculate the target polishing rate.

~~11. The polishing apparatus according to claim 9 or 10, wherein the operation controller stores, in the memory, a relational expression indicating a correlation between polishing rate and temperature of the polishing surface, and the operation controller is configured to determine the target temperature of the polishing surface corresponding to the target polishing rate based on the relational expression.~~

~~12. The polishing apparatus according to claim 11, wherein the relational expression is a relational expression produced by:~~

~~polishing one of sample substrates on the polishing surface of the polishing pad while keeping the temperature of the polishing surface constant by the heat exchanger;~~

~~calculating a polishing rate of the one sample substrate;~~

~~repeating polishing of one of the sample substrates and calculation of a polishing rate of the one sample substrate, while changing the sample substrate to be polished from one to another of the plurality of sample substrates and while changing the temperature of the polishing surface to another temperature, thereby obtaining a plurality of polishing rates corresponding to a plurality of temperatures of the polishing surface; and~~

~~determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.~~

~~13. The polishing apparatus according to claim 11, wherein the relational expression is a relational expression produced by:~~

~~polishing a sample substrate on the polishing surface of the polishing pad while measuring a temperature of the polishing surface;~~

~~calculating a plurality of polishing rates of the sample substrate corresponding to a plurality of temperatures of the polishing surface, respectively; and~~

~~determining the relational expression indicating a correlation between the plurality of temperatures of the polishing surface and the plurality of polishing rates.~~

7~~14~~. A polishing apparatus comprising:

a polishing table for supporting a polishing pad;

a polishing head configured to polish a substrate by pressing the substrate against a polishing surface of the polishing pad;

a heat exchanger having a heating flow passage and a cooling flow passage therein, the heat exchanger being arranged above the polishing table;

a pad-temperature measuring device configured to measure a temperature of the polishing surface;

a fluid supply system having a heating-fluid supply pipe and a cooling-fluid supply pipe coupled to the heating flow passage and the cooling flow passage, respectively;

a film-thickness sensor attached to the polishing table; and

an operation controller having a memory and a processing device, the memory storing a program therein, the processing device being configured to perform an arithmetic operation according to an instruction contained in the program,

the operation controller being configured to

calculate a target polishing rate required for an actual polishing time to coincide with a target polishing time, the actual polishing time being a time duration from start of polishing the substrate until a film thickness of the substrate reaches a target thickness, and

operate the fluid supply system during polishing of the substrate to adjust a temperature of the polishing surface by the heat exchanger such that a current polishing rate of the substrate is maintained at the target polishing rate,

wherein the operation controller is configured to instruct the heat exchanger to adjust the temperature of the polishing surface within a temperature range that does not exceed a predetermined upper limit temperature, the upper limit temperature being determined based on a temperature of the polishing surface that maximizes a polishing rate of the substrate.

8~~15~~. The polishing apparatus according to claim 7~~14~~, wherein the operation controller is configured to:

calculate a remaining film thickness by subtracting the target thickness from a film thickness of the substrate at a present point in time;

calculate a remaining time by subtracting an elapsed time from the target polishing time, the elapsed time being a period of time from start of polishing the substrate to the present point in time; and

divide the remaining film thickness by the remaining time to calculate the target polishing rate.

~~16. The polishing apparatus according to claim 14 or 15, wherein the operation controller is configured to allow the heat exchanger to adjust the temperature of the polishing surface within a temperature range that does not exceed a predetermined upper limit temperature, the upper limit temperature being determined based on a temperature of the polishing surface that maximizes a polishing rate of the substrate.~~