CLAIMS

[Claim 1] A CMP apparatus comprising:

a polishing pad surface property measuring device configured to apply a laser beam to a surface of a polishing pad and to receive reflected light from the polishing pad to obtain reflection intensity in each reflection angle;

a processor configured to perform a Fourier transform on a reflection intensity distribution obtained by the polishing pad surface property measuring device to obtain a spatial wavelength spectrum of the surface of the polishing pad, and to perform numerical analysis on the spatial wavelength spectrum to obtain surface properties of the polishing pad;

a dressing control unit configured to determine dressing conditions of the polishing pad by a closed loop control based on the surface properties of the polishing pad obtained by the processor; and

a dressing apparatus configured to dress the polishing pad based on the dressing conditions determined by the dressing control unit;

wherein the polishing pad surface property measuring device comprises at least a laser light source, a light emitter, a light receiver and a mirror; and

wherein the polishing pad surface property measuring device further comprises at least one of an ND filter, a bandpass filter which allows transmission of only light within ±5 nm with respect to a wavelength of the laser beam of the light source, and an optical fiber.

[Claim 2] The CMP apparatus according to claim 1, wherein the determination of the dressing conditions comprises:

obtaining a difference between a measured surface property value of the pad and a preset desired surface property value of the pad, as a desired surface property variation of the pad; and

assigning the desired surface property variation of the pad to a regression equation prepared by obtaining in advance a relationship between a variation of at least one of a dressing load, a dresser rotational speed, a polishing pad rotational speed, and a dresser swinging speed and a surface property variation of the pad to determine at least one of the dressing load, the dresser rotational speed, the polishing pad rotational speed, and the dresser swinging speed.

[Claim 3] The CMP apparatus according to claim 1, wherein the numerical analysis for obtaining the surface properties of the polishing pad performed by the processor comprises dividing a sum of the reflection intensity of a predetermined spatial wavelength range by a sum of the reflection intensity of a wider spatial wavelength range.

[Claim 4] The CMP apparatus according to claim 1, wherein the light receiver comprises a linear or planar CCD element or CMOS element having a size capable of receiving fourth-order diffracted light at the highest or seventh-order diffracted light at the highest of the laser beam reflected from the polishing pad.

[Claim 5] The CMP apparatus according to claim 1, wherein the laser beam applied to the surface of the polishing pad is s-polarized.

[Claim 6] The CMP apparatus according to claim 1, wherein the dressing control unit is configured to adjust at least one of a dressing load, a polishing pad rotational speed, a dresser rotational speed, and a dresser swinging speed.

[Claim 7] The CMP apparatus according to claim 1, wherein irradiation of the laser beam is performed by swinging the light source to adjust an incident angle of the

laser beam to the surface of the polishing pad.

[Claim 8] A CMP apparatus comprising:

a polishing pad surface property measuring device configured to apply a laser beam to a surface of a polishing pad and to receive reflected light from the polishing pad to obtain reflection intensity in each reflection angle;

a processor configured to perform a Fourier transform on a reflection intensity distribution obtained by the polishing pad surface property measuring device to obtain a spatial wavelength spectrum of the surface of the polishing pad, and to perform numerical analysis on the spatial wavelength spectrum to obtain surface properties of the polishing pad; and

a display unit configured to display at least one of a state of the dresser and a state of the polishing pad after comparing the surface properties of the polishing pad obtained by the processor and a preset surface property value of the pad;

wherein the polishing pad surface property measuring device comprises at least a laser light source, a light emitter, a light receiver and a mirror; and

wherein the polishing pad surface property measuring device further comprises at least one of an ND filter, a bandpass filter which allows transmission of only light within ±5 nm with respect to a wavelength of the laser beam of the light source, and an optical fiber.

[Claim 9] The CMP apparatus according to claim 8, wherein the state of the dresser is one of an alarm representing life of the dresser and a poor performance state of the dresser.

[Claim 10] The CMP apparatus according to claim 8, wherein the state of the polishing pad is presence or absence of an abnormality of the surface properties of the polishing pad.

[Claim 11] A CMP apparatus comprising:

a polishing pad surface property measuring device configured to apply a laser beam to a surface of a polishing pad and to receive reflected light from the polishing pad to obtain reflection intensity in each reflection angle;

a processor configured to perform a Fourier transform on a reflection intensity

distribution obtained by the polishing pad surface property measuring device to obtain a spatial wavelength spectrum of the surface of the polishing pad, and to perform numerical analysis on the spatial wavelength spectrum to obtain surface properties of the polishing pad; and

a display unit configured to display at least one of a state of the dresser and a state of the polishing pad based on the surface properties of the polishing pad obtained by the processor;

wherein the polishing pad surface property measuring device comprises at least a laser light source, a light emitter, a light receiver and a mirror; and

wherein the polishing pad surface property measuring device further comprises at least one of an ND filter, a bandpass filter which allows transmission of only light within ±5 nm with respect to a wavelength of the laser beam of the light source, and an optical fiber.

[Claim 12] The CMP apparatus according to claim 11, wherein the state of the dresser is dressing capability of the dresser.

[Claim 13] The CMP apparatus according to claim 11, wherein the state of the polishing pad is a surface property value of the polishing pad.

[Claim 14] A CMP apparatus comprising:

a polishing pad surface property measuring device configured to apply a laser beam to a surface of a polishing pad and to receive reflected light from the polishing pad to obtain reflection intensity in each reflection angle;

a processor configured to perform a Fourier transform on a reflection intensity distribution obtained by the polishing pad surface property measuring device to obtain a spatial wavelength spectrum of the surface of the polishing pad, and to perform numerical analysis on the spatial wavelength spectrum to obtain surface properties of the polishing pad; and

an abnormality judgement unit configured to judge an abnormality of the surface properties of the polishing pad when a surface property value of the polishing pad obtained by the processor is compared with a preset range of the surface property value of the pad and falls outside the preset range;

wherein the polishing pad surface property measuring device comprises at least a laser light source, a light emitter, a light receiver and a mirror; and

wherein the polishing pad surface property measuring device further comprises at least one of an ND filter, a bandpass filter which allows transmission of only light within ±5 nm with respect to a wavelength of the laser beam of the light source, and an optical fiber.

[Claim 15] The CMP apparatus according to claim 14, wherein when the abnormality is judged by the abnormality judgement unit, a display unit issues an alarm of the abnormality.

[Claim 16] A computer-readable recording medium which records a program for causing a CMP apparatus to perform predetermined operations, the recording medium which records the program causing a computer to perform:

a step for applying a laser beam from a laser light source through a light emitter and a mirror to a surface of a polishing pad;

a step for receiving reflected light from the polishing pad by a light receiver, the step for applying the laser beam and the step for receiving the light being performed by using at least one of an ND filter, a bandpass filter which allows transmission of only light within ±5 nm with respect to a wavelength of the laser beam of the light source, and an optical fiber;

a step for taking in information of the received light;

a step for obtaining reflection intensity in each reflection angle obtained from the taken-in information;

a step for creating a reflection intensity distribution by performing the step for applying the laser beam, the step for receiving the light, the step for taking in the information and the step for obtaining the reflection intensity for predetermined time; or a step for creating a reflection intensity distribution by repeating the step for applying the laser beam, the step for receiving the light, the step for taking in the information and the step for obtaining the reflection intensity a predetermined number of times;

a step for obtaining a spatial wavelength spectrum of the surface of the polishing pad by performing a Fourier transform on the reflection intensity distribution;

a step for performing numerical analysis from the spatial wavelength spectrum; and

a step for obtaining surface properties of the polishing pad from the numerical analysis.

[Claim 17] The computer-readable recording medium according to claim 16, wherein the recording medium records the program causing the computer to perform further:

a step for comparing the obtained surface property value and a preset surface property value of the pad; and

a step for displaying at least one of a state of the dresser or a state of the polishing pad from the compared result.

[Claim 18] The computer-readable recording medium according to claim 16, wherein the recording medium records the program causing the computer to perform further:

a step for determining dressing conditions of the polishing pad by a closed loop control based on the obtained surface property value.

[Claim 19] The computer-readable recording medium according to claim 18, wherein the step for determining the dressing conditions comprises:

a step for obtaining a difference between the surface property value obtained from the numerical analysis and a preset desired surface property value of the pad, as a desired surface property variation of the pad;

a step for assigning the desired surface property variation of the pad to a predetermined regression equation which has been obtained and stored in advance; and

a step for selecting optimum dressing conditions from the result of the above assignment.

[Claim 20] The computer-readable recording medium according to claim 16, wherein the recording medium records the program causing the computer to perform further:

a step for adjusting an incident angle of the laser beam to the polishing pad before the step for applying the laser beam.

[Claim 21] The CMP apparatus according to claim 1, wherein the polishing pad surface property measuring device comprises the laser light source for emitting a laser beam; the light emitter for leading the laser beam emitted from the laser light source in a predetermined direction; the mirror which can change an optical path by reflecting the laser beam emitted from the light emitter to adjust an incident angle of the laser beam applied to the polishing pad; the bandpass filter which allows transmission of only the light,

reflected by the surface of the polishing pad, within ±5 nm with respect to a wavelength of the laser beam of the light source; and the light receiver for receiving the light which has passed through the bandpass filter.

[Claim 22] The CMP apparatus according to claim 1, wherein the polishing pad surface property measuring device comprises the laser light source for emitting a laser beam; the light emitter for leading the laser beam emitted from the laser light source in a predetermined direction; and the light receiver for receiving the light reflected by the surface of the polishing pad; and

wherein the laser light source is configured to be swingable to apply the laser beam to the polishing pad at a plurality of positions on the surface of the polishing pad; and the light receiver is configured to receive the light reflected by the surface of the polishing pad at the plurality of positions on the surface of the polishing pad.

[Claim 23] The CMP apparatus according to claim 22, further comprising the bandpass filter provided between the polishing pad and the light receiver.

[Claim 24] The CMP apparatus according to claim 22, wherein the light receiver is swingable to receive the light reflected by the surface of the polishing pad at the plurality of positions on the surface of the polishing pad.

[Claim 25] The CMP apparatus according to claim 1, wherein the polishing pad surface property measuring device comprises the laser light source for emitting a laser beam; the light emitter for leading the laser beam emitted from the laser light source in a predetermined direction; and the light receiver comprising a plurality of light receivers for receiving the light reflected by the surface of the polishing pad; and

wherein the laser light source is configured to be swingable to apply the laser beam to the polishing pad at a plurality of positions on the surface of the polishing pad; and the plurality of light receivers are configured to receive the light reflected by the surface of the polishing pad at the plurality of positions on the surface of the polishing pad.