

What is claimed is:

1. A film thickness measurement apparatus configured to measure a film thickness of a film formed on a substrate, the film thickness measurement apparatus comprising:
 - 5 an imaging device that images a front surface of the substrate;
 - a measured value storage part that stores a plurality of film thickness measured values obtained by measurement in advance at a plurality of coordinates on a measurement preparation substrate and coordinates corresponding to the film thickness measured values, for a film formed on the measurement preparation substrate and
 - 10 having a non-uniform thickness;
 - an image storage part that stores a preparation imaged image obtained by imaging the measurement preparation substrate in advance by the imaging device;
 - a pixel value extraction part that extracts a pixel value at each coordinates stored in the measured value storage part from the preparation imaged image stored in the
 - 15 image storage part;
 - a correlation data generation part that extracts, from the measured value storage part, the film thickness measured value at each coordinates corresponding to the extracted pixel value, and generates correlation data between the extracted film thickness measured value and the extracted pixel value; and
 - 20 a film thickness calculation part that calculates a film thickness of a film formed on a substrate being a film thickness measurement object on a basis of a pixel value of an imaged image of the substrate being the film thickness measurement object and the correlation data generated in the correlation data generation part.
- 25 2. The film thickness measurement apparatus according to claim 1, further comprising:
 - an image correction part that calculates an imaging error in the imaging device, generates a corrected imaged image obtained by correcting the imaging error of the preparation imaged image stored in the image storage part, and stores the corrected
 - 30 imaged image,
 - wherein the pixel value extraction part extracts a pixel value from the corrected imaged image stored in the image correction part.

3. The film thickness measurement apparatus according to claim 2,
wherein calculation of the imaging error in the image correction part is performed by:

5 acquiring another preparation imaged image obtained by imaging the measurement preparation substrate in a state that the measurement preparation substrate is rotated in a circumferential direction by a predetermined angle from a state that the preparation imaged image stored in the image storage part is imaged;

generating an average image obtained by combining the another preparation imaged image in a state of being reversely rotated in the circumferential direction by the predetermined angle with the imaged image and then averaging a resultant thereof; and

obtaining a difference between the average image and the preparation imaged image or the another preparation imaged image.

15 4. The film thickness measurement apparatus according to claim 3,
wherein the image correction part is configured to:

extract a pixel value corresponding to a desired film thickness from the preparation imaged image or the another preparation imaged image, and generate a replaced image made by replacing pixel values at the plurality of coordinates on an entire surface of the measurement preparation substrate with the extracted pixel value;
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correct the replaced image by an imaging error difference calculated by the image correction part to generate a reference image, and

wherein the pixel value extraction part extracts a pixel value from a difference image between the reference image and the preparation imaged image or the another preparation imaged image.
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5. The film thickness measurement apparatus according to ~~any one of claims 1 to 4~~,
wherein when the preparation imaged image and the imaged image of the substrate being the film thickness measurement object are composed of a plurality of primary colors, the correlation data generation part generates the correlation data for each of the primary colors and specifies a primary color having a largest correlation
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coefficient between the film thickness measured value and the extracted pixel value among the correlation data generated by the correlation data generation part, and

wherein the film thickness calculation part calculates the film thickness on a basis of the correlation data on the specified primary color.

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6. A film thickness measurement method of measuring a film thickness of a film formed on a substrate, the film thickness measurement method comprising:

a film thickness coordinate acquisition step of acquiring film thickness measured values obtained by measurement in advance at a plurality of points on a measurement preparation substrate and coordinates corresponding to the film thickness measured values, for a film formed on the measurement preparation substrate and having a non-uniform thickness;

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a pixel value extraction step of extracting a pixel value at each coordinates acquired at the film thickness coordinate acquisition step from a preparation imaged image obtained by imaging the measurement preparation substrate in advance by an imaging device;

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a correlation data generation step of generating correlation data between the pixel value extracted at each coordinates and the film thickness measured value at each coordinates; and

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a film thickness calculation step of imaging a substrate being a film thickness measurement object by the imaging device to acquire an imaged image, and calculating a film thickness of a film formed on the substrate being the film thickness measurement object on a basis of a pixel value of the imaged image and the correlation data.

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7. The film thickness measurement method according to claim 6, further comprising:

an image correction step of calculating an imaging error in the imaging device, and generating a corrected imaged image obtained by correcting the imaging error of the preparation imaged image,

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wherein the pixel value extraction step extracts a pixel value from the corrected imaged image generated at the image correction step.

8. The film thickness measurement method according to claim 7,
wherein calculation of the imaging error at the image correction step is performed by:

5 acquiring another preparation imaged image obtained by imaging the measurement preparation substrate in a state that the measurement preparation substrate is rotated in a circumferential direction by a predetermined angle from a state that the preparation imaged image is imaged;

generating an average image obtained by combining the another preparation imaged image in a state of being reversely rotated in the circumferential direction by the predetermined angle with the imaged image and then averaging a resultant thereof; and

10 obtaining a difference between the average image and the preparation imaged image or the another preparation imaged image.

9. The film thickness measurement method according to claim 8,
15 wherein the image correction step further comprises:

a replaced image generation step of extracting a pixel value corresponding to a desired film thickness from the preparation imaged image or the another preparation imaged image, and generating a replaced image made by replacing pixel values at the plurality of coordinates on an entire surface of the measurement preparation substrate with the extracted pixel value; and

20 a reference image generation step of correcting the replaced image by the calculated imaging error difference to generate a reference image, and

wherein the pixel value extraction step extracts a pixel value from a difference image between the reference image and the preparation imaged image or the another preparation imaged image.

10. The film thickness measurement method according to ~~any one of claims 6 to 9~~,
wherein when the preparation imaged image and the imaged image of the substrate being the film thickness measurement object are composed of a plurality of primary colors, the correlation data generation step generates the correlation data for
30 each of the primary colors and specifies a primary color having a largest correlation

coefficient between the film thickness measured value and the extracted pixel value among the correlation data generated at the correlation data generation step, and

wherein the film thickness calculation step calculates the film thickness on a basis of the correlation data for the specified primary color.

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11. A non-transitory computer-readable storage medium storing a program running on a computer of a control device configured to control a film thickness measurement apparatus for the film thickness measurement apparatus to perform ~~at~~ the film thickness measurement method according to any one of measuring a film thickness of a film
10 formed on a substrate,

the film thickness measurement method comprising: claims 6 to 10

a film thickness coordinate acquisition step of acquiring film thickness measured values obtained by measurement in advance at a plurality of points on a measurement preparation substrate and coordinates corresponding to the film thickness measured
15 values, for a film formed on the measurement preparation substrate and having a non-uniform thickness;

a pixel value extraction step of extracting a pixel value at each coordinates acquired at the film thickness coordinate acquisition step from a preparation imaged image obtained by imaging the measurement preparation substrate in advance by an
20 imaging device;

a correlation data generation step of generating correlation data between the pixel value extracted at each coordinates and the film thickness measured value at each coordinates; and

a film thickness calculation step of imaging a substrate being a film thickness measurement object by the imaging device to acquire an imaged image, and calculating
25 a film thickness of a film formed on the substrate being the film thickness measurement object on a basis of a pixel value of the imaged image and the correlation data.

12. ~~A computer-readable storage medium storing the program according to claim 11.~~