CLAIMS

[Claim 1] An information processing apparatus comprising:

an information acquisition section configured to acquire polishing condition information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring in the chemical mechanical polishing of the substrate, the chemical mechanical polishing being performed by a substrate processing apparatus including a polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad; and

a state prediction section configured to predict substrate slip-out information for the polishing condition information by inputting the polishing condition information acquired by the information acquisition section to a learning model that has been generated by machine learning that causes the learning model to learn a correlation between the polishing condition information and the substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed.

[Claim 2] The information processing apparatus according to claim 1, wherein the polishing condition information further includes top-ring state information indicating a state of the top ring in polishing of the substrate.

[Claim 3] The information processing apparatus according to claim 1 or claim 2, wherein the polishing condition information further includes polishing-table state information indicating a state of the polishing table in polishing of the substrate.

[Claim 4] The information processing apparatus according to any one of claims 1 to 3, wherein the top-ring vibration information included in the polishing condition information includes at least one of:

acceleration of the top ring;

speed of the top ring; and

displacement of the top ring.

[Claim 5] The information processing apparatus according to any one of claims 1 to 4, wherein the top-ring sound information included in the polishing condition information includes at least one of:

operating sound of the top ring; and

processing sound of the polishing surface generated by the top ring.

[Claim 6] The information processing apparatus according to any one of claims 2 to 5, wherein the top ring includes:

a top ring body which is moved by a rotating mechanism, a vertical movement mechanism, and an oscillation mechanism;

a membrane housed in the top ring body and configured to press the substrate against the polishing pad according to pressurized fluid supplied to a membrane pressure chamber; and

a retainer ring disposed at a periphery of the membrane and configured to press the polishing pad according to pressurized fluid supplied to a retainer-ring pressure chamber, and

the top-ring state information included in the polishing condition information includes at least one of:

a rotation torque of the top ring;

a driving current of the top ring;

a driving voltage of the top ring;

a pressure in the membrane pressure chamber;

a flow rate of the pressurized fluid supplied to the membrane pressure chamber;

a condition of the membrane;

a pressing force of the retainer-ring pressing mechanism;

an amount of element for regulating a pressing force of the retainer-ring pressing mechanism; and

a condition of the retainer ring.

[Claim 7] The information processing apparatus according to any one of claims 3 to 6, wherein the polishing-table state information included in the polishing condition information includes at least one of:

a rotation torque of the polishing table;

a driving current of the polishing table;

a driving voltage of the polishing table;

a condition of the polishing pad; and

a surface temperature of the polishing pad.

[Claim 8] The information processing apparatus according to any one of claims 1 to 7, wherein the substrate slip-out information comprises slip-out predictive information indicating a sign of slip-out of the substrate that will occur before the slip-out of the substrate occurs.

[Claim 9] The information processing apparatus according to any one of claims 1 to 7, wherein the substrate slip-out information comprises slip-out occurrence information indicating whether slip-out of the substrate has occurred.

[Claim 10] An inference apparatus comprising:

a memory; and

a processor,

the processor being configured to perform:

an information acquisition process of acquiring polishing condition

information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring or a polishing table in the chemical mechanical polishing of the substrate performed by a substrate processing apparatus including the polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad; and

an inference process of inferring substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed under conditions indicated by the polishing condition information when the polishing condition information is acquired in the information acquisition process.

[Claim 11] A machine-learning apparatus comprising:

a learning-data storage section storing multiple sets of learning data including polishing condition information and substrate slip-out information, the polishing condition information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring in the chemical mechanical polishing of the substrate performed by a substrate processing apparatus including a polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad, the substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed;

a machine-learning section configured to cause a learning model to learn a correlation between the polishing condition information and the substrate slip-out information by inputting the multiple sets of learning data to the learning model; and

a learned-model storage section configured to store the learning model that has learned the correlation by the machine-learning section.

[Claim 12] An information processing method comprising:

an information acquisition process of acquiring polishing condition information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring in the chemical mechanical polishing of the substrate performed by a substrate processing apparatus including a polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad; and

a state prediction process of predicting substrate slip-out information for the polishing condition information by inputting the polishing condition information acquired by the information acquisition process to a learning model that has been generated by machine learning that causes the learning model to learn a correlation between the polishing condition information and the substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed.

[Claim 13] An inference method executed by an inference apparatus including a memory and a processor, the processor performing:

an information acquisition process of acquiring polishing condition information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring in the chemical mechanical polishing of the substrate performed by a substrate processing apparatus including a polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad; and

an inference process of inferring substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed under conditions indicated by the polishing condition information when the

polishing condition information is acquired in the information acquisition process.

[Claim 14] A machine-learning method comprising:

a learning-data storage process of storing multiple sets of learning data including polishing condition information and substrate slip-out information, the polishing condition information including top-ring vibration information indicating vibration of a top ring in chemical mechanical polishing of the substrate and top-ring sound information indicating sound generated from the top ring in the chemical mechanical polishing of the substrate performed by a substrate processing apparatus including a polishing table rotatably supporting the polishing pad and the top ring configured to press the substrate against the polishing pad, the substrate slip-out information indicating occurrence of slip out of the substrate on which the chemical mechanical polishing is performed;

a machine-learning process of causing a learning model to learn a correlation between the polishing condition information and the substrate slip-out information by inputting the multiple sets of learning data to the learning model; and

a learned-model storage process of storing the learning model that has learned the correlation by the machine-learning section.