CLAIMS

What is claimed is:

1. A method facilitated by at least one processor of a computing system, comprising:

integrating disparate information related to a semiconductor production tool into a data structure, wherein the disparate information includes at least spectroscopic intensity information, sensor information, and measurement information;

learning at least one relationship that characterizes a value of a first variable of the data structure in terms of values of one or more disparate variables in the data structure; and

optimizing performance of the semiconductor production tool with the at least one relationship.

2. The method of claim 1, wherein the sensor information includes measurements of physical quantities and measurements of maintenance information,

where the measurements of physical quantities includes measurements of at least one of pressure, gas flow, or power, and

where the measurements of maintenance information includes measurements of elapsed time since last wet-clean and age of tool parts.

3. The method of claim 1, wherein learning the at least one relationship further comprising:

generating an expression for an intensity of a spectral line as a function of a set of gas flows corresponding to respective gases; and

identifying mass flow control (MFC) drift and shift errors when a predicted value of spectral intensity does not match a measured value of spectral intensity

4. The method of claim 1, wherein learning the at least one relationship further comprising generating an expression for the first variable as a function of the one or more disparate variables,

wherein the first variable is a wafer output characteristic and the one or more disparate variables relate to one or more of tool sensor measurements, spectral intensity measurements, or wafer input characteristics.

5. The method of claim 1, further comprising selecting the first variable of the data structure.

6. The method of claim 1, wherein learning the at least one relationship further comprises employing a genetic algorithm to generate the at least one relationship.

7. The method of claim 1, wherein optimizing performance of the semiconductor production tool further comprises:

receiving a set of controllable parameter expressions, wherein a controllable parameter expression, in the set of controllable parameter expressions, specifies a minimum value of a controllable parameter, a maximum value of the controllable parameter, and a minimal value by which the controllable parameter can change;

receiving a set of target values, wherein a target value in the set of target values specifies a value for a wafer output characteristic; and

identifying parameters for the semiconductor production tool based upon the at least one relationship, the set of controllable parameter expressions, and the set of target values.

8. The method of claim 7, further comprising:

creating a recipe that includes the identified parameters,

wherein identifying the parameters further comprises employing an inverse problem solving technique.

9. The method of claim 1, further comprising identifying one or more influential variables of the data structure which contribute to favorable wafer yields.

10. The method of claim 9, further comprising:

receiving status information, wherein the status information specifies a state of each chamber of the semiconductor production tool as one of a good chamber or a poor chamber; and

integrating the status information into the data structure.

11. The method of claim 10, further comprising autonomously learning a Boolean-valued function that predicts the state of a chamber of the semiconductor production tool based upon at least one of the spectroscopic intensity information in the data structure or the sensor information in the data structure.

12. The method of claim 11, wherein autonomously learning the Boolean-valued function further comprises restricting the Boolean-valued function to a fixed size, in terms of a number of parameters.

13. The method of claim 11, further comprising:

for a parameter of the Boolean-valued function:

ordering chambers of the semiconductor production tool by corresponding values of the parameter;

ordering the chambers of the semiconductor production tool by yield performance; and

identifying the parameter as an influential variable when the order of the chambers by values of the parameter matches the order of the chambers by yield performance.

14. The method of claim 1, further comprising identifying a pair of wavelengths to employ in automated endpoint detection.

15. The method of claim 14, further comprising:

identifying a first set of wavelengths whose corresponding intensities in the spectroscopic intensity information increase during a etch step performed by the semiconductor production tool;

identifying a second set of wavelengths who corresponding intensities in the spectroscopic intensity information decrease during the etch step; and

selecting a first wavelength from the first set of wavelengths and a second wavelength form the second set of wavelengths, wherein the first wavelength and the second wavelength are employed for automated endpoint detection.

16. The method of claim 15, further comprising:

augmenting intensity values, from the spectroscopic intensity information and associated with a plurality of wafers, corresponding to the first wavelength and the second wavelength with state information that specifies a state of each of the plurality of wafers; and

autonomously learning a Boolean-valued function that predicts the state of a wafer based upon intensity values associated with the wafer and corresponding to the first wavelength and the second wavelength.

17. The method of claim 16, further comprising halting the etch step of the semiconductor production tool when the Boolean-valued function predicts a change in the state of the wafer from a poor state to a good state.

18. A system for a semiconductor production tool, comprising:

a learning engine configured to receive sensor information, spectral intensity information, and device measurement information related to the semiconductor production tool, to integrate the received information into a unified training matrix, and to utilize the unified training matrix to generate an expression that predicts a value for an output characteristic of a wafer processed by the semiconductor production tool based upon values of one or more disparate values included in the sensor information, spectral intensity information, or device measurement information.

19. The system of claim 18, further comprising a tuning engine configured to:

obtain a set of controllable parameter expressions, wherein a controllable parameter expression, in the set of controllable parameter expressions, specifies a minimum value of a controllable parameter, a maximum value of the controllable parameter, and a minimal value by which the controllable parameter can change;

obtain a set of target values, wherein a target value in the set of target values specifies a value for the wafer output characteristic; and

select values for the controllable parameters in accordance with the controllable parameter expressions, wherein the selected values, according to the expression generated by the learning engine, achieve the target values in the set of target values.

20. A computer-readable storage medium storing computer-executable instructions that, when executed by at least one processor, cause a computer to:

consolidate disparate information related to a semiconductor production tool into a data structure, wherein the disparate information includes at least spectroscopic intensity information, sensor information, and measurement information;

generate at least one relationship that characterizes a value of a first variable of the data structure in terms of values of one or more disparate variables in the data structure; and

optimize performance of the semiconductor production tool with the at least one relationship.

CLAIMS

1. A method, comprising:

integrating disparate information related to a semiconductor production tool into a data structure comprising at least three fields, wherein the at least three fields comprise at least a first field that contains spectroscopic intensity information, a second field that contains tool operation information, and a third field that contains wafer measurement information;

selecting a field of the at least three fields as a distinguished output; and

learning, by a learning engine comprising a processor, and based on the data structure, at least one relationship that characterizes the field in terms of one or more other fields of the at least three fields, wherein the spectroscopic intensity information comprises at least one of an intensity of light at a defined wavelength or a spectral line detected by a spectroscope, the method further comprising normalizing the spectroscopic intensity information prior to use by the learning engine, wherein the normalizing comprises:

measuring the spectroscopic intensity information; and

determining a total intensity of the spectroscopic intensity information based on a reference, wherein the total intensity is determined as a function of resolution of values within the spectroscopic intensity information over a wavelength range.

2. The method of claim 1, wherein the tool operation information comprises at least one of a measurement of a physical quantity or maintenance information, wherein the measurement of the physical quantity comprises a measurement of at least one of a pressure, a gas flow, or a power, and wherein the maintenance information comprises at least one of an elapsed time since a most recent wet-clean or an age of a tool part.

3. The method of claim 1, wherein the learning the at least one relationship comprises:

generating an expression for an intensity of a spectral line as a function of a set of gas flows corresponding to respective gases; and

identifying at least one of a mass flow control (MFC) drift or a shift error in response to a determination, based on the expression, that a predicted value of a spectral intensity does not match a measured value of the spectral intensity.

4. The method of claim 1, wherein the learning the at least one relationship comprises generating an expression for the field as a function of the one or more other fields, and wherein the field represents a wafer output characteristic and the one or more other fields relate to one or more of a tool sensor measurement, a spectral intensity measurement, or a wafer input characteristic.

5. The method of claim 1, further comprising receiving selection input that facilitates selection of the field for which the at least one relationship is to be learned.

6. The method of claim 1, wherein the learning the at least one relationship comprises employing a genetic algorithm to generate the at least one relationship.

7. The method of claim 1, wherein the adjusting the operation of the semiconductor production tool comprises:

receiving a set of controllable parameter expressions, wherein a controllable parameter expression, of the set of controllable parameter expressions, specifies a minimum value of a controllable parameter, a maximum value of the controllable parameter, and a minimum value by which the controllable parameter is allowed to change;

receiving a set of target values, wherein a target value of the set of target values represents a wafer output characteristic; and

determining an operating parameter for the semiconductor production tool based upon the at least one relationship, the set of controllable parameter expressions, and the set of target values.

8. The method of claim 7, further comprising creating a recipe that includes the operating parameter, wherein the determining the operating parameter comprises determining the operating parameter using an inverse problem solving technique.

9. The method of claim 1, further comprising identifying one or more influential variables of the data structure determined to contribute to acceptable wafer yields.

10. The method of claim 1, further comprising:

receiving status information, wherein the status information specifies a state of respective chambers of the semiconductor production tool as one of a good chamber or a poor chamber; and

integrating the status information into the data structure.

11. The method of claim 10, further comprising learning a Boolean-valued function that predicts the state of a chamber of the semiconductor production tool based on at least one of the spectroscopic intensity information in the data structure or the tool operation information in the data structure.

12. The method of claim 11, further comprising:

for a parameter of the Boolean-valued function:

ordering chambers of the semiconductor production tool by corresponding values of the parameter to yield a first order;

ordering the chambers of the semiconductor production tool by yield performance to yield a second order; and

identifying the parameter as an influential variable in response to a determination that the first order matches the second order.

13. The method of claim 1, further comprising:

identifying a first set of wavelengths associated with a first set of intensities in the spectroscopic intensity information that increase during an etch step performed by the semiconductor production tool;

identifying a second set of wavelengths associated with a second set of intensities in the spectroscopic intensity information that decrease during the etch step; and

selecting a first wavelength from the first set of wavelengths and a second wavelength from the second set of wavelengths for detection of an endpoint.

14. The method of claim 13, further comprising:

augmenting first intensity values, from the spectroscopic intensity information and associated with a plurality of wafers, corresponding to the first wavelength and the second wavelength with state information that specifies respective states of the plurality of wafers; and

learning a Boolean-valued function that predicts a state of a wafer based upon second intensity values associated with the wafer and corresponding to the first wavelength and the second wavelength.

15. The method of claim 14, further comprising halting the etch step of the semiconductor production tool in response to a determination that the Boolean-valued function predicts a change in the state of the wafer from a defined poor state to a defined good state.

16. A system for a semiconductor production tool, comprising:

a memory storing computer executable components; and

a processor configured to execute the following computer executable components stored in the memory:

a learning engine configured to integrate tool operation information, spectral intensity information, and device measurement information related to the semiconductor production tool-into a first field, a second field, and a third field, respectively, of a unified training data structure, and, based on selection of a distinguished field of the first field, the second field, or the third field, utilize the unified training data structure to generate an expression for prediction of a first value of the distinguished field based upon one or more second values of respective one or more other fields of the first field, the second field, or the third field,

wherein the spectral intensity information comprises at least one of an intensity of light at a defined wavelength or a spectral line detected by a spectroscope, the method further comprising normalizing the spectral intensity information prior to use by the learning engine, wherein the normalizing comprises:

measuring the spectral intensity information; and

determining a total intensity of the spectral intensity information based on a reference, wherein the total intensity is determined as a function of resolution of values within the spectral intensity information over a wavelength range.

17. The system of claim 16, further comprising a tuning engine configured to:

obtain a set of controllable parameter expressions, wherein a controllable parameter expression, of the set of controllable parameter expressions, specifies a minimum value of a controllable parameter, a maximum value of the controllable parameter, and a minimum value by which the controllable parameter is permitted to change;

obtain a set of target values, wherein a target value of the set of target values represents the wafer output characteristic; and

select a controller parameter value for the controllable parameter in accordance with at least one of the set of controllable parameter expressions, wherein the controller parameter value, according to the expression generated by the learning engine, is determined to achieve the target values.

18. A non-transitory computer-readable medium having stored thereon computer-executable instructions that, in response to execution, cause a device comprising a processor to perform operations, comprising:

consolidating disparate information related to a semiconductor production tool into a data structure comprising a set of fields, wherein the set of fields comprises at least a first field that stores spectroscopic intensity information, a second field that stores tool operation information, and a third field that stores wafer measurement information;

receiving selection of one field of the set of fields; and

generating at least one relationship that characterizes a first value of the one field in terms of one or more second values of one or more other fields of the set of fields,

wherein the spectroscopic intensity information comprises at least one of an intensity of light at a defined wavelength or a spectral line detected by a spectroscope, the method further comprising normalizing the spectroscopic intensity information prior to use by the learning engine, wherein the normalizing comprises:

measuring the spectroscopic intensity information; and

determining a total intensity of the spectroscopic intensity information based on a reference, wherein the total intensity is determined as a function of resolution of values within the spectroscopic intensity information over a wavelength range.

19. The non-transitory computer-readable medium of claim 18, wherein the operations further comprise modifying an operation of the semiconductor production tool based on the at least one relationship.