

within clean room environments where real estate or floor space is already expensive and at a premium.

[00012] Accordingly, it is desirable to improve substrate processing involving smaller circuit devices and features while maintaining the ability to qualify and monitor the process during production. It is desirable to reduce the number of junctures during fabrication wherein substrates are taken out of vacuum to atmosphere, and then must be subsequently placed back under vacuum in a processing chamber for further processing. It is further desirable to reduce the lag time between the process or substrate going out of specification, and the recognition of that issue by a fabricator or device maker so that they can respond more quickly. It is further desirable to continue to automate equipment and utilize process data to lessen human intervention in the fabrication process, leading to prescriptive optimization and full decision automation.

[00013] Therefore, there is an overall need to address the drawbacks in the current fabrication processes and equipment platforms.

SUMMARY

[00014] This disclosure relates to a high volume manufacturing platform which incorporates metrology instruments integrated to measure workpieces before and/or after being treated in the platform's processing chambers. Transfer chambers connected to the process chambers are integrated with the metrology sensors to enable measurements being done within the platform, and not a stand-alone metrology tool. In this instance, maintaining workpieces within the platform's controlled environment reduces the potential for added particles by reducing workpiece movement and minimizing the exposure of different environments to the workpiece.

[00014a] According to an aspect of the present invention, there is provided a processing system for processing a workpiece for the fabrication of electronic devices thereon, the processing system comprising:

a plurality of processing chambers for the fabrication of electronic devices in a processing sequence;

a workpiece transfer chamber coupled with the plurality of processing chambers and comprising a workpiece transfer mechanism; and

a measurement module coupled with the workpiece transfer chamber and including an inspection system operable for measuring data associated with an attribute of the workpiece that is being processed in the processing sequence,

wherein at least a portion of the measurement module is positioned inside of an internal space of the workpiece transfer chamber, the measurement module including a measurement region located within a dedicated area of the internal space, and the workpiece transfer mechanism transfers a workpiece to the measurement region and supports the workpiece within the measurement region while the inspection system measures the data associated with an attribute of the workpiece.

[00014b] There is provided a processing system, comprising:

- a distributed transfer system comprising:
 - at least one internal vacuum chamber;
 - at least one substrate transfer mechanism disposed within the internal vacuum chamber;
 - a plurality of processing module ports disposed along the distributed transfer system;
 - a plurality of measurement inspection systems within the distributed transfer system;
 - one or more of film-forming modules, at least one of the film-forming modules coupled to a corresponding processing module port;
 - one or more etch modules, at least one of the etch modules coupled to a corresponding processing module port;
 - one or more cleaning modules, at least one of the cleaning modules coupled to a corresponding processing module port.

[00014c] There is provided a processing system, comprising:

- a distributed transfer system comprising:
 - at least one internal vacuum chamber;
 - at least one substrate transfer mechanism disposed within the internal vacuum chamber;
 - a plurality of processing module ports disposed along the distributed transfer system;
 - a plurality of measurement inspection systems within the distributed transfer system;
 - one or more film-forming modules, a film-forming module coupled to a corresponding processing module port;
 - one or more etch modules, an etch module coupled to a corresponding processing module port;
 - a batch processing module comprising a process chamber capable of simultaneously treating substrates; and
 - a staging chamber coupled to the batch processing module and the distributed transfer system, the staging chamber comprising a staging area to stage substrates for the batch processing chamber.

[00014d] There is provided a manufacturing platform for processing a workpiece for the fabrication of electronic devices thereon, the processing system comprising, comprising:

a plurality of processing modules hosted on a common manufacturing platform, the processing modules configured for manipulating materials on a workpiece in processing steps

5 as part of a processing sequence;

the plurality of processing modules including a first module and a second module, the first and second modules facilitating different processes in the process sequence;

at least one measurement module hosted on the common manufacturing platform, the measurement module including an inspection system operable for measuring data associated with an attribute of the workpiece at least one of before or after the workpiece is processed in a processing module of the common manufacturing platform;

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at least one workpiece transfer module hosted on the common manufacturing platform and configured for the movement of the workpiece between the processing modules and the at least one measurement module;

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an active interdiction control system hosted at least in part on the common manufacturing platform and coupled with the measurement module, the active interdiction control system configured for processing the measured data associated with an attribute on the workpiece for detecting non-conformities and configured to perform corrective processing of the workpiece at least in part in a processing module upstream and/or downstream in the process sequence when non-conformities are detected;

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the active interdiction control system further configured for controlling movement and processing of the workpiece in the processing sequence;

the common manufacturing platform, the processing modules, and the measurement module operating in a controlled environment, and the workpiece transfer module configured for transferring the workpiece between the plurality of processing modules in the processing sequence and the measurement module without leaving the controlled environment.

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[00014e] There is provided a method, comprising:

processing a workpiece through a plurality of processing modules hosted on a common manufacturing platform, the workpiece comprising a plurality of electronic devices, wherein the processing includes performing a process sequence having at least one film-forming process and at least one etching process or film-treatment process;

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gathering fabrication measurement data of the workpiece on the common manufacturing platform, wherein the fabrication measurement data is a measurement of an attribute of the workpiece based on at least a portion of the process sequence performed on the common manufacturing platform;

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gathering in-situ process measurement data from a workpiece being processed in at least one of the processing modules that is performing a process of at least a portion of the process sequence;

5 detecting non-conformities of the workpiece based on at least one of the gathered fabrication measurement data or the in-situ process measurement data;

 performing active interdiction to the process sequence when non-conformities are detected to execute corrective processing of the workpiece in the process sequence on the common manufacturing platform after the measurement data has been gathered.

10 **[00015]** In one embodiment, a processing system for a workpiece for the fabrication of electronic devices includes a plurality of processing modules used to treat the workpieces and are arranged around one or more workpiece transfer modules which include a workpiece transfer mechanism to move the workpieces throughout the system in a predetermined processing sequence. In some instances, the processing
15 sequence will include a measurement step to monitor the state or condition of the workpiece for process control purposes. The system includes a measurement module coupled with the workpiece transfer module and including an inspection system operable for measuring data associated with an attribute of the workpiece that is being processed in the processing sequence. In most instances, at least a portion of the

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Claims:

1. A processing system for processing a workpiece for the fabrication of electronic devices thereon, the processing system comprising:

a plurality of processing chambers for the fabrication of electronic devices in a processing sequence;

a workpiece transfer chamber coupled with the plurality of processing chambers and comprising a workpiece transfer mechanism; and

a measurement module coupled with the workpiece transfer chamber and including an inspection system operable for measuring data associated with an attribute of the workpiece that is being processed in the processing sequence,

wherein at least a portion of the measurement module is positioned inside of an internal space of the workpiece transfer chamber, the measurement module including a measurement region located within a dedicated area of the internal space, and the workpiece transfer mechanism transfers a workpiece to the measurement region and supports the workpiece within the measurement region while the inspection system measures the data associated with an attribute of the workpiece.

2. The processing system of claim 1, wherein the inspection system measures data associated with one or more properties of a workpiece or data associated with one or more layers formed on a workpiece, the one or more properties including a physical property, a chemical property, an optical property, an electrical property, or a material property, or a combination of two or more thereof.

3. The processing system of claim 1 wherein the workpiece transfer chamber includes a plurality of side ports through which a workpiece is moved to and from the plurality of processing chambers, the plurality of processing chambers including at least one etch chambers and at least one film forming chamber.

4. The processing system of claim 1 wherein the workpiece transfer chamber includes a plurality of side ports through which a workpiece is moved to and from the plurality of processing chambers, the measurement module being separate from the workpiece transfer chamber and at least a portion thereof coupled with the workpiece

transfer chamber at a port formed in the top of the transfer module and above the plurality of side ports.

5. The processing system of claim 1 wherein the inspection system is operable for measuring data of a workpiece positioned in the measurement region at least one of before or after the workpiece is processed in a processing chamber.

6. The processing system of claim 1, further comprising:

- a second transfer chamber having an internal space for the movement of the workpiece, the second transfer chamber being coupled to one or more additional processing chambers where the workpiece is processed;

- a pass-through chamber having an internal space for the movement of the workpiece, the pass-through chamber positioned between the workpiece transfer chamber and the second transfer chamber;

- an second measurement region located within a dedicated area of the pass-through chamber internal space, the second measurement region accessible by the transfer mechanism for positioning a workpiece in the second measurement region at least one of before or after the workpiece is processed in a processing chamber; and

- an second inspection system configured to engage a workpiece that is positioned in the second measurement region, the inspection system operable for measuring data associated with an attribute on the workpiece.

7. The processing system of claim 1 wherein the workpiece transfer mechanism is positioned inside an internal space of the workpiece transfer chamber, the workpiece transfer mechanism being configured to move a workpiece through the internal space and selectively into and out of the plurality of processing chambers and into and out of the measurement region.

8. The processing system of claim 1, the measurement region including a support mechanism for supporting a workpiece positioned in the measurement region, the inspection system engaging the support mechanism for measuring data associated with an attribute on a workpiece supported by the support mechanism.

9. The processing system of claim 8, wherein the support mechanism is configured to move the workpiece within at least two degrees of freedom for measuring data associated with an attribute of the workpiece.

10. The processing system of claim 8, wherein the support mechanism includes at least one temperature control element for controlling the workpiece temperature.

11. The processing system of claim 7, wherein the transfer mechanism is configured for positioning a workpiece in the measurement region, the transfer mechanism moving the workpiece for engagement with the inspection system for measuring data associated with an attribute on the workpiece.

12. The processing system of claim 7, the measurement region including a support mechanism for supporting a workpiece positioned in the measurement region, the transfer mechanism configured for positioning the workpiece on support mechanism and the inspection system measuring data associated with an attribute on a workpiece supported by the support mechanism.

13. The processing system of claim 5, wherein the inspection system is positioned externally of the transfer chamber internal space, the inspection system configured for engaging the workpiece by directing an inspection signal into the measurement region from outside the internal space for measuring data associated with an attribute on the workpiece.

14. The processing system of claim 13, further comprising an access port coupled with the workpiece transfer chamber, the access port being transparent to the passage of the inspection signal from the inspection system into the internal space to the measurement region.

15. The processing system of claim 5, wherein the inspection system is positioned inside the transfer chamber internal space and proximate the measurement region, the inspection system engaging the workpiece by directing an inspection signal into the measurement region for measuring data associated with an attribute on the workpiece.

16. The processing system of claim 5, wherein the inspection system is positioned in the transfer chamber internal space and proximate the measurement region, the inspection system engaging the workpiece by physically contacting the workpiece or a support mechanism for measuring data associated with an attribute of the workpiece.

17. The processing system of claim 1 wherein the inspection system includes:
at least one signal source for directing at least one of an electromagnetic signal, an optical signal, a particle beam, or a charged particle beam to be incident onto a surface of a workpiece positioned in the measurement region; and
at least one detector arranged to receive at least one of electromagnetic signal, an optical signal, a particle beam, or a charged particle beam reflected from a surface of a workpiece for measuring data associated with an attribute on the workpiece.

18. The processing system of claim 1, wherein the inspection system is operable for measuring data associated with an attribute including one or more of the following: a layer thickness, a layer conformality, a layer coverage, a layer profile, an edge placement location, an edge placement error (EPE), a critical dimension (CD), a block critical dimension (CD), a grid critical dimension (CD), a line width roughness (LWR), a line edge roughness (LER), a block LWR, a grid LWR, a property relating to selective deposition, a property relating to selective etch, a physical property, an optical property, an electrical property, a refractive index, a resistance, a current, a voltage, a temperature, a mass, a velocity, an acceleration, or a combination thereof associated with fabricated electronic devices on the workpiece.

19. The processing system of claim 1, wherein the inspection system is operable for measuring data associated with an attribute of the workpiece using at least one of the following techniques or devices:

reflectometry, interferometry, scatterometry, profilometry, ellipsometry, X-ray photo-emission spectroscopy, ion scattering spectroscopy, low energy ion scattering (LEIS) spectroscopy, auger electron spectroscopy, secondary ion mass spectroscopy, reflection absorption IR spectroscopy, electron beam inspection, particle inspection, particle counting device, optical inspection, dopant concentration metrology, film resistivity metrology, a micro-balance, an accelerometer, a voltage probe, a current

probe, a temperature probe, a strain gage, or a combination thereof associated with fabricated electronic devices on the workpiece.

20. The processing system of claim 1, wherein the workpiece transfer chamber internal space and measurement region are maintained as a controlled environment that includes at least one of a vacuum environment or an inert gas atmosphere.

21. The processing system of claim 6 wherein the plurality of processing chambers includes:

- a first processing chamber configured for performing a self-assembled monolayer (SAM) process;

- a second processing chamber configured for performing a film deposition process; and

- a third processing chamber configured for performing an etch process.

22. The processing system of claim 21 wherein the second processing chamber is configured for performing a film deposition process by atomic layer deposition (ALD), plasma-enhanced ALD (PEALD), chemical vapor deposition (CVD), plasma-enhanced CVD (PECVD), or Physical vapor deposition (PVD).

23. The processing system of claim 21 further comprising

- a fourth processing chamber configured for performing a treatment process using a reactive treatment gas, heat-treating, or a combination thereof.