the matter worse. What is more, different applications have different needs. A pump system that meets the needs of a particular application may not be suitable for a different application.

SUMMARY OF THE INVENTION

[0004] In semiconductor manufacturing, various pumps may be used to mix chemicals as well as dispensing the mixture of chemicals onto wafers. High performance pumps, such as the Entegris IntelliGen Mini photolithography rolling edge diaphragm pump, can be used to mix and dispense the chemicals directly (Entegris and IntelliGen are trademarks of Entegris, Inc. of Chaska, Minnesota). These chemicals may vary from application to application and different applications may have different needs. Thus, a pump system used in dispensing the chemicals must consider a plurality of factors, including size, cost, performance (both speed and accuracy), reliability, adaptability, and so on.

[0005] Embodiments disclosed herein can address these needs with a customizable dispense system that is built on modular architecture and that includes a single main controller for controlling components in this versatile, "plug-and-play" dispense system. Within this disclosure, the term "customizable" refers to the fact that embodiments of a dispense system disclosed herein can be easily changed, modified, or otherwise altered to suit various needs. Such a change, modification, or alteration may occur dynamically whenever such a need arises. For example, one embodiment of a customizable dispense system disclosed herein may initially be built with a pneumatic to pneumatic configuration. Pneumatically driven pumps (pneumatic pumps) are generally less expensive than motor-driven pumps (motor pumps) and can provide positive pressure filtration and good throughput, which makes this pneumatic to pneumatic configuration ideal for handling applications such as those for non-critical layers. The pneumatic to pneumatic configuration can be easily changed, modified, or otherwise altered to a motor to motor configuration for critical layer applications. In some embodiments, the single main controller is configured with the necessary intelligence, and hence is referred to herein as a "smart" controller, to automatically recognize a change in the customizable dispense system and operate according to a new configuration and/or a new application.

[0005a] According to a first aspect of the present invention, there is provided a customizable dispense system, comprising: a smart controller configured to operate a plurality of pumps in semiconductor manufacturing processes that are sensitive to defects in printed patterns, the plurality of pumps including at least one pneumatic pump and at least one motor pump; and a plurality of lines connecting the smart controller with a track and a variety of devices, including pump heads for the at least one pneumatic pump and the at least one motor pump, wherein the smart controller is configured to, upon switching one of the plurality of lines from communicating with a first pump to communicating with a second pump, automatically recognize the second pump and automatically apply a control scheme corresponding to the second pump.

[0005b] According to a second aspect of the present invention, there is provided a customizable dispense system, comprising: a set of feed pumps for directing chemicals used in semiconductor manufacturing processes; a set of dispense pumps for dispensing the chemicals; and a smart controller configured to operate the set of feed pumps and the set of dispense pumps, wherein the set of feed pumps and the set of dispense pumps comprise one or more integrated pumps, each of the one or more integrated pumps comprising two or more pneumatic pumps physically combined as a unit, wherein the two or more pneumatic pumps in the unit operate independent of one another, and wherein the two or more pneumatic pumps in the unit are independently controlled by the smart controller; wherein the smart controller is further configured to, upon switching from communicating with a first pump to communicating with a second pump, automatically recognize the second pump and automatically apply a control scheme corresponding to the second pump.

[0005c] According to a third aspect of the present invention, there is provided a customizable dispense system, comprising: a set of feed pumps for directing chemicals used in semiconductor manufacturing processes; a set of dispense pumps for dispensing the chemicals; a smart controller configured to operate the set of feed pumps and the set of dispense pumps, wherein the set of feed pumps and the set of dispense pumps comprise one or more integrated pumps, each of the one or more integrated pumps comprising two or more pneumatic pumps physically combined as a unit, wherein the two or more pneumatic pumps in the unit operate independent of one another, wherein the two or more pneumatic pumps in the unit are independently controlled by the smart controller, and wherein the smart controller is further configured to, upon interfacing with a newly connected pump, automatically recognize the newly connected pump and automatically apply a control scheme corresponding to the

newly connected pump, wherein the newly connected pump is a motor pump or a pneumatic pump.

[0005d] According to a fourth aspect of the present invention, there is provided a filtration method, comprising: at a controller of a dispense system having a feed pump and a dispense pump, determining an upstream pressure for fluid upstream from a filter positioned between the feed pump and the dispense pump; setting a feed stage fluid pressure to the upstream pressure; setting a dispense stage fluid pressure to a filtration pressure setpoint; opening valves to allow the fluid flowing from a feed side to a dispense side through the filter, wherein the feed stage fluid pressure and the dispense stage fluid pressure cause a differential pressure across the filter, thereby moving the fluid from the feed side to the dispense side through the filter at a target rate; and determining an end of filtration based on a change in fluid pressure at the dispense side.

[0006] In some embodiments, the smart controller of a customizable dispense system disclosed herein can be configured to operate a plurality of pumps in semiconductor

be configured to operate the set of feed pumps and the set of dispense pumps which may include one or more integrated pumps.

[0012] Software implementing embodiments disclosed herein may be implemented in suitable computer-executable instructions that may reside on one or more non-transitory computer readable medium. Within this disclosure, the term "computer-readable storage medium" encompasses all types of data storage medium that can be read by a processing unit such as a processor or a controller. Examples of computer-readable storage media can include random access memories, read-only memories, hard drives, data cartridges, floppy diskettes, flash memory drives, and the like.

[0013] Embodiments disclosed herein can provide many advantages. For example, instead of a fixed number of pumps, a customizable dispense system disclosed herein can support a variable number of different types of pumps over time. This mix and match flexibility may allows the system to be tailored to each particular application, reduces the cost of maintaining the system, and provides a way to easily upgrade to a new type of pumps and/or a new system setup.

[0014] These, and other, aspects of the disclosure will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following description, while indicating various embodiments of the disclosure and numerous specific details thereof, is given by way of illustration and not of limitation. Many substitutions, modifications, additions and/or rearrangements may be made within the scope of the disclosure without departing from the spirit thereof, and the disclosure includes all such substitutions, modifications, additions and/or rearrangements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The drawings accompanying and forming part of this specification are included to depict certain aspects of the disclosure. It should be noted that the features illustrated in the drawings are not necessarily drawn to scale. A more complete understanding of the disclosure and the advantages thereof may be acquired by referring to the following description, taken in conjunction with the accompanying drawings in which like reference numbers indicate like features and wherein: