[0005] One condition that can result in an improper liquid dispense is air in the dispense pump or downstream tubing. Existing systems undergo lengthy priming routines to ensure that air is removed from a pump before the pump is used to dispense fluid to a wafer. However, such systems assume the priming routine was successful and do not account for air introduced after priming. Several existing systems also monitor a pump's dispense cycles to determine whether a dispense was a "good" dispense. While such systems give a qualitative assessment of a dispense and generate an alert before a series of "bad" dispense occurs, they do not prevent the initial "bad" dispense from occurring nor do they provide a quantitate assessment of the amount of air in a system. Furthermore, such systems may have difficulty detecting a bad dispense when the bad dispense is caused by air that is a relatively great distance (greater than 0.5 meters) away from the pump outlet.

SUMMARY OF THE DISCLOSURE

[0005a] According to a first aspect of the present invention, there is provided a pumping system, comprising:

a pump;

a controller coupled to the pump, the controller having a processor and a non-transitory computer readable medium storing instructions translatable by the processor to perform:

controlling the pump to isolate a portion of the pump, the isolated portion of the pump being filled with a liquid, wherein the isolated portion of the pump has a volume;

bringing the isolated portion of the pump to a predefined starting pressure;

changing the volume of the isolated portion of the pump by a known amount;

measuring an ending pressure in the isolated portion of the pump;

determining an actual pressure change between the predefined starting pressure and the ending pressure in the isolated portion of the pump; and

determining if air or gas is present in the isolated portion of the pump utilizing the actual pressure change.

[0005b] According to a second aspect of the present invention, there is provided a method for detecting air in a pumping system, comprising:

controlling a pump to isolate a portion of the pump, the isolated portion of the pump being filled with a liquid, wherein the isolated portion of the pump has a volume;

bringing the isolated portion of the pump to a predefined starting pressure;

changing the volume of the isolated portion of the pump by a known amount;

measuring an ending pressure in the isolated portion of the pump;

determining an actual pressure change between the predefined starting pressure and the ending pressure in the isolated portion of the pump; and

determining if air or gas is present in the isolated portion of the pump utilizing the actual pressure change.

[0005c] According to a third aspect of the present invention, there is provided a computer program product comprising a non-transitory computer readable medium storing a set of instructions translatable by a controller to perform:

controlling a pump to isolate a portion of the pump, the isolated portion of the pump being filled with a liquid, wherein the isolated portion of the pump has a volume;

bringing the isolated portion of the pump to a predefined starting pressure;

changing the volume of the isolated portion of the pump by a known amount

measuring an ending pressure in the isolated portion of the pump;

determining an actual pressure change between the predefined starting pressure and the ending pressure in the isolated portion of the pump; and

determining if air or gas is present in the isolated portion of the pump utilizing the actual pressure change.

[0006] Embodiments provide new ways to detect air in a pumping system. The pumping system may comprise a pump and a controller coupled to the pump. The controller may comprise a processor and a non-transitory computer readable medium storing instructions translatable by the processor to control the pump to isolate a portion of the pump. The isolated portion of the pump may include a chamber and a component downstream from the chamber. The isolated portion may be filled with a liquid. Pressure in the isolated portion may be normalized to a starting pressure. The isolated portion may include a chamber, tubing, lines, valves or other pump or system components. A piston in the isolated portion is moved some distance from a predetermined starting position to a predetermined ending position. The movement of the piston can be caused by a controlled movement of a motor driving the pump. After the movement, another pressure measurement (an ending pressure) is taken. In one embodiment, the actual change between the starting pressure and the ending pressure can be used to detect the presence of air or gas in a liquid. One way this can be done is by comparing the actual change with an expected change. The expected change may be established for a particular system set up and/or fluid property such as viscosity.

[0007] In embodiments where the starting and ending pressures may be preselected, a difference between the starting and ending positions of a pump component may be