System Development for Chemical Temperature Control in Semiconductor Manufacturing

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Abstract. This study develops leak detection algorithm to automatically detect the amount of deionized water inside circulators, to automatically supply or supplement deionized water if there is a lack of deionized water, and to detect the leak of deionized water inside circulators at an early stage in order to maintain constant temperature of various chemicals used in semiconductor wafer manufacturing facilities and processes. This study developed DWCCS which engineers operate by remote control with multiple facilities and which maintains constant temperature of chemicals used in semiconductor device manufacturing facilities and processes.

Keywords: Chemical Control, DWCCS, Down Time, Semiconductor process

1 Introduction

This study develops leak detection algorithm to automatically detect the amount of deionized water inside circulators, to automatically supply or supplement deionized water if there is a lack of deionized water, and to detect the leak of deionized water inside circulators at an early stage in order to maintain constant temperature of various chemicals used in semiconductor wafer manufacturing facilities and processes. Also, it is to decrease down-time (DT) of process facilities and failure due to temperature changes of chemicals in wafer processing processes by sending alarms to equipment engineers working in a distance, in case leak of deionized water inside circulators is detected. This study developed DWCCS (Deionized Water Circulation Control System); its control system collects deionized water samples from circulators and measures their concentration by programmed routes according to measuring cycles set by engineers. It automatically processes the deionized water clean process, if the concentration is higher than the standard turbidity. Also, this may be easily applied to existing semiconductor manufacturing lines.

2 Deionized Water Circulation Control System

In case a wafer turns out bad due to inefficiency of wafer processing processes, it has to be discarded or reworked. Failure to decide the wafer quality results in decreasing transference numbers. Moreover, with the increasing demand of consumers and the development of semiconductor-related technology, sizes of semiconductor wafers are dramatically increasing. As costly large-sized wafers emerge, it is now essential to conduct constant research and development to increase transference numbers in manufacturing processes and research on control system for process improvement.

Therefore, this study developed DWCCS with advantages; it is easily applied to existing semiconductor producing lines and is easy to be converted to LCD producing lines. Also, an engineer may control a maximum of nine circulators in a distance through one DWCCS by remote control; losses in each process may decrease near to zero and losses and failure due to temperature changes in chemicals may be prevented. When development was completed, application test was carried out on DWCCS against producing lines. [3,4]

Figure 1 shows a conceptual diagram of DWCCS, the system for which this study aims.

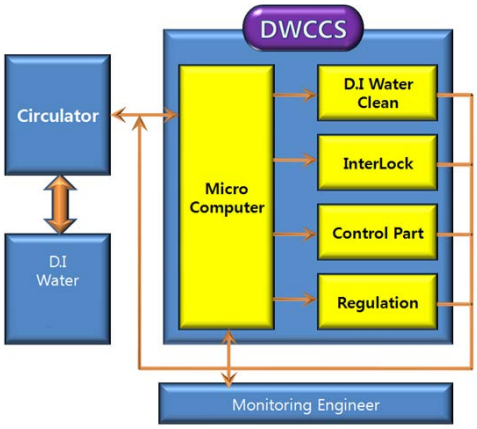

Fig. 1. Conceptual diagram of DWCCS

Figure 2 shows a diagram of concentration measuring part of D.I water. As for concentration measuring part, according to concentration cycle set by users (turbidity measuring cycle for circulating water), the controller collects circulating water and puts it in to concentration measuring unit for concentration measurement according to programmed order. If its turbidity exceeds the turbidity set by users, circulating water cleaning process is automatically operated.

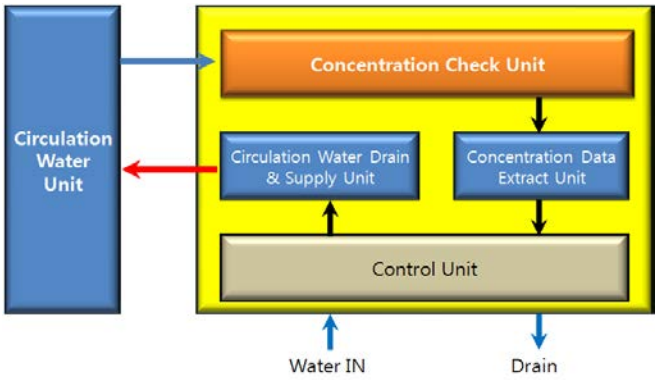

Fig. 2. Concentration measuring unit for concentration measurement

Water supply system consists of concentration measuring part/supply and collecting drain part, system controlling part, interlock, and external support part. When supply signals are input in level sensor, concentration measuring part/supply and collecting drain part supplies water from supply and collecting drain part until it reaches the target water level.

When supply signals are input on external sensors (water level sensor, water level interlock sensor, concentration measuring sensor, and leak sensor), system controlling part first controls automatic water level controlling function of circulating water and safety blocks related to turbidity tests of circulating constant-temperature water and system leak safety. It also saves and adjusts automatic operating factors of the system. Also, it is equipped with a function to send early alarms for decrease of circulating water due to deficient devices.

Interlock part consists of leak detecting bath part and water valve interlock part. In case water leak occurs in concentration measuring part/supply and collecting drain part due to DWCCS system problems, firstly the water stays in water collecting bath at the bottom of the system and secondly highly sensitive Sus Type Leak detecting sensor implements emergency handling process (four-layer interlock system) to prevent accidents due to leak.

External support part consists of level sensor unit, supply/collecting & drain part, and main power supply part. Stop/start sensor for water supply has a function of maintaining circulating water level automatically. Overflow interlock sensor implements a function of blocking the system in case the water level constantly increases due to system problems.

3 Conclusion

This study developed DWCCS to improve transference numbers and DT properties and the work efficiency of process engineers by maintaining constant temperature of chemicals used in the manufacturing process and by controlling multiple circulators. This equipment is easily applied to existing semiconductor producing lines and is

easy to be converted to LCD producing lines; losses and failure due to temperature changes in chemicals may be prevented. Constant research should be conducted on the development of probe units which sets power automatically in connection with DWCCS output and pattern signals.

References

1. Hyoung-Keun Park : Study on the Silicon Pump and Control System for TFT-LCD Manufacturing Process : Journal of the Korea Academia-Industrial cooperation Society, vol. 13, no. 8, pp.3618-3622(2012)
2. Hyoung-Keun Park : Development of the Chemical Flow Control System for Spinner Equipment in Semiconductor Manufacturing Process : Journal of the Korea Academia-Industrial cooperation Society, vol. 12, no. 4, pp.1812-1816(2011)
3. L. Godson, B. Raja, D. Mohan Lal, S. Wongwises : Experimental Investigation on the Thermal Conductivity and Viscosity of Silver-Deionized Water Nanofluid : Experimental Heat Transfer vol. 23, no. 4, pp.317-332(2010)
4. Seong-Eun Lee, Seung-Jin Oh, Sang-Mun So, Heon-Do Kim, Sung-Woong Chung and Hyun-Chul Sohn : Preparation of Silicon-on-Insulator Wafer Using Spin Etching and a Subsequent Selective Etching Process : Japanese Journal of Applied Physics Part 1-Regular Papers Short Notes & Review Papers, vol. 41, no. 8, pp.5025-5029(2002)
5. Lim SW. Mo RT. Pianetta PA. Chidsey CED : Effect of silicon surface termination on copper deposition in deionized water : Journal of The Electrochemical Society, vol. 148, no. 1, pp.16-20(2001)