[Detection of incorrect assembly in equipment maintenance using EES data - Daisuke Tokiwa]

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INTRODUCTION

The chamber conditions in dry etching equipment for semiconductor manufacturing are altered by reaction products and deterioration of chamber parts. Therefore, the equipment must be regularly maintained in order to control the chamber conditions. After chamber maintenance, the etching rate, particle generation, and other parameters are measured to check whether etching properties remain stable. However, incorrect assembly of parts and insufficient cleaning cause production problems in the dry etching process. When problems are detected, the etched wafers are scrapped, and the etching chamber must be cleaned again. It is therefore necessary to detect these problems before the wafers are etched.

METHODS

It is difficult to detect small changes in equipment parameters from summary data such as the mean, maximum, and minimum. Here, we used equipment engineering system (EES) data (heater power and helium gas pressure) to detect problems during equipment maintenance. In particular, we analyzed the lower electrode in dry etching equipment.

RESULTS AND DISCUSSION

In Figure 1, a fishbone chart shows the causes of changes in etching properties and equipment parameters. Materials, equipment, and work methods are controlled by procedure manuals for parts replacement and instrument calibration. We focus on uncontrollable factors that lead to differences in parts assembly and cleaning by operators. The torque applied to screw clamps is controlled, but we cannot perfectly eliminate differences in parts assembly. Therefore, we analyzed EES data to detect such uncontrollable factors. In this paper, we report a case of detecting incorrect assembly and contamination of the lower electrode in dry etching equipment. Figure 2 shows the power used by correctly and incorrectly assembled lower electrode heaters. When the heater is assembled correctly, the heater power converges quickly. When it is assembled incorrectly, however, the heater power converges slowly and the heater takes longer to reach the set-point temperature. We consider that incorrect assembly results in a gap between the lower electrode and heater. As a result, the heater power is not transmitted correctly, and the convergence of heater power is slow. Figure 3 shows the pressure of helium gas that flows between the wafer and lower electrode. The flow of helium gas is used to increase the efficiency of heat exchange. In this equipment, the helium gas flow is controlled so that the pressure is fixed. When the helium gas pressure reaches the set point, the flow rate becomes low. Then, when the high-pressure residual helium gas in the gas piping is outgassed, the gas pressure falls slightly. This decrease in gas pressure is considerably larger when the lower electrode is contaminated than when it is not. We can detect contamination of the lower electrode by monitoring the size of this decrease in gas pressure. By these methods, we can detect incorrect assembly and contamination of the lower electrode in dry etching equipment and reduce the occurrence of equipment problems.

CONCLUSION

We developed methods in which EES data are analyzed to detect setup problems after equipment maintenance.

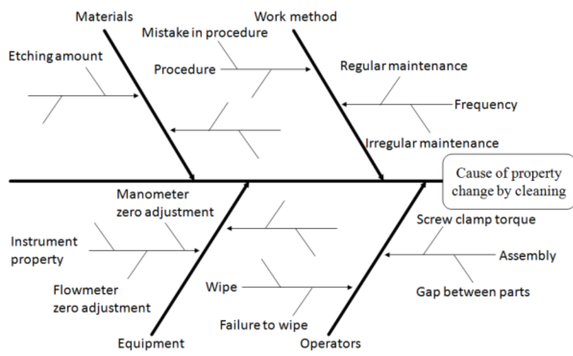

Figure1. Fishbone chart

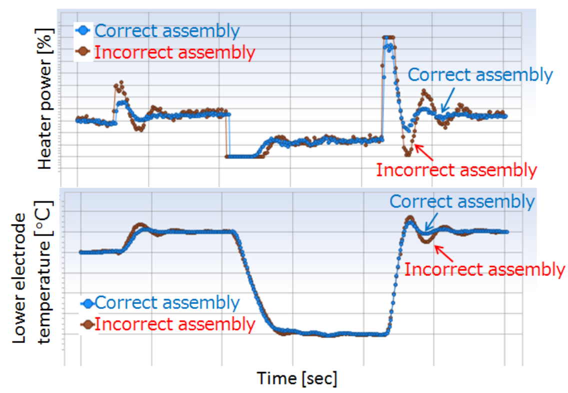

Figure2. Lower electrode heater power and temperature

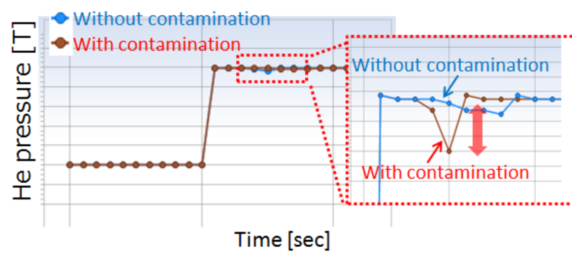

Figure3. Lower electrode helium pressure