The Advanced Monitoring Method for the Residual Charge in Wafer - Tsuyoshi Yokogaki

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Abstract

In order to solve wafer sticking problem in electrostatic chuck (ESC) of dry etching equipment and so on, we developed the advanced method to monitor residual charge in wafer. In this paper, we report our monitoring method and results in oxide etching equipment. In addition, we also report that this method can be used to optimize procedure of removal charge of dry etching equipment.

1.Introduction

Recently, there are many problems such as wafer sticking and wafer damage because of residual charge in ESC, especially in case of SOI wafer. To avoid these problems, it is necessary to remove residual charge by applying reverse voltage and/or plasma discharge. However, there is no effective method to monitor residual charge in wafer[(1)]. Therefore, procedure of removal charge is not optimized and sticking problem occurs. Hence, we tried to develop the advanced monitoring method of the residual charge in wafer.

2.Experimental

Fig. 1 shows oxide film etching equipment used for evaluation. We used a monopolar Coulomb force type ESC. Voltage sensor and electrostatic voltmeter which has high input impedance, were connected to ESC power supply line to monitor residual charge in wafer. In addition, switch was inserted to separate ESC from ESC power supply. First, we applied voltage to ESC in order to chuck wafer. Next, we turned off ESC and Switch at the same time. Then, we remove charge in wafer by vacuum ionizer. Thus, we monitored residual charge in wafer, successfully.

3. Results

Fig. 2 shows an example of measurement result. The horizontal axis shows time and the vertical axis shows the electric potential monitored by electrostatic voltmeter. The electric potential shows 0 V when voltage was turned off. Then, it gradually increases. Finally, the electric potential is further increased when vacuum ionizer was turned on and it shows stable value (hereinafter refer to as Sv). The mechanism of the electric potential change is shown in Fig. 3. The electric potential immediately shows 0 V just after turning off voltage, because the quantity of positive charge on ESC and negative charge in wafer are equal. Then negative charge in wafer decreases by self-discharge, and the electric potential increases. Finally, residual charge was removed by vacuum ionizer and the electric potential increases. When all residual charge in wafer was removed, the electric potential becomes stable and shows the Sv. Therefore, the Sv indicates the quantity of wafer charge stored by ESC voltage. Next, we evaluate relationship between the applying voltage to ESC and the Sv. The results are shown in Fig. 4. The Sv is proportional to the voltage in the range from 1kV to 2kV. Generally, the quantity of charge in wafer is proportional to the applying voltage to ESC. Hence, it is verified that the Sv indicates the quantity of charge in wafer by this result. Furthermore, we applied this method to applying time of reverse voltage to remove charge. We evaluated relationship between applying time of reverse voltage and the Sv. The results are shown in Fig. 5. When applying time is short, charge remains in wafer. On the other hand, when applying time is long, the opposite polarity charge occurs. According to this result, we found out that optimal applying time is about 20 seconds.

4. Conclusion

We developed the advanced method to monitor residual charge in wafer to solve wafer sticking problem in ESC. we can optimize applying time of reverse voltage by our method. In the future, we will apply our method to various kinds of equipment, including Johnson - Rahbek force type ESC.

Reference (1); ULVAC JAPAN LTD. Measuring Method for Quantity of Residual Charge and Judging Method for Its Condition of Movement. Japan Patent JP1999-40661(1999.02.12)

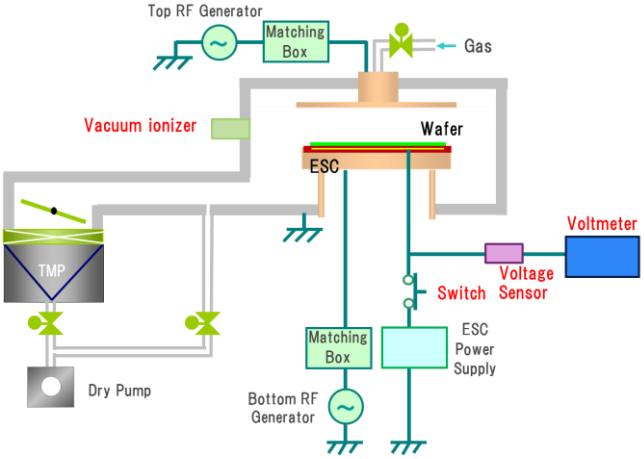

Figure 1. Oxide film etching equipment used for development.

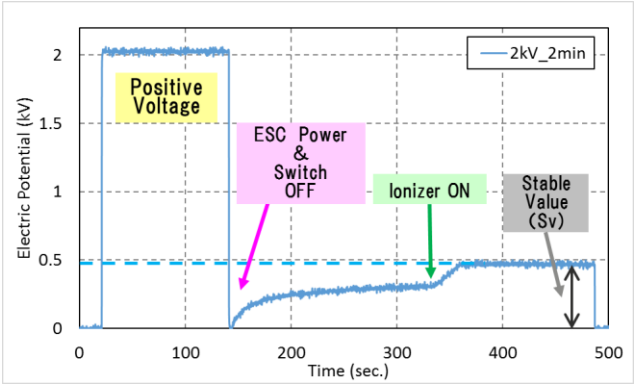

Figure 2. An example of measurement result of residual charge.

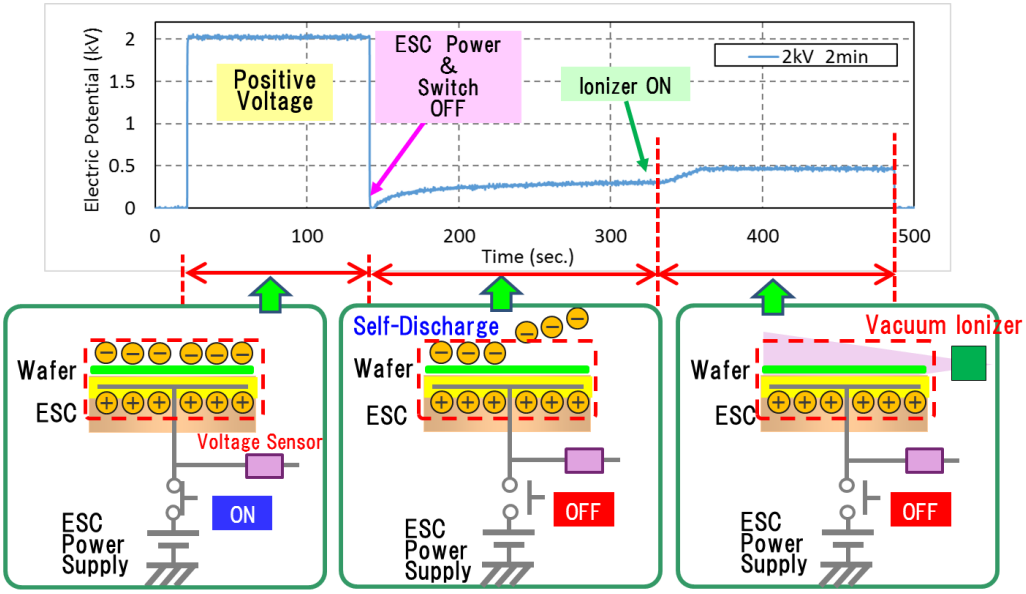

Figure 3. The mechanism of the electric potential change.

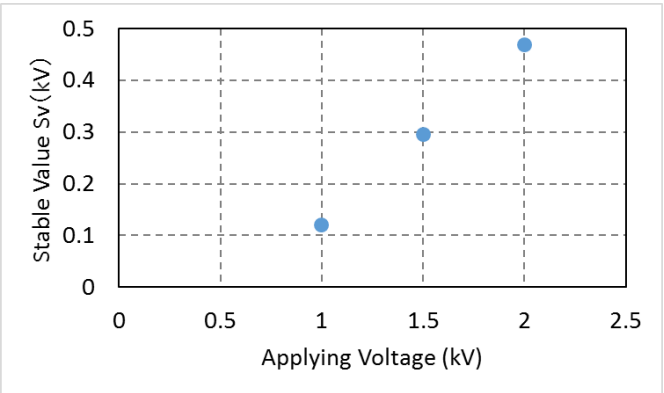

Figure 4. Relationship between the applying voltage to ESC and the Sv.

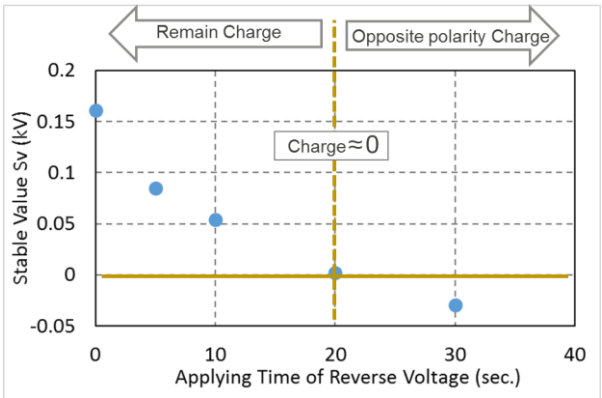

Figure 5. Relationship between applying time of reverse voltage and the Sv.