Surface cleaning using CO_2 gas cluster for semiconductor device

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Introduction

Demand for the development of cleaning technology has increased accordingly the importance of cleaning process and miniaturization of semiconductor devices. The cleaning existing techniques, there is various difficulties surface damage, chemical reaction, by-products, such as cleaning efficiency in a wet cleaning methods and chemicals(1). For this reason, dry cleaning method is introduced, is what aerosol cleaning technic. Aerosol cleaning is washing by forming an aerosol using the operating gas of the gaseous and the physical direct collision with the surface contaminants. However, due to damage of the pattern is induced by a generating particles in the aerosol within which is also induced to overcome these problems.

Experiment

In this paper, we studied the cleaning performance evaluation using gas cluster device(Fig.1.). Cluster is operating gas have become one of the tens or hundreds a molecules form the size of several nm. And it becomes the size of 30-60 nm to grow by condensation in short time. When that formed small clusters different from the aerosol cleaning grows, thereby to minimize damage to the pattern. Surface treatment using a cluster cleaning device, is based on the removal by collision(2). Thus, the degree of momentum to be transferred to the arrival from the cluster and affects the cleaning characteristics, this is dependent on the size of the cluster that is generated. Size distribution of the product cluster is a function of variables such as cooling temperature injection distance, flow rate, spray angle, the nozzle. Therefore, in this study, to evaluate the cleaning characteristics using CO_2 cluster evaluated type of contaminant particles, PRE(particle removal efficiency) corresponding to the size for these variables, and the patterns of various line widths in use, an experiment was conducted for damage. Particles which are used in the

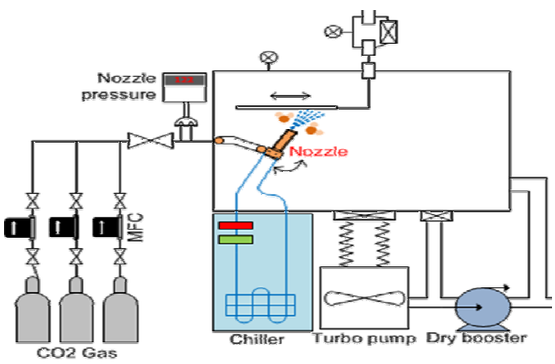

Fig. 1. Schematic of CO2 gas cluster cleaning equipment.

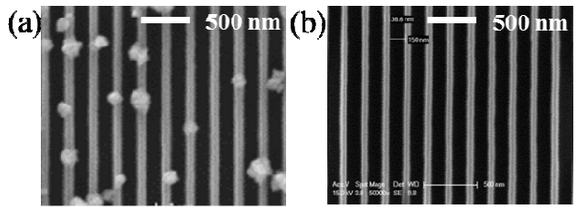

Fig. 2. SEM image of pattern wafer (a) CeO_2 Contamination (b) after CO_2 cluster cleaning

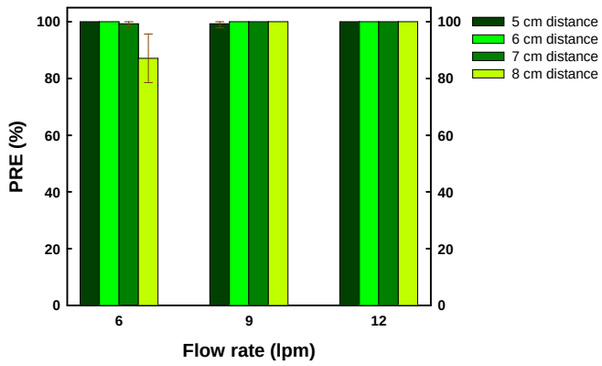

Fig. 3. Particle removal efficiency of CeO_2(300 nm) by CO_2 gas cluster cleaning

removal efficiency is the SiO_2 and CeO_2, and was then evaluated for cleaning efficiency by producing the coupon wafer was contaminated quantitatively the size 30,50,100,300 nm. Quantitative contamination, electrostatic particle deposition system classification of sizes using SMPS(scanning mobility particle sizer). Also, experiment the pattern collapse using the pattern of the Poly-Si with a line width of 35 ~ 180 nm.

Experiment results

Figure 2 shows the SEM(scanning electron microscope) images of CO_2 gas cluster cleaning on pattern wafer before and after. The experimental results, it was confirmed that the observed PRE of contamination particle is more than 95% of pattern collapse relatively in accordance with the terms of cluster formation(Fig.3).

Conclusion

Therefore, it was confirmed that CO_2 gas cluster cleaning is used as an alternative cleaning method with a high cleaning efficiency. While complementing the disadvantages of cleaning existing methods when based on theoretical calculations, we assume a cluster size needed for cleaning is applied to the cleaned by this was.

Reference

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