Study on high flow rate F-radical generation by compact water-cooled surface wave plasma source for remote plasma cleaning process

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In this study, cleaning process experiments using a F-radical generated from a compact water-cooled surface wave plasma source were carried out in a process chamber. This is why it is called remote plasma source cleaning. It is essential process of improving performance. For quick cleaning, it is necessary to generate more F-radicals. The cleaning processes for the various $Si/SiO_2/Si_3N_4$, were investigated by varying the various process parameters, such as the NF_3 Gas flow rate, process temperature, microwave power. Stable plasma have been maintained in conditions of high flow rate (1 ~ 10 slm of NF_3) at low microwave power (1 ~ 3 kW). We present the result of the species emitted during cleaning was monitored by residual gas analysis (RGA), and the observed in the pressure and etch rate.

1. Introduction

A remote plasma source cleaning is used to clean residues of process steps using silicon in the semiconductor and display industry. And it is essential process of maintaining high throughput during the thin film deposition process and lowering the defect rate of refinement process and increasing productivity. Remote plasma source cleaning have been attempted and used by various methods using chemical reactions. The industry has moved from wet cleaning to *in-situ* plasma cleaning and, finally, to remote plasma cleaning. The first generation technology for remote plasma source cleaning used microwave and second generation of equipment used a toroidal RF plasma source. The third generation of equipment, also based on toroidal plasma technology, offers significant expansion in the process flow rate and pressure operating range, including the capability to operate on cleaning gases other than NF_3. Existing microwave remote plasma source cleaning to require complicated set-up where was not sufficient. Due to these shortcomings the microwave type has been low preference. But it can be operated in a wide area (10 mTorr to 760 Torr), and in this area it has a plasma density of 10^8 ~ 10^{15} ㎝$^{-3}$. Also have high electron temperature in terms of electron temperature and is efficient in dissociation and radical generation of molecular flow. In this research, it is an improved structure than existing surfa-guide type surface wave plasma discharge tube. It is improvements have been made on the cooling and microwave transmission efficiency. So overcome the problem of capacity and no loss of electromagnetic waves.

2. Experimental

The compact water-cooled surface wave plasma source is shown in Figure 1. F-radicals are generated by using the surface wave plasma source. The plasma is generated and continued by an electromagnetic wave electric filed formed into the waveguide. The apparatus of the cleaning system is shown in Figure 2. The decomposition rate of NF_3 was measured via RGA, and the pressure change before and after decomposition was investigated. Also, the observed in the etch rate of the sample. We intend to show the relationship of process temperature and substrate position to etch rate.

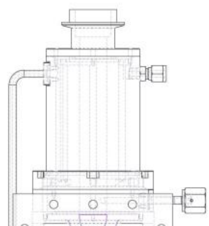

Fig 1. Structure of compact water-cooled surface wave plasma source

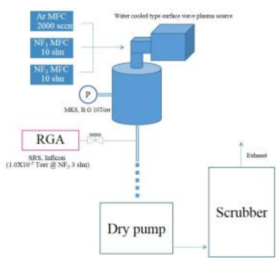

Fig 2. Schematic of compact water-cooled surface wave plasma source