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150 kHz帯大電力パルスバースト型ICPエッチングのバースト幅特性
Burst width characteristics of 150 kHz band high-power burst inductively coupled plasma etching

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Introduction

Inductively coupled plasma (ICP) has been widely used for plasma processing of materials such as deposition of film and etching because of its advantage. A new ICP system using burst wave has been developed. In this system, the impedance matching circuit which conventional ICP system requires is not necessary because the frequency is set to 100-200 kHz. In addition, the high power can be delivered to the plasma. Therefore, high density plasma can be obtained in this system. In addition, the burst width and duty ratio can be free set to optimize the process condition.

In this study, the influence of the burst width on the etching characteristic of ICP driven by high voltage burst pulse was investigated. The burst width was varied in the range of 400-1000 μs.

Experimental Setup

Figure 1 shows a schematic of the experimental apparatus. The vacuum chamber consisted of a cylindrical glass tube. The plasma source consisted of a solenoid coil (50 turns, length 70mm, 83 μH) wound on a glass tube. A capacitor (12 nF) was connected to the coil in parallel and was used to make a resonance circuit. The 400-1000 μs wide high voltage burst pulses with frequency 157 kHz were generated using power supply (PS-1, PEKURIS KJ14-4873) and applied the solenoid coil to generate ICP. The repetition rate of the burst pulse is 10 Hz. Argon and tetrafluoro-carbon gases were supplied though mass flow controllers (SEC-400MK3 and SEC-E40MK3, HORIBA) into the chamber. The silicon wafer to be etched was set on the target electrode. A stainless-steel mask with 1 mm square holes was placed on the wafer. The target electrode was placed at 70 mm from end of coil. The bias voltage to the target electrode was applied by a pulse power supply (PS-2, PEKURISU, KJ06-3265) with a negative polarity pulse voltage of 800 V. The application timing was synchronized with the burst signal. The bias voltage was applied to the target for 20 min after the presputter process. After etching process, the etching depth of the wafer was measured by a surface roughness tester, and etching rate was calculated by diving the etching depth by the processing time.

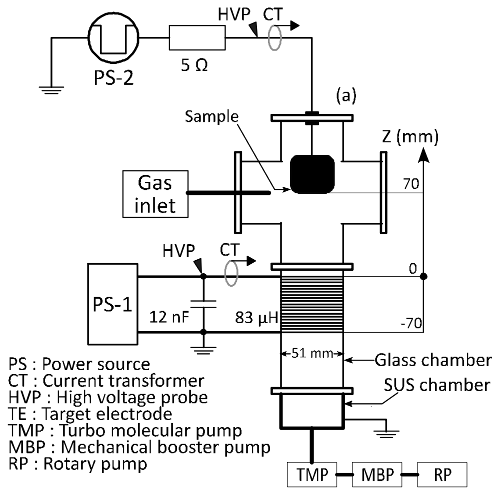

Fig. 1. Schematic of the experimental apparatus.

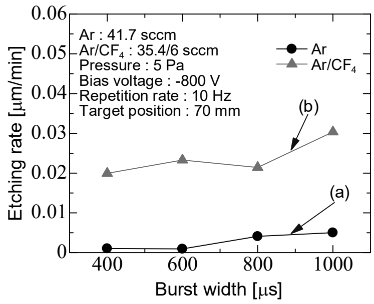

Fig. 2. Burst width characteristics of the etching rate for (a) Ar discharge and (b) Ar/CF_4 discharge with fixed repetition rate (10 Hz).

Results

Figure 2 shows the etching rate for (a) Ar discharge and (b) Ar/CF_4 discharge as a function of the burst width with a repetition rate of 10 Hz. The etching rate increased slightly with the increasing burst width, and about 0.04 μm/min for Ar discharge and 0.02-0.03 μm/min for Ar/CF_4 discharge. The etching rate in the case of Ar/CF_4 discharge was 5-10 time higher than that of Ar discharge.

Acknowledgments

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References

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