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Characteristics of Inductive Coupled Plasma with Internal Linear Antenna Using Multi-Polar Magnetic Field for FPD Processing

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Abstract. An internal linear inductive antenna referred to as "double comb-type antenna" was used for a large-area plasma source with the substrate area of 880mm × 660mm and the effects of multi-polar magnetic field applied by inserting permanent magnets parallel to the linear internal antennas on the plasma characteristics were investigated. By applying the multi-polar magnetic field, high density plasmas on the order of $3.2 \times 10^{11} cm^{-3}$ which is 50% higher than that obtained for the source without multi-polar magnetic field could be obtained at the RF power of 5000W. Also stable impedance matching with a low Q-factor of the plasma system could be obtained. The application of the multi-polar magnetic field not only increased the plasma density but also improved the plasma uniformity (less than 3%) within the 880mm × 660mm processing area.

Introduction

Development of a uniform large-area plasma source for flat panel displays(FPDs) is one of the import technologies for next generation FPD processing. For this reason, many researchers have been studied to develop large-area plasma sources for FPDs [1-4]. Various high density plasma sources have been investigated for FPD processing such as inductively coupled plasma(ICP) source, electron cyclotron resonance(ECR) plasma source [5], helicon plasma source [6] etc, during the past ten years. Especially, because of easier scaleability of the plasma source, the ICP sources have been investigated more intensively than other high density plasma sources. In this study, to improve plasma characteristics such as plasma density, plasma uniformity, electrical property of the antenna for the linear internal type ICP source which is not utilizing traveling wave, a modified linear internal type ICP source antenna termed as "double comb-antenna" with multi-polar magnetic field has been developed [2, 7, 8-13] and its plasma characteristics have been investigated and compared with those obtained without multi-polar magnetic field.

Experimental Procedure

The linear internal ICP source with the magnetic field used in this study is shown in Figure 1(a). The processing chamber was a rectangular shape for the application of large-area FPD processing. The size of the processing chamber was 1,020mm × 830mm and the substrate size was 880mm × 660mm. "Double comb-antenna" shown in Figure 1(a) was consisted of five linear internal antennas and one end of each antenna was connected to a 5kW 13.56MHz RF power generator through a L-type matching network while the other end of the antenna was grounded. The linear antenna was made of 10mm diameter copper tubing for water cooling and was covered by quartz tubing of 15mm diameter and 2mm thickness for dielectric isolation from the plasma. As shown in Figure 1(b), permanent magnets having 3000G on the magnet surface were installed above the quartz tube for the application of multi-polar magnetic field.