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Investigation of Capacitively Coupled Plasma with electron beam by impedance analysis

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A deep trench with high aspect ratio is required in the etch process, and it is well known that ion flux and energy can be independently controlled by means of dual or triple frequency. However, multi frequency capacitively coupled plasma (CCP) has a few problems to achieve high aspect ratio, such as surface charging and power coupling to bias voltage as well as interference between the frequencies. In this study, a new type of CCP, which is modified by using electron beam, is introduced. Electron beam, which is generated by thermal tungsten filament, is used to provide excess electrons, solve surface charging issues, and generate plasma in low pressure. Rf power is applied to the CCP to get bias voltage. Because of excess electrons, the bias voltage of the powered electrode becomes extremely high to balance between electron and ion fluxes at the electrode.

To see the characteristics of the plasma, we have done impedance analysis which is very convenient non-invasive measurement tool. The effects of pressure, electron beam current, beam energy, and RF power in this phenomenon are carefully examined. This plasma source can be used to generate high energy ions in etching process and provides a more convenient and independent control of ion energy.

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