design document for

An Automated RF Tuner
For RIE Applications

submitted to:

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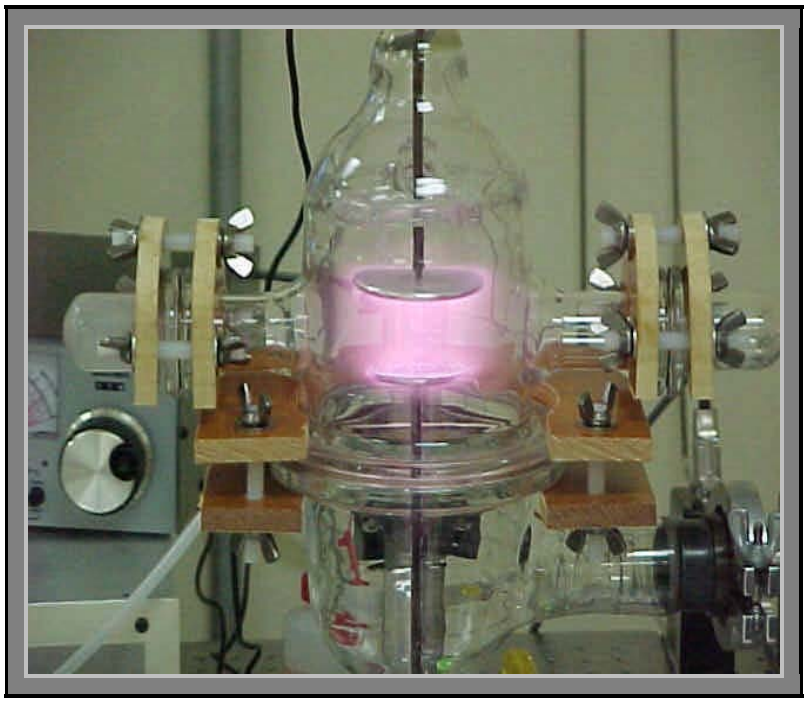

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EXECUTIVE SUMMARY

The Reactive Ion Etching (RIE) system in the Emerging Materials Research Laboratories (EMRL) uses RF power to strike the plasma used in the dry etching process. In order to achieve high quality etching, the RIE system requires that the plasma absorb a constant amount of power. Uniform power transfer from the RF source to the plasma is maintained by matching or tuning the RF source to the respective RF load, which is composed of two electrodes and the plasma. The plasma acts as the dielectric between the two electrodes—therefore, making the RF load capacitive. The capacitive impedance of the load is continuously changing due to changes in temperature, pressure, and the dielectric constant of the plasma. Currently, the matching or tuning of the source and load is performed manually in the RIE system. Unfortunately, this makes the RIE process both tedious and difficult to reproduce. Furthermore, the results are significantly dependent on the person operating the system and their tuning skills.

The Automated RF Tuner is designed to establish and maintain a maximum Voltage Standing Wave Ratio (VSWR) of 1.1, which is an acceptable percentage of reflected power for the RIE application. The Tuner accommodates a PC interface which enables monitoring capabilities and limited software control of the tuning network. The PC monitor software has the ability to graphically display the forward and reflected power detected by the tuner circuitry. The Automated RF Tuner is packaged in a standard 19-in. aluminum rack mount enclosure, which provides proper shielding for the internal electronics of the device and also protects the user from the possibility of contact with RF power.

The Automated RF Tuner utilizes the matching techniques and the power detection circuitry of a manually operated MFJ-962D “T” Network Roller Inductor Tuner in conjunction with a micro-controller and a set of servomotors. The micro-controller operates with an impedance-tuning algorithm to control the servomotors, which, in turn, rotate the mechanical variable impedance devices of the tuning network. The buffered output of the detection circuitry of the MFJ-962D provides inputs to the micro-controller that determines the relative positions of the mechanically varying impedance components in the matching network. The PC interface permits software control of the tuner and also graphically displays the matching network performance (i.e., forward and reflected power).

The Automated RF Tuner is inexpensive compared to its counterparts on the market because the system is customized to serve only RIE applications. Limiting the target applications to only RIE systems simplifies the physical interfaces and the algorithm used to vary the variable impedance components, which then, match the load to the source. The Automated RF Tuner’s PC interface is favorable because it employs technology and equipment already used in the existing RIE system.

This device will significantly simplify the RIE process by automating the matching process and allowing the operator to leave the RIE system unattended because the matching will be conducted and monitored automatically. Also, the tuning will be performed utilizing the same matching algorithm regardless of the operator. Therefore, the results will be more repeatable, which implies more refined recipes for etching can be developed. Therefore, the fabrication quality of the semiconductor devices can be optimized.