ABSTRACT

THESIS: PLASMA DIAGNOSIS WITH AN EXTERNAL CAPACITIVE COUPLING PROBE

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Artificially produced plasmas have important applications in medicine, microelectronics, and many other fields of science. Effective operation of plasma devices requires accurate and reliable diagnostic tools that help optimize plasma parameters such as cathode fall, electron density and energy distribution. While well established, the Langmuir probe technique is limited to applications where a probe can be inserted into devices. For many other applications, the external probe technique is the only choice for diagnoses and measurements of plasma parameters. External probe techniques have been widely used in plasma diagnoses such as target bias in RF magnetron sputtering, and cathode fall measurement in gas discharge devices.

However, some of the external probe diagnostic techniques such as the cathode fall measurement with a capacitive coupling band have a large uncertainty in measurements, and the results in the literature are often inconsistent with each other. These discrepancies are due to insufficient understanding of the physical and circuitry basis of the diagnostic technique. This research seeks to better understand the external probe measurement, to improve the measurement technique, and to properly interpret the measurement results. A circuit model for plasma is

proposed along with typical circuits for the external probe diagnostics using a capacitively coupled band. Detailed analysis of the diagnostic circuits is performed to reveal the interactions between various circuit elements, and to explain the inconsistency of the past cathode fall measurement results with the external probe technique in the literature. The circuit model and the analysis results are further validated.