CHAPTER I

INTRODUCTION

1.1 Thesis Motivation

In order to obtain the detailed knowledge of properties that define plasma in any processes, many parameters must be realized. Two of most importance of such parameters are densities and energies. These properties strongly rely on the type of discharge, gas species, gas pressure, and power given to gas. Therefore, plasma diagnostic tools are essential to determine the parameters.

There are two categories of plasma-diagnostic techniques, perturbation and non-perturbation. Optical emission spectroscopy is one of the plasma un-perturbing techniques analyzing light emitted from plasma. Not only are density and temperature of plasma can be analyzed, but also the type of the excited species that can be determined by means of this technique [1]. The other category is an electrical probe which directly perturbs plasma by drawing current into the exploring probe as a function of voltages supplying to it. In comparison, the spectroscopy investigates plasma as a whole, while the probe is a local investigation. Hence, local properties, such as plasma and floating potentials, and density and energy of electrons, can be determined by using latter process.

The main advantage of the optical technique relies on its non-intrusive character. P. Jamroz [2] characterized the gas mixtures in the plasma phase of 100 kHz low-pressure discharge by using the optical emission spectroscopy. High energy species were identified by optical temperature (electron excitation temperature) and by electron number density. The emission intensities of main species were monitored as a function of plasma composition. Shu Qin [3] used the spectroscopy to study the sheath thickness measurement of a pulsed glow discharge on which ion density based.

The comparison of the density measured by the optical technique with an electrical (or Langmuir) probe was in a good agreement. However, the optical emission spectroscopy was suitable for the pulse-mode plasma because high-voltage pulse would create a detectable sheath structure.

The electrical-probe technique has been widely used to determine electron and ion densities, electron temperature, and potentials in plasma [4-8]. Since it is less complicate than any other techniques not only in probe construction but also in data analysis. The probe construction consists of a small metallic electrode, and a power source biasing to the electrode. By means of the probe biasing, probe current-voltage responses can be analyzed for plasma parameters. Although the interpretation of the probe characteristic is less complicated and can be carried out with manual or, more likely, with computer assistance. This can lead to miss-estimation of such parameters if one does not have enough understanding in the probe theory. Besides, the process of manual analysis is generally routine, and usually not able to analyze plasma parameters as an in-situ or as a real-time process.

The basis principle of the probe characteristic and interpretation has been published in many research articles and textbooks. Some researches also constructed an algorithm for the determination of plasma parameters. J. B. Friedmann [9] proposed an algorithm for the plasma analysis in an electron cyclotron resonance plasma source. In their algorithm, the sweep voltage was partitioned into three intervals and used several models and fitting techniques in each interval. However, the algorithm required some initial values that had to input by a user. Bong-Kyoung Park and colleagues [10,11] derived a plasma-analyzing algorithm with wavelet transformation. They introduced the wavelet technique to reduce noise level from the differentiated data without losing any important information. By getting rid of noise that caused an interruption in the analysis algorithm, plasma parameters could be determined. In these research articles, their algorithms help user to reduce time consuming in manual process of analysis.

As mentioned in many publications, the electrical probe technique is possibly the easiest method in set-up and analysis. The process of the probe interpretation can be programmed to automatically analyze plasma parameters to reduce time consuming, and this is helpful for one to use this diagnostic tool in most plasma measurements. However, in some plasma igniting processes, we need to realize such parameters instantly to predict tendency of the processes. Therefore, in this work, we have developed programs to carry out probe measuring I-V characteristics and to analyze plasma parameters in plasma processes as an in-situ and as a real-time analysis..

1.2 Aim of Thesis

To measure plasma parameters with the electrical probe technique by using a computerized power source bias to the probe, and analyze the result.

1.3 Overview of Thesis

After the introduction in the first section, this thesis is divided into 6 chapters. The basis principle is detailed in chapter II including the physical meaning of plasma parameters, probe characteristics and interpretations, and plasma discharges. Chapter III is devoted to the development of the probe-measuring and probe-analyzing programs. In chapter IV, the experimental set-ups, such as probe construction and plasma reactors, shall be described, while results and discussions will be given in chapter V. Then the last chapter, chapter VI will summarize the thesis.