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PHYSICAL CHARACTERISTICS OF PLASMA MONOPOLE ANTENNA CONSTRUCTED THROUGH RF CHARGING OF DIFFERENT GASES

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledge as referenced work. This research report has been not submitted to any other academic institution or non-academic institutions for any degree or qualification.

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ABSTRACT

Plasma antennas represent the importance of technology in wireless communication that was developed due to its potential and innovativeness. Plasma antenna is a type of antenna in which the metal conducting elements of a conventional antenna are replaced by plasma. In microwave field, the analyses of different gases by using discharge tube are investigated by injecting the RF source to produce monopole plasma antenna. The discharges have limitation on practical usefulness in commercial applications. This thesis introduces a concept of plasma monopole antennas through RF- charging of different inert gas. The plasma antenna is constructed using different inert gases as the plasma medium. The relationship between the generated plasma parameters and the antenna characteristics are investigated and discussed in two related topics. First, the preliminary studies on plasma antenna performance and behaviour are presented. Special focus is given on proving the theoretical plasma antenna on simulation by using different gas to analyse the characteristics of plasma antenna behaviour. The antenna's capability to operate as a transceiver is verified through simulation by using CST Microwave Studio. It is shown that the S- parameter for different gases and pressures give different performance due to the number of turns of coupling sleeve used. The effect of the thickness of the coupling sleeve is also discussed. The second topic in this thesis is the development of plasma antenna where the implications on the fabricated antenna characteristics are discussed. The antenna characteristics that will be taken into account is the s- parameter, radiation pattern and antenna gain. The capability of plasma antenna is satisfied to transmit and receive the signal when the plasma antenna is supplied with RF sources. This research works are limited to the investigations of basic plasma antenna characteristics in a single antenna setup. Further investigations such as actual implementation of plasma antenna in wireless transmission are also described.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

The utilization of plasma technology in wireless communication has been developed due to its promising potential and innovativeness. Ionized plasma acts as an RF element for transmitting and receiving electromagnetic wave [1]. The ionized plasma has the ability to be turned on and off, reducing its radar cross section and any unwanted effects on the RF network. Therefore, plasma technology is said to be in accordance with the current and near future requirements.

Plasma antenna is a type of antenna in which the metal conducting elements of a conventional antenna are replaced by plasma. Plasma antenna works when a contained gas is ionized into plasma state and become electrically conductive so that it responds strongly to the magnetic fields and can be used as an antenna when RF is supplied [2] -[3].

For antenna applications, the antenna must be maintained in precise spatial distributions such as filaments, columns, or sheets. The plasma volume can be contained in an enclosure (tube) or suspended in free space [4]. By containing the plasma in a glass tube (afterwards termed as plasma column), one could parameterize various elements of the plasma charging setup to properly design an efficient antenna. Rayner et. al. has successfully conducted a study of the relations of several parameters such as the column length, applied RF power and plasma density to specific physical antenna characteristics in [2]. Furthermore, it was also found that the characteristic of a plasma antenna is controlled by parameters such as the plasma density, tube shape, and current distribution [3]. It has been reported that the performance of plasma antenna and metal antenna are similar in terms of their RF characteristic [5] - [6], but performs better in terms of robustness to thermal noise [7]

Plasma can be generated by the electron impact ionization, photo-ionization, or simply heating the gas inside the tube. Inert gases are commonly used in plasma because of their large ionization potential which reflects the stability of the electron configuration [8]. Nevertheless, variations of physical characteristics of different inert