Seminar

Institute for Plasma Research

Title : Design, Optimization and Fabrication of Leaky Mode Plasma Antenna for Wideband Application at 2.45 GHz

Speaker: Dr. Rasila Hirani
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Venue : Online - Join the talk:
https://meet.ipr.res.in/Dr.RasilaHirani_PDFTalk

Abstract :

Today's communication systems demand larger bandwidth and high data rates in telecommunication industry, defense technologies, wireless networking and satellite communications and many more. Plasma behave as conductor or dielectric material for electromagnetic waves, and these behavior is controllable by changing complex permittivity, or electron density and gas pressure, which is associated with the electron plasma frequency and the electron elastic collision frequency; this controllability and the time-varying manner for permittivity distinguish plasmas from other electromagnetic media. The plasma permittivity value is directly proportional to the plasma density which can be changed with input excitation power. Therefore, plasma antenna is electrically reconfigurable at desired frequency and so finds perspective application where frequent retuning is required.

Complete full wave modal analysis of dispersion and radiation characteristics of Dielectric Tube Waveguide Loaded with Plasma (DTWLP), in both guided and leaky modes will be discussed in depth. The guided mode dispersion theory has been thoroughly modified in terms of Bessel function of outer layer to introduce leaky mode wave propagation theory. The proposed leaky mode dispersion characteristics of DTWLP is analytically solved and numerically computed using Muller's complex root search algorithm in MATLAB with an aim to define its complex propagation constant behavior. Accordingly, complex leaky mode characteristics and its classification as guided mode, reactive mode and antenna mode have been investigated. These modal characteristics reveal wide fundamental antenna mode (TM01) with variation in plasma density, which can find prospective application in high resolution radar and communication system where re-tuning of the antenna to a new frequency or making it electrically invisible is required. A computational cum simulation study is also performed using CST Microwave Studio software which confirms analytical findings.

A full wave analytical theory has been developed and numerically solved for finding out the radiation characteristics for the fundamental TM01 and hybrid HE11 modes of the plasma column antenna for both guided and leaky mode configurations using electric and magnetic field vector potentials and polarization current method.

From the application point of view, design, simulation and implementation of plasma antenna has been investigated at 2.45 GHz frequency and its potential use in the development of leaky wave antenna was investigated. This antenna is designed and optimized in CST MW studio which may finds application in Wi-Fi. The reconfigurable leaky wave plasma antenna has been characterized based on the electrical properties of the plasma that can be controlled with the input excitation power, frequency and density. The design has been optimized in terms of the plasma column axial length, plasma frequency and collision frequency as well as length and diameter of ground cylinder.

The proposed design of plasma antenna has been fabricated and measurement has been done with VNA. The simulation and experimental results were found to be in agreement. This type of antenna is useful for RADAR and communication systems where continuous change in frequency is required.