Seminar

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Institute for Plasma Research

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Title: Experimental Study of Low Power Microwave and Plasma Interactions

Speaker: Ms. Hiral B. Joshi
Institute for Plasma Research, Gandhinagar

Date: 1st September 2022 (Thursday)

Time: 03:30 PM

Venue: Join the talk online:
https://lobby.ipr.res.in/opentalk_hiral

Abstract

Plasma is a quasi-neutral medium that consists of charged particles and neutrals. The interaction of these particles gives rise to a variety of wave phenomena. The study of interaction of electromagnetic waves with plasma relates to the investigation of the properties of Earth's ionosphere (radio communication). This is mainly dependent upon the plasma frequency in the ionosphere. Extensive work has been carried out in the simulation field is based on the assumption that the wave propagating is a plane wave and hence the source used is a plane wave source. On the contrary the work carried out here uses a horn antenna as the source of microwave and hence the experimental validation is appropriate.

The study here is focused on the interaction of microwaves with plasma and to use it for *stealth application*. The study here is twofold: First is the simulation study and the second is its experimental validation. The CST microwave studio is software to simulate the microwave scattering parameters. A simulation is carried out to study the absorption of microwaves in plasma before the experiment is carried out using the CST microwave studio. The simulation is done using the Drude dispersion model which explains the propagation of electromagnetic waves in cold collisional plasma. According to this model the plasma is treated as a stationary medium with a fixed permittivity. The permittivity of a Drude material is dependent on the two plasma parameters namely electron plasma frequency ω_p and electron neutral collisional frequency υ_c. In terms of electromagnetic properties, one may define plasma as a non-homogeneous, non-linear and dispersive medium. The effect of plasma parameters namely plasma frequency and collisional frequency is studied using the simulation. An optimum value of these parameters is identified. The simulations are also carried out by varying plasma geometries. The model is validated by suitable experiments carried out in the laboratory. For attenuation of microwaves of 8-12 GHz an operating range of plasma frequency and collisional frequency is identified. The reduction and control of RCS of an object have been attempted by various techniques, including shaping, use of radar absorbing materials, frequency selective surfaces, engineered materials etc. Plasma based RADAR Cross-section (RCS) reduction is a technique that is associated with the reflection and absorption of incident EM wave by the plasma layer surrounding the structure whose RCS is to be reduced.The FTA has a potential to reduce the RADAR cross-section of the metallic target. The FTA is placed in a Teflon housing to form a panel. This panel is paced in front of the target whose RCS has to be studied. X-band microwaves are radiated upon the plasma panel using standard gain horn antenna and received using another identical antenna. This measurement is carried out using Naval Research Laboratory (NRL) arch method as recommended in IEEE standard 1128. The difference in the return loss of the microwave (MW) power with and without plasma is understood as absorption. A minimum of 25 % and a maximum of 90 % reduction in RCS is observed in the X-band. An attempt has been made to explain the variations in the RCS reduction in the targeted frequency range.