IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Technologies, Part 2 (6)

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FEASIBILITY STUDY ON A PLASMA BASED REFLECTIVE SURFACE FOR SATCOM SYSTEMS

Abstract

Gaseous Plasma Antennas (GPAs) can be defined as devices that exploit weakly or fully ionised gas to transmit and receive electromagnetic (EM) waves. GPAs can offer several advantages over metal antennas: while in use, they are (i) electronically reconfigurable with respect to frequency, and gain on time scales in the order of microseconds to milliseconds, and (ii) transparent to incoming EM waves whose frequency is greater than the plasma frequency. When not in use, the plasma can be turned ”off”, and the GPA reverts to a dielectric tube with a very low radar cross-section. Thus, a GPA can potentially achieve frequency hopping electronically, rather than mechanically, and reduce co-site interferences. Moreover, the reduced interferences make GPAs suitable to be stacked into arrays that can steer the beam electronically by switching on and off the plasma array elements. Reconfigurability and beam-steering capabilities make GPAs very appealing for Satellite Communications (SatCom) applications. In fact, the reduced co-site interferences allow GPAs to be stacked in each other's proximity on the same satellite, reducing the mass and volume budget for the telecommunication subsystem. Moreover, the antenna pointing and tracking obtained by steering the beam electronically, rather than varying the orbital attitude of the satellite, can be an enabling factor for several space missions. Target applications are up and down linking, cross-linking, and radar surveillance.

In this work we present a feasibility study on a plasma based reflective surface in C-band whose beam steering and focusing capabilities can be controlled electrically rather than mechanically. The study here presented combines numerical and experimental approaches. A target plasma discharge has been characterized experimentally to provide the plasma parameters to estimate the antenna performance by means of full-wave numerical simulations. As a first step, the numerical simulations considered a simplified model of a plasma based reflective surface, whose performance has been analysed while varying the plasma parameters of the elements comprising the reflective surface. Successively, the equipment and the electrodes used to generate the plasma have been included in the design, to model a more realistic system. Eventually, the influence that the plasma generation equipment has at system level has been carefully analysed and discussed.