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CURL PLASMA ANTENNA FOR SATCOM NAVIGATION SYSTEMS

Abstract

Gaseous Plasma Antennas (GPAs) have been 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: when the plasma is turned "on", they are (i) electronically reconfigurable with respect to frequency, and gain on time scales the order of microseconds to milliseconds, and (ii) transparent to incoming EM waves whose frequency is greater than the plasma frequency. When the plasma is turned "off", 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 when several antennas are placed in close proximity. 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.

The reconfiguration and beam-steering capabilities, together with the reduced interferences, make GPAs very appealing for Satellite Communication (SatCom), especially in navigation systems (i.e., systems that provide geolocation and time information). In navigation systems, the antenna pointing and tracking obtained electronically, rather than varying the orbital attitude of the satellite, can be crucial. Navigation systems, as for example the European Galileo, require improvements on the navigation antennas: this is confirmed by the growing demand to identify and implement antennas that can enhance the capability of the constellation by ensuring more robust GPS service especially in GPS-denied environments or in regions where service is inconsistent. GPS antennas are required (i) to cover the L frequency band (1-2 GHz), and (ii) to use Circular Polarization (CP).

In this work, we present the preliminary results of a curl GPA that works in the L-band, specifically designed for SatCom navigation systems in the framework of the Italian Space Agency (ASI) project "EPT.com – Enabling Plasma Technology towards Satellite Communications". Curl antennas are in

fact inherently circularly polarized. The study here presented combines numerical and experimental approaches. A plasma experimental characterization provided the plasma parameters to estimate the antenna performances by means of full-wave numerical simulations. The numerical simulations considered in a first stage a simplified plasma curl plasma antenna and successively it included a more realistic design that comprises the equipment and the electrodes used to generate the plasma. Furthermore, the influence of the plasma parameters on the antenna parameters has been analyzed.