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ADVANCEMENTS IN PLASMA ANTENNAS FOR SATCOM NAVIGATION 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: when the plasma is turned "on", 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 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. 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), such as in up and down linking, cross-linking, or in radar surveillance. In those systems, the antenna pointing and tracking obtained by steering the beam electronically, rather than varying the orbital attitude of the satellite, can be crucial. Moreover, the lower co-site interferences may reduce losses due to mutual coupling between antennas placed in close proximity as in small satellites, thus enhancing the efficiency of the space telecommunication systems. Despite these advantages, the use of GPAs has been limited by the lack of suitable technological solutions to generate the plasma. In fact, the antenna performances might drop if plasma production is not efficient enough, namely if the plasma is poorly conductive. In this work, we present the recent advancements in GPAs obtained in the framework of the Italian Space Agency (ASI) project "EPT.com – Enabling Plasma Technology towards Satellite Communications". The study here presented combines numerical and experimental approaches. A prototype of GPA working in the Ultra High Frequency band has been manufactured and characterized both in terms of plasma and antenna performances. The measured plasma parameters have been used to estimate the antenna gain by means of full-wave numerical simulations. The approach has been validated by comparing the numerical results against measurements of the gain realized in an anechoic environment. Finally, a GPA targeted at SatCom has been preliminary designed. In this preliminary design, the influence that the plasma generation equipment has at system level has been carefully analysed and discussed.