Optimization Studies of Pseudospark Sourced Electron Beam for Development of Plasma Assisted Slow Wave Oscillator

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Abstract

In this work an effort has been made to design and develop different Pseudospark (PS) discharge based Plasma Cathode Electrode (PCE) Guns and their optimization so as to develop X-band plasma assisted slow wave oscillator first time in the Country. In fact, some research work has been done in past showing that the presence of plasma in conventional microwave tubes, such as, Travelling Wave Tubes (TWTs), Klystrons, and Gyrotrons increases the beam current transport. The presence of plasma also relaxes the requirement of the external magnetic field and significantly improves their performance with respect to RF power, bandwidth, efficiency, compactness, and long-pulse as well as high pulse repetition frequency (PRF) operation capabilities. The plasma assisted slow wave oscillator largely rely on beam-wave interaction process inside a plasma filled slow wave structure (SWS) for the generation of microwave radiation driven by energetic electron beams from PCE-Guns, which has not been thoroughly investigated. Accordingly five types of PCE-Guns have been designed and developed where PS discharge concept has been utilized.

The developed PCE-Guns include different configurations –like, single-gap single-aperture (SGSA), single-gap multi-aperture (SGMA), a novel single-gap sheet-beam (SGSB), multi-gap single-aperture (MGSA) and a novel tapered multi-gap multi-aperture (TMGMA) [1-5]. The performance of the developed PCE-Guns have been optimized at different operating conditions including operating gas pressure, applied voltage, electrode arrangement, electrode gaps, aperture geometry and breakdown mechanisms. Two diagnostic techniques have also been developed to investigate the generated electron beams. A simple two isolated concentric ring diagnostic arrangement gives the qualitative assessment of focusing and defocusing locations of the electron beam during its propagation inside the drift space region [2,5]. The another diagnostic technique is based on dielectric charging and scanning electron microscope (SEM) based imaging which enables the exact shape and size estimations of the generated electron-beam from the PCE-gun [1,3]. To better understand the electron beam generation from the developed PCE-Guns, simulations using 'OOPIC-Pro' and Vsim-6 have also been carried out [4]. A good correlation has been found between experimental and simulation results. These studies led to develop first indigenous demountable prototype of X-band plasma assisted slow wave oscillator, which has generated non-coherent microwave signal in the range 10-11.7 GHz.

References:

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