Electromagnetic Wave Modes Sustaining Microwave Microplasma in Coaxial Geometry

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Electromagnetic wave travelling along a dielectric tube can produce plasma inside the tube which is the typical cylindrical plasma column of surface-wave-sustained discharges (SWD). One of the main characteristics of surface-wave-sustained cylindrical plasma column is the single wave mode regime of operation. Usually only the azimuthally symmetric wave propagates in this configuration. If there is a metal cylinder at the tube axis, electromagnetic wave could produce plasma outside the dielectric tube. This configuration is called coaxial discharge.

Sustaining the coaxial discharge by various wave modes in metal–dielectric–plasma configuration is theoretically studied. It confirms the assumptions based on the experiments that not only the azimuthally symmetric but also higher modes can sustain the discharge.

The purpose of this work is to investigate theoretically the wave and plasma characteristics of coaxial microplasma sustained by azimuthally symmetric, dipolar and higher wave modes. The basic relation in our model is the local dispersion relation obtained from Maxwell's equations. Since the plasma is axially inhomogeneous the local dispersion relation gives the dependence between the normalized plasma density and the dimensionless wave number, so called phase diagrams. From the behavior of the phase diagrams at different wave modes and discharge conditions one can obtain information about the ability of the wave to sustain the plasma and about the plasma density.