Dependence on the radial dimensions of microwave atmospheric pressure argon plasma

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Atmospheric-pressure argon plasmas tend to experience contractions [1]. The reduction of plasma dimensions to less than 1 mm allows the generation and maintenance of stable, glow discharges at high pressure. Plasmas obtained in this manner are referred to as microplasmas and are characterized by great stability, high electron densities and high generation of excimers and other chemical reactive species. These plasmas are also in a non-equilibrium state with the electron temperature much higher than the heavy particle's temperature. The small size, in combination with the above mentioned characteristics, make them suitable for local surface treatment and thus direct creations of micro-scale patterns, synthesis of nanomaterials and numerous other applications [2,3].

In this work a nonthermal atmospheric pressure plasma torch sustained by a surface wave at 2.45 GHz is studied theoretically. The dependencies of the plasma characteristics as well as the wave properties on the discharge radius are investigated. The radius is varied from μm to mm. The influence of the tube parameters – thickness and dielectric permittivity – on the discharge is also examined.

The study is performed by means of a 1D self-consistent model. A steady-state Boltzmann equation in an effective field approximation coupled with a collisional-radiative model for high-pressure argon discharge is numerically solved together with Maxwell's equations for an azimuthally symmetric TM surface wave. The dependencies of the plasma characteristics as well as the wave propagation and attenuation coefficient and the power density on the axial coordinate for different radii are presented. A strong dependence of the plasma properties on the radial size is observed.

References

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