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P4.3017 SNSS discharge propagation velocity dependence on gas pressure and microwave power

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It is essential to know discharge propagation velocity dependences on various operational parameters as for understanding of discharge development physics as for applications. This applies as well for self-non-self-sustained (SNSS) discharges [1] in subthreshold microwave fields. For microwaves at wavelength λ = 2 cm it was found [2] that two modes of supersonic discharge propagation exist: step-like propagation with λ/4 steps at air pressures below 200 Torr and step-like propagation with 2 mm step at pressures above 200 Torr. Another result was the decrease of the discharge axial propagation velocity from 2x10^5 cm/s to 1x10^5 cm/s at increase of air pressure from 200 Torr to 750 Torr. These experiments were carried out at microwave power density 20 kW/cm^2. Yet still there are no systematic measurements of the SNSS discharge propagation velocity in subthreshold microwave fields of millimeter wavelengths.
In this work we present results of the first measurements of SNSS discharge propagation velocity at varying of microwave power (wavelength λ= 4 mm) in the range of 90 kW…360 kW (3.8…15 kW/cm^2 power densities respectively) and varying air pressure 200…600 Torr. Velocity measurements [3] were done using phase shifts measurements of microwave radiation reflected from the head of the discharge. It was found that the discharge propagation velocity exceeds 3x10^4 cm/s at air pressure 200 Torr and microwave power above 100 kW, at air pressure 400 Torr and microwave power above 230 kW, at air pressure 600 Torr and microwave power above 280 kW. The comparison of supersonic propagation velocities at air pressures 200 Torr, 400 Torr, and 600 Torr shows that the propagation velocity decreases as the pressure increases but with a bit slower rate. The obtained results indicate necessity to update physical model of the SNSS discharge.
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[1] K.V. Artem'ev, G.M. Batanov, N.K. Berezhetskaya et al. Journal of Physics: Conf. Series, 2017, V.907, 012022.
[2] G.M. Batanov, S. I. Gritsinin, I.A. Kossyi et al. Plasma Physics and Plasma Electronics, ed. by L.M. Kovrizhnykh, Nova Science Publishers, Commack (1985), p. 241.
[3]. K.V. Artem'ev, G.M. Batanov, N.K. Berezhetskaya et al. JETP Letters, 2018, V.107, I.4, pp. 219-222.

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