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O3.301 The role of thermal effects in constriction of positive column in inert gases

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Constriction, which is the fundamental phenomenon of gas discharge physics, has been attracting the attention of scientists for more than a century. However, scientists still discuss [1], what is the main mechanism, which leads to a constriction. Among all mechanisms one can name the inhomogeneous heating of a neutral gas, which causes a decrease of the reduced electric field and a compression of the ionization sources. Inhomogeneous heating also leads to a decrease of the dissociation degree of molecular ions and to an increasing loss of charged particles in the radial direction due to the dissociative recombination, which either results in the plasma compression. Constriction may be also caused by an abrupt non-linear dependence of the ionization rate on the electron density. Depending on the discharge conditions (discharge current, pressure, gas type) one or another mechanism may dominate.
Current work presents the experimental study of the influence of the inhomogeneous gas heating on the formation of constricted positive column in neon and argon at intermediate pressures (pR=50-500 Torr cm). Discharge current, exceeding the critical value, was modulated by rectangular pulses of short duration to avoid the inhomogeneous gas heating. Temperature field of neutral atoms was determined using interferometry method basing on the Michelson interferometer. Fig. 1 gives an example of the interference pattern in the stationary constricted neon and ascending argon discharges during the heating of the neutral gas.
The heat equation, solved along with the Navier-Stokes equation, allowed describing the buoyancy effect in a constricted discharge in argon, which had not been previously done. It is shown that under described discharge conditions, in spite of the absence of inhomogeneous gas heating, discharge switches to the constricted regime in neon and argon. It can be concluded that at presented discharge conditions a nonlinear dependence of the ionization rate on the electron density is the basic mechanism of constriction.

References
[1] Ridenti M. A., de Amorim J., Dal Pino A., Guerra V. and Petrov G. M., Phys. Rev. E, Vol. 97, p. 13201 (2018)

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