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Impact of gas heating on an rf-plasma structure in a microcell at high pressure[1]

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In a micro-plasma confined in a small volume at atmospheric pressure, we may have to consider the influence of the local heating of feed gases on the inner plasma parameters, plasma production rate etc. A capacitively coupled micro-plasma in an axisymmetric two dimensional space is theoretically investigated in Ar driven at 13.56 MHz as a typical example. The governing equation of temperature in a gas phase and on a wall is joined with conventional system equations of electrons, ions and long-lived metastable molecules as well as the potential based on the relaxation continuum (rct) model. We first stress in the micro-plasma at atmospheric pressure that an electron with intermediate energy plays an important role in plasma production through stepwise ionization in the presence of high-density metastable having a low ionization threshold. A new sustaining mechanism in the rf-CCP will be demonstrated. That is, the rf micro-plasma is sustained in the instantaneous anode-phase of the powered electrode. Secondly we bring up the enhancement of the net ionization rate by high energy electrons through the increase of the local reduced field, E(r,t)/N(r), under the appearance of a broad minimum of the number density of the heated neutral gas. In the later part of the talk, we will discuss the historically development of the basic concept, reduced-field, employed in the field of collisional low temperature plasmas.

[1]Work done in collaboration with Masaki Yamasaki and Takashi Yagisawa, Faculty of Science and Technology, Keio University.