Influence of the Electrode Spacing on the Performance Characteristics of Inertial Electrostatic Confinement Fusion in Low Pressure Operation

Yasushi Yamamoto, Kazuyuki Noborio, Satoshi Konishi
Inst. of Advanced energy, Kyoto University, Gokasho Uji, Kyoto, 611-0011, Japan
y-yamamoto@iae.kyoto-u.ac.jp

To understand the phenomenon in an inertial electrostatic confinement fusion (IECF) device, we have been developing an 1-D particle simulation code including the atomic processes between the ion beam, the neutral beam, and background gases. Now, the characteristics of electrical discharge (voltage dependence on gas pressure et al.) and of the neutron generation in the experiments can be almost reproduced by the simulation. Moreover, it has been quantitatively clarified through these simulations that the loop of the neutralization by charge-exchange and re-ionization becomes predominant in the self-sustaining mechanism of IECF discharge when gas pressure is deceased less than 1 Pa. This result indicates that the mean-free-path of the reionization reaction influences the relation of the anode-cathode spacing and discharge pressure. On the other hand, it is understood from the calculation of the space distribution of the nuclear fusion reaction that the nuclear fusion reaction between energetic ions and background gas has the peak value near the cathode where electric field strength is strong.

In the on-going IECF experiments, further reduction of the operation pressure using external plasma sources is actively investigated to realize beam current accumulation by the ion reciprocation between electrodes which is one of key features of the IECF concept. In this case, the operation of IECF is no more self-sustained discharge mode, and the restriction of electrode spacing may be disappeared. Therefore, it is thought that increase of the electric field strength by shortening the distance between anode and cathode can promptly accelerate the ion, and the loss by the charge exchange in low energy can be decreased.

In this presentation, we examine the effects of the electrode spacing in the low gas pressure region (<0.1 Pa) on IECF operation characteristics and fusion reaction rate by the 1-D particle simulation.

References

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