One Dimensional Simulation of an Inertial Electrostatic Confinement Fusion at Low Gas Pressure Operation

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In order to find conditions which make it possible to obtain large output/input ratio in a Spherical Inertial Electrostatic Confinement Fusion (S-IECF), we have developed a one-dimensional simulation code which can be directly compared with experimental results, and have analyzed characteristics. In this study, we have examined “assisted glow discharge” in which ions are supplied by additional ion source to maintain discharge at low gas pressure.

We have developed a 1-D Particle in Cell code with Monte Carlo collision scheme. To simulate the IECF device, several special methods are required, (a) modeling of the cathode grid which has high transparency, (b) implementation of atomic and molecular processes to simulate deuterium gas operation, and (c) calculation of spatial distribution and amount of fusion reaction. Using this code, potential distribution, behavior of each particles and neutron production rate (NPR) can be calculated.

To simulate “assisted glow discharge”, calculation injecting D_2^+ from the position of the anode has been done. At low gas pressure (<0.5Pa), the discharge can not be sustained for lack of charged particle without ion source, and adding it enable self-maintaining discharge. Gas pressure (P), applied voltage (V) and discharge current (I) can be controlled independently by adjusting the ion current injected from the ion source (I_{assist}). Dependency on the P of the I and the NPR are calculated with constant I_{assist} and V_c. Simulation results show that at low gas pressure, (a) the frequency of collision between the beam particles and the background gas is reduced (b) energy loss of each ion is decreased, though the NPR does not increase because number of particle decrease. Comparing contribution to the NPR of each species and number of each species, it is found that D^+ is more reactive than D_2^+. Therefore when changing injected species to D^+, larger NPR is obtained. At low gas pressure, simulation result that most part of discharge current is occupied by secondary electron current (e.g. 80% at P = 0.2mTorr and V_c = 60kV) suggests that reduction of secondary electron emission coefficient is effective to improve the ratio of the output (NPR) to the input power, which is important to apply the IECF to practical use.

From these results, we consider that low gas pressure operation of IECF by adding external ion source is effective to improve the efficiency.