Three-dimensional electromagnetic particle simulations of a magnetron based on the real model

(Graduate School of Electrical and Electronic Engineering, Laboratory of Computer Simulation for Humanosperic Sciences, RISH, Kyoto University)

Yosuke Uranishi

Magnetron is a cylindrical diode which converts input DC to microwave at high efficiency and large capacity. It has a cathode in the center and an anode which covers the cathode with some internal resonance cavities. Each of the internal resonators opens out into the anode-cathode space. Electrons continuously emitted from the cathode interact with electromagnetic field(EM) in the anode-cathode space. The electron kinetic energy transferred to the microwave energy through the resonance.

It is very hard to analyze theoretically the electron resonance with the electromagnetic field in the internal space bounded by complex shaped conductors of magnetrons. In order to get higher efficiency and lower noise of magnetron, we first have to quantitatively understand the internal phenomena in magnetrons.

We have developed a three dimensional magnetron simulator using Particle In Cell(PIC) method. To simulate the electrons-EM field resonance in a real magnetron, we used the cartesian coordinate system so that we could model precisely the commercial magnetron named as 2M210M1F1 designed by Panasonic for microwave ovens. In the simulation, we obtained 2.64GHz self-oscillation microwave with efficiency of 73% ,which almost agrees with the real efficiency. This agreement assures that the developed simulator can quantitatively simulate the real magnetron behavior.

Next, to obtain the information of relationships between the internal structures of magnetorons and characteristics of output microwaves, we tested different shapes of cathodes and antennas. As a result, characteristics of output power and efficiency changed on some level.

Finally, we simulate the injection locking method that enables us to control the output phase and frequency of microwaves by injecting a reference microwave signal. As a result, We could successfully controll the output phase and frequency and observe the transient state of synchronisation.

Acknowledgements

Computation in the present study was performed with the KDK system of Research Institute for Sustainable Humanosphere (RISH) and Academic Center for Computing and Media Studies at Kyoto University as a collaborative research project.