Resonant sheath heating in magnetized Capacitively Coupled Plasmas

Quan-Zhi Zhang[1], Jing-Yu Sun[1], Wen-Qi Lu[1], Julian Schulze[1,2], Yuan-Hong Song[1], and You-Nian Wang[1]
[1]School of Physics, Dalian University of Technology, Dalian 116024, China
[2]Department of Electrical Engineering and Information Science, Ruhr-University Bochum, Germany
e-mail (speaker): qzzhang@dlut.edu.cn

Magnetically enhanced rf plasma sources are finding increasing interest for various applications, such as integrated circuits fabrication, biomedical treatment and greenhouse gas conversion. A transverse static magnetic field approximately parallel to the electrodes is usually applied with the goal of confining the electrons and increasing the plasma density at a given pressure. However, the fundamentals are not understood in many cases.

A new electron heating mechanism 'MRSR' based on a resonance is reported both theoretically and experimentally in magnetized capacitively coupled plasmas at low pressure (as seen in figure 1). The MRSR effect was qualitatively predicted by Lieberman et al. [1], and elaborated in this work based on a combination of kinetic particle simulation and experimental measurement. This effect strictly follows a resonance condition between the applied magnetic field and the driving frequency, which does not depend on the initial velocity of the electrons, which allows most of electrons near the sheaths to be affected. This effect is expected to be highly relevant to both fundamental and applied plasma science. In fact, it helps to understand the electron heating dynamics in low pressure magnetized rf capacitively coupled plasmas and may promote the industrial applications of magnetized low temperature plasmas in semiconductor fabrication.

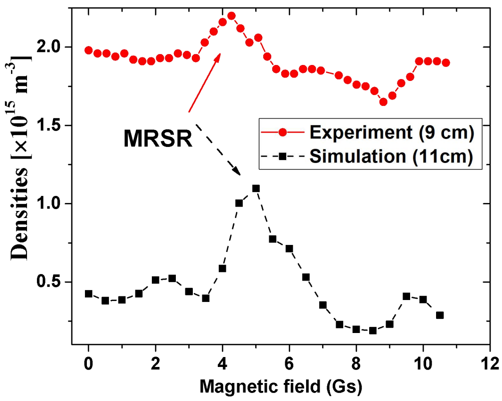

Figure 1. Space and time averaged plasma density as a function of the transverse magnetic fields at 27.12Mhz

References

[1] M.A. Lieberman, A.J. Lichtenberg, S.E. Savas, IEEE Transactions on Plasma Science 19, 189 (1991).