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Plasma-Wall Interaction in Presence of Intense Electron Emission from Walls[1]

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The plasma-surface interaction in presence of strong thermionic or secondary electron emission has been studied theoretically and experimentally both as a basic phenomenon and in relation to numerous plasma applications such as, for example, cathodes, emissive probes, divertor plasma, surface discharges, dusty plasmas, plasma thrusters and plasma processing. The electron flux to the wall is determined by the electron velocity distribution function (EVDF) and by the sheath potential, which is set by ambipolar condition consistent with the EVDF and the wall emitting properties. Nonlinear coupling between EVDF and sheath potential is responsible for a number of unusual phenomena. For example, we observed relaxation sheath oscillations [1]. We have shown that the criterion for instability is that the secondary electron emission coefficient of electrons with energy normal to the wall bordering the wall potential becomes larger than unity [1]. We observed new regime where all plasma electrons leave and are substituted by secondary electrons. In this regime, there is practically no electric field in plasma and sheath, so that ions are not drawn to the wall, plasma electrons are not confined and the plasma potential is negative. We also observed disappearance of plasma and sheath potential in case of collisionless plasma decay. Emitted electrons excite electron plasma waves due to the two-stream instability, which is, consequently, followed by the parametric instability and excitation of ion sound waves. Implications of these instabilities on collisionless electron heating are being studied for RF-DC combined system. Finally, methods to control plasma profiles with an auxiliary electrode in dc discharges are studied experimentally and making use of particle-in-cell simulations.

[1] M. D. Campanell et. al. PRL 108, 235001 (2012) and 255001 (2012).

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