KN1900

Towards 3-D visualization of the ground state atom dynamics in HiPIMS discharges

Nikolay Britun[1], Jaroslav Hnilica[2], Peter Klein[2], Petr Vasina[2], Matthieu Michiels[3], Rony Snyders[1]

[1]University of Mons, Mons, Belgium [2]Masaryk University, Brno, Czech Republic [3] Materia Nova, Mons, Belgium

nikolay.britun@umons.ac.be

The study is focused on the visualization of ground state atoms, both neutral and ionized, produced in high-power impulse magnetron sputtering (HiPIMS) discharges. The effects of the pulse energy as well as plasma-on and plasma-off time duration on the particle density evolution in the plasma volume have been studied in Ar-Ti case. For particle visualization laser-induced fluorescence (LIF) imaging combined with the data post-processing have been utilized. Additionally, the atom and ion number densities have been obtained using optical absorption spectroscopy. The time-resolved 2-D density distributions of the sputtered atoms and ions obtained by LIF imaging have been post-processed using self-developed MATLAB^{TM} code in order to elucidate the directivity of particle motion in various directions above the magnetron cathode.

The obtained results demonstrate that the plasma-on time duration mainly alters the ionization degree of sputtered Ti and, to a much lesser extent, the time evolution of its number density. At the same time, the plasma-off time mainly affects the number density of the atoms constantly present in the discharge volume. Moreover, time-resolved analysis of Ti ionization degree shows its dramatic decrease after the plasma pulse for more intense pulses (when higher power is applier during a shorter plasma-on time).

This study significantly clarifies sputtering dynamics of the ground state species in HiPIMS discharge, both qualitatively and quantitatively, showing a possibility to determine the atom and ion number density as well as the particle fluxes in the discharge at any moment of time. The obtained results should be of a great interest for the future optimization of HiPIMS processes, especially those related to multi-pulse operation.

Keywords
high-power magnetron sputtering
ground state atoms
laser-induced fluorescence
2-D imaging
plasma diagnostics