OR1502

Towards deeper understanding of a HiPIMS discharge by time-resolved optical plasma diagnostics

Nikolay Britun[1], Maria Palmucci[1], Stephanos Konstantinidis[1], Rony Snyders[1]

[1]Chimie des Interactions Plasma Surface, Mons, Belgium

nikolay.britun@umons.ac.be

As a promising sputter deposition technique, High Power Impulse Magnetron Sputtering (HiPIMS) requires an extensive time-resolve plasma characterization for which the non-intrusive optical plasma diagnostics methods are suitable. Our recent progress on time-resolved study of a HiPIMS discharge is presented. Optical Emission Spectroscopy (OES), Resonance Optical Absorption Spectroscopy (ROAS), and Laser-Induced Fluorescence (LIF) results are reported. The absolute densities of species, gas temperature T_g, velocity distribution of sputtered species, etc. were determined.

Results obtained during sputtering of Ti in Ar indicate the large differences in the absolute densities of Ti, Ti^+, Ti^{met} and Ar^{met}. Moreover, the arrival time of these species during the HiPIMS pulse is found to be different, which is accompanied by the population inversion of the ground and metastable states during the pulse. T_g of the thermalized species during the pulse is determined based on the rotational band analysis of N_2^+ (391.4 nm) assuming partial gas thermalization.

In addition, time-resolved study of the broadening of Ti spectral lines conducted by LIF indicates a rapid decrease of the broadening during the plasma off-time. After deconvolution with another valuable broadenings, it was assigned to rapid relaxation of the velocity distribution of sputtered species [1].

The obtained results bring the following time-resolved picture of HiPIMS discharge. During the pulse, Ti and Ti^+ species are produced keeping their ground state and metastable sublevels population inverted due to high gas excitation. This is following by an increase of Ti^{met} and finally Ar^{met} densities, which also reveal the sublevels inversion. At the same time, T_g is found to increase linearly during the pulse being proportional to the applied power. After HiPIMS pulse ends, the ballistically moving species rapidly dissipate their energy, and gas cools down to the room temperature.

[1] N. Britun, M. Palmucci, R.Snyders, Appl. Phys. Lett., 99 (2011) 131504

Keywords
HiPIMS
diagnostics
time-resolved