OR2302

**Time resolved tunable diode-laser induced fluorescence measurements of titanium neutral atoms sputtered in reactive Ar/N2 HiPIMS discharge**

Abderzak EL FARSY, Ludovic DE POUCQUES, Jordan LEDIG, Jamal BOUGDIRA

Institut Jean Lamour, Nancy, France

abderzak.el-farsy@univ-lorraine.fr

This work is dedicated to study the transport behavior of the Ti neutral atoms sputtered in reactive high power impulse magnetron sputtering (R-HiPIMS) device used for TiN coating deposition which is interesting in many industrial applications. Time resolved tunable diode-laser induced fluorescence TR-TDLIF ($\lambda_0$=398.17 nm) measurements were performed to probe the atoms velocity distribution functions. Several parameters such as pressure, target-probe volume distance and gas mixture ($Ar/N_2$) have been investigated, at fixed discharge power (350 $W.cm^{-2}$) and discharge time ($T_d$=10 µs, f=1 kHz). It was found that the TR-TDLIF signal has to be fitted using three Gaussian distributions. They correspond to the energetic (EN), thermalized (TH) and quasi-thermalized ($TH_{GV}$ : TH atoms with a group velocity) atoms populations. From the fitting, deposited fluxes and energies were estimated and in order to obtain local quantitative measurements, the TR-TDLIF signal was calibrated using laser absorption spectroscopy. The measurements, performed at 20 mTorr and 3 cm from the target, indicate that the metallic Ti target undergo a strong nitridation process (transition from metallic mode to compound mode) after inserting only 1% of $N_2$ in the gas mixture. This is inferred from the reduction of the impulse flux values of EN, TH and $TH_{GV}$ sputtered atoms that have been found to be respectively 1, 2 and 0.6 ($*10^9$ $.part.cm^{-2}$) in the case of 1% $N_2$ compared to the corresponding values 4.3, 8.5 and 2.5 ($*10^9.part.cm^{-2}$) in the case of pure Ar. From the energy point of view, at 5 mTorr and 5 cm, it was detected that the mean energies of EN and $TH_{GV}$ atoms decrease drastically in the temporal post-discharge from 8.5 eV and 0.5 eV to 1 eV and 0.2 eV, respectively. Furthermore, the TiN coatings have been analyzed by several means (like SEM, XRD and EDS) and correlations with the TR-TDLIF results have been investigated in order to understand the underline physics of sputtering and atoms transport behaviors, and to study their influences on TiN coating properties. In the same line, a comparative study with reactive direct current magnetron sputtering process (R-dcMS) has been performed.

**Keywords**
HiPIMS, Reactive sputtering (Nitrogen), LIF, Diode laser