Diagnostics of an argon/oxygen magnetron plasma and comparison with Monte Carlo simulation

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A sputter deposition process is a rather complex mechanism, specially in a reactive gas mixture. To understand it properly, it is necessary to separate the different part involved, i.e., the sputtering, the plasma chemistry, the growth of deposited layers... Our work is related to the plasma itself: what kind of chemistry, which influence of the experimental conditions and which relationship does exist between the flux/energy/angular distribution of heavy particles and the homogeneity/charateristics of the growing film. For this study, we have analysed the plasma with two powerful diagnostic tools, a Langmuir probe and a mass spectrometer. The experimental conditions are chosen as the conditions for real deposition. The results of these experiments will be compared with numerical simulation results. For this purpose, we are developing a 3D simulation code whose aim is to give as output the chemistry and flux/energy/angular distribution of heavy particles. The first part of this code is based on the Monte Carlo technique to follow the emitted secondary electrons in front of the cathode and throughout the plasma. The chemistry of the plasma is obtained through the simulation of the collisions encountered by the electrons until they are lost on the walls. The magnetic field has been simulated in 3D and compared with the real one (experimentally measured). The simulations are performed for a reactive environment of argon and oxygen. The main assumption up to now is a fixed electric field throughout the whole simulation, obtained from a particle-in-cell code, developed earlier in the group [1]. This simulation allows to obtain the electron velocity distribution function and the ionization and excitation rates. These results are compared with those obtained by the PIC-MC code mentioned above. The geometry under investigation is a unique magnetron cylindrical planar source, although the goal of the project is to implement soon a flexible geometry allowing complex deposition with two magnetron sources working together. Within this project, the balance equations for every plasma species and another Monte Carlo module for the heavy particles will also be developed in order to obtain the energy and angular distribution functions for heavy particles and their fluxes towards the substrate.

[1] I. Kolev, A. Bogaerts, R. Gijbels, Influence of the electron recapture by the target on the discharge characteristics in dc planar magnetrons, Physical Review E 72, (2005) 05642