PO3043

Transport and Ion Energy Distributions in Magnetron Sputtering

Jan Trieschmann, Sara Gallian, Dennis Krüger, Frederik Schmidt, Ralf Peter Brinkmann, Thomas Mussenbrock

Ruhr University Bochum, Bochum, Germany

jan.trieschmann@rub.de

Within the various types of sputtering discharges, the transport of sputtered particles is one of the most prominent aspects governing the properties of the deposited thin films. In radio frequency sputtering the main contribution to the film growth stems from low energetic neutral particles (more energetic than the thermal background). In contrast, for magnetically enhanced discharges (e.g., High Power Impulse Magnetron Sputtering, HiPIMS) a significant contribution is due to ionized species. As proposed for example in [1,2], the peculiar spatial profile of the electric potential (which may include a distinct potential 'hump') plays a crucial role in determining their energy distribution at the surfaces. In particular at the substrate, pronounced groups of low, mid and high energy ions emerge. In this work the transport of (initially neutral) sputtered aluminum particles is investigated by means of Monte-Carlo simulations. Depending on the influence of the sputtered species on the process gas (argon), the simulations are classified: (i) when negligible, the transport is simulated using the Test Multi-Particle Method assuming a stationary argon background; (ii) when of importance, the simulation is performed using the Direct Simulation Monte-Carlo method, consistently taking into account the argon process gas (e.g., its rarefaction). In both cases ionization is included in terms of an imposed ionization rate profile. Ions are moreover subject to an again imposed profile of the electric potential. Both of which profiles are estimated on the basis of experimental observations [3] and applied to a one-dimensional exemplary model of a stationary magnetized discharge. It is validated that indeed a 'hump' in the electric potential does give rise to characteristically separated low and high energy groups in the ion energy distribution at the substrate.

This work is supported by the German Research Foundation (DFG) in the frame of the transregional collaborative research centre SFB-TR 87.

[1] A. Anders et al., Appl. Phys. Lett.103, 144103 (2013)
[2] C. Maszl et al., J. Phys. D: Appl. Phys. 47, 224002 (2014)
[3] A. Hecimovic, private communications (2016)

Keywords
HiPIMS
Simulation