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HIPIMS: A plasma surface interaction model

Ralf Peter Brinkmann[1], Dennis Krüger[1], Denis Eremin[1], Tobias Gergs[1], Thomas Mussenbrock[2], Jan Trieschmann[2]

[1]Ruhr-Universität Bochum, Bochum, Germany [2]BTU Cottbus-Senftenberg, Cottbus, Germany

ralf-peter.brinkmann@tet.rub.de

High Power Impulse Magnetron Sputtering (HIPIMS), also known as High Power Pulsed Magnetron (HPPMS), is a physical vapor deposition (PVD) technique which utilizes magnetron discharges of extremely high power (kW/cm^2) in short pulses (100 µs). Compared to conventional magnetron sputtering, HIPIMS is capable of generating films of high density and advantageous microscopic morphology. This capability is generally attributed to the fact that in HIPIMS the critical figure of merit of PVD processes, the average energy per deposited atom, is nearly a factor of ten higher than in other deposition processes [Anders 2009]. This contribution will focus on HIPIMS modeling work conducted within the Colloborative Research Center SFB-TR 87. A plasma surface interaction model is presented which results from coupling two electron models, a heavy species model, and a surface model. The first electron model follows the energetic electrons (which emerge as secondaries from the cathode) by means of a Monte Carlo simulation; the second electron model accounts for the thermalized plasma electrons with the help of kinetic theory. The assumptions underlying the models are via comparison with Particle-in-Cell (PIC) simulations. The heavy species model describes ions and neutrals using a Direct Simulation Monte Carlo method (DSMC). The surface processes are analyzed by means of Classical Molecular Dynamics (CMD). The relevance of this plasma surface interaction model to the simulation of HiPIMS discharges [Gallian et al. 2015] and to the interpretation of recent experimental findings [Hecimovic et al., 2017] is discussed.
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