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3D modelling of bipolar magnetron sputtering plasma discharges

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Dual rotatable magnetron sputtering sources are state of the art in large area coating technology and are nowadays also being used for deposition of precision interference coatings. For the latter, a precise uniformity control on flat as well as on curved moving substrates is mandatory. The design of optimized deposition setups including uniformity masks and specialized substrate holders usually requires time consuming experimental iterations. Thus, a simulation tool capable of predicting the film thickness distribution and optimizing the geometrical setup is desirable.

Based on known erosion profiles on the sputter targets, the angularly resolved particle flux profile close to the substrate can be obtained via Direct Simulation Monte Carlo (DSMC) method. This enables subsequent computation of the film thickness profile on curved substrates in different positions. However, in a bipolar pulse magnetron discharge a uniform plasma density distribution cannot always be presumed and a proper determination of the sputter erosion profiles is not trivial.

In order to get a more detailed picture on possible plasma non-uniformities in dual cylindrical magnetron discharges, we present 3D Particle-in-Cell Monte-Carlo (PIC-MC) simulations of the plasma discharge in Argon. Due to numerical constraints, the PIC-MC simulations are performed at lower plasma density compared to real discharges but nevertheless represent the relative plasma density profile in a reasonable approximation. The impact of different parameters such as total pressure, magnet tilting angle and electrical pulse shape on the plasma distribution is shown, and the results are compared with experimental findings.

Keywords
plasma modelling
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bipolar pulsing