OR2304

Detailed numerical study of an Ar/O2 magnetron discharge with a hybrid model.

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Nowadays, magnetron sputter deposition has become the established technique of choice for the deposition of a large variety of industrially important thin metallic or compound films. To manufacture an oxide film, an argon/oxygen plasma is created for a process called "reactive sputter deposition" [1].
To study the processes in the Ar/O_2 discharge, we apply numerical modeling: a broad range of possible output values and reachable locations inside the reactor can be obtained. Different kinds of models to simulate gas discharges are subdivided into analytical, continuum and particle models, and hybrid models comprise combinations of these aforementioned models. Dependent on the type of discharge, the desired accuracy and computation time, the most optimal model can be chosen.
We developed a hybrid model: the fast electrons are described with the Monte Carlo (MC) method, whereas ions and neutrals are described with balance equations. In order to limit the computation time, this model is non self-consistent. This implies that the electric field is not recalculated in each time step from the charged particle density, but is given as input in the simulation. These considerations shorten the computation time tremendously, in comparison to a fully self-consistent particle treatment, such as a particle-in-cell/Monte Carlo collisions (PIC/MCC) model. However, the PIC/MCC model is more exact, since all the species are followed individually in their movement in the magnetic field and in the self-consistently calculated electric field [2-4].
With this hybrid model, density distributions, fluxes and reaction rates are calculated. The hybrid model is tested by comparing with the results obtained with a PIC/MCC model [3,4]. The advantage of the short calculation time of the developed hybrid model enables it to be used for larger and more complicated geometries, such as industrial and dual magnetron setups.
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Keywords
magnetron discharge
plasma simulation
hybrid model