SIMULATION OF PLASMA TREATMENT OF UNEVEN SUBSTRATES IN MAGNETIC FIELD

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Plasma-assisted technologies are widely used techniques for material treatment. The unevenness of treated substrates can cause problems in case when the active particles in plasma do not reach the whole surface. The presence of external magnetic field changes the behavior of plasma and therefore, the efficiency of the treatment can alter too. Besides the magnetic field, the motion of charged particles is influenced by several other factors as plasma pressure, substrate bias, etc. The theoretical prediction of the treating process is difficult especially when the active plasma species are reactive. Such problems can be effectively analyzed by computer simulations. Despite of their time requirements, the particle models provide us with the most detailed output information including particle fluxes to the substrate, their energy and angular distributions, spatial distributions of electrostatic potential, number densities of charged species, etc.

In our two-dimensional simulation we used a hybrid particle approach which combines the deterministic method of molecular dynamics with stochastic Monte Carlo method for generation of collisions. The motion of charged particles in electric field is computed by the Particle in Cell method based on the sparse system solver UMFPACK\(^1\) and the effect of magnetic field is added using the “Half acceleration – rotation – half acceleration” method\(^2\). The simulation is based on our previous publication\(^3\).

The aim of our research was to find the particle fluxes from chemically active mixture of argon and oxygen plasmas to the substrate with a rectangular-shaped groove. Among other parameters, we determined the depth which the plasma was able to reach, depending on the groove dimensions and magnetic field. Some of the results were validated using a fully three-dimensional fluid-particle hybrid simulation.


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