PO4098

Detailed study of plasma-substrate interaction in plasma-assisted technologies

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The low-temperature plasmas are used in many technological applications, therefore the detailed description and understanding of physical and chemical processes taking part during plasma-solid interaction is very desirable. While the theoretical study is usually limited to simplified substrate geometries, the computer simulation proved to be a suitable tool for the study of plasma properties near the immersed substrates with realistic surfaces.

In order to analyse the plasma behaviour near uneven substrates, a hybrid computer model created by the combination of multidimensional fluid modelling and particle simulation approach was used. The fluid and particle parts of the hybrid model were connected by iterative process and the basic scattering processes were included into both parts of the model. The fluid technique was used for the determination of spatial distribution of electric potential near the substrate. The particle simulation technique was used first to calculate the local values of electron energy distribution function and subsequently to obtain various parameters of fluid model as mobility and diffusion coefficients, rate constants of interactions with neutrals, etc. When the whole iterative process stabilised, the non self-consistent simulation was used for the determination of resulting plasma properties near the immersed substrate.

The used three-dimensional hybrid computer model enabled us to study in detail the plasma properties near realistic metal substrates with complex geometries or with perturbations on both macroscopic and microscopic spatial scales. The main attention was devoted to the sheath structure, local perturbed electric fields and both energy and angular distributions of charged particles striking substrates and their influence on various plasma-assisted technologies as plasma immersion ion implantation or plasma etching.

Keywords
plasma-substrate interaction
uneven substrate
hybrid modelling