Material Processing in Chemically Active Plasmas

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Detailed description of physico-chemical processes taking place during the interaction of plasma with a material surface is rather difficult, especially at higher pressures and/or in chemically active plasmas, and thus a combination of experimental and computational approaches seems to be very convenient.

As a basis for our computational study, the experimental data obtained in the positive column of dc glow discharge in oxygen, both pure and in the mixture with argon, were used. The measurements were performed at low and medium pressures ranging from 67 Pa till about 800 Pa. The probe and optical diagnostics were applied and basic plasma parameters were measured.

The following computer experiment based on two different techniques of computational physics was used. First, the particle simulation approach based on a self-consistent PIC-MCC technique, was used for study of interaction between low-temperature multicomponent plasma and the surface immersed. As input we used concentrations of basic charged species obtained from our following model.

The macroscopic kinetic approach was then chosen for the study of chemical processes in the chemically active plasma. The kinetic scheme contained more than one hundred reactions between neutral, charged and excited species in oxygen and argon. The chemical reactions and the corresponding rate constants were obtained both from the literature and from own calculations with the help of ELENDIF program. The time dependencies of concentrations of the neutral, excited and charged species were obtained for various discharge parameters from our computer model of volume processes in a dc glow discharge in the Ar/O2 mixture.

The properties of multicomponent plasma near the surfaces of immersed materials to be processed were studied. The potential distributions in the sheath and presheath were calculated and concentrations of all kinds of charged particles were determined in the dependence on plasma parameters, especially on plasma pressure.

Keywords
computer model
plasma - surface interaction
oxygen/argon plasma