The Chemical Elemental Demixing in the Simulation of Air Plasma and CO_2 Plasma Flows in the Inductive Plasmatron Chamber

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The effect of diffusive chemical elemental demixing due to differences in diffusive properties of chemical species was first discovered and studied in the analysis of air mixture flow in a multicomponent boundary layer near the stagnation point on a catalytic wall [1, 2].

Numerical simulation of induction air plasma and CO_2 plasma in the inductive plasmatron chamber has demonstrated chemical elemental demixing due to the differences in rates of chemical reactions of atoms dissociation and recombination and due to the difference in diffusion rates for atomic and molecular species of the mixture.

The Navier-Stokes equations for the 100-kW IPG-4 facility (IPM RAS) conditions were used in the numerical simulation of the flows in the plasmatron chamber. The Stephan-Maxwell relations were taken for the diffusion model. It was obtained, that chemical elemental demixing does not occur while the coefficients of binary diffusion are the same for all the species of the atomic-molecular mixture.

The demixing effect is observed in the vicinities of the internal stagnation points, in the regions of axis of symmetry and walls of the chamber. Oxygen accumulation near the chamber axis of symmetry leads to the increase of this element concentration in the plasma jet. If this jet is further used in experiments on body hypersonic airflows, the effect mentioned may cause the intensive oxidation of sample surface. This fact must be taken into account, when the inductive plasmatrons are used in experimental studies of heat exchange under hypersonic flow conditions.

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