PLASMA PARAMETERS NEAR THE CATHODE OF A PLASMA PHOTOELECTRIC CONVERTER

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The most important technical applications of nonideal plasma relate to energy transformation [1]. It was previously shown that gas parameter values of 0.6 can be achieved in photoresonant plasma of alkali metal vapors under conditions of saturation of the resonant transition [2].

In this work, we analyze the parameters of nonequilibrium plasma arising near the cathode wall of a plasma photoelectric converter of focused solar radiation [3]. The equations for the balance of temperatures of electrons, heavy particles and the concentration of charged particles in the plasma of sodium vapor in the pressure range 10^4–10^5 Pa are considered. The model takes into account the removal of energy due to the thermal conductivity of electrons into the ionization layer, the exchange of energy between the heavy component and electrons, the release of energy during plasma-chemical reactions involving excited sodium atoms and molecular sodium ions.

The work shows that in the near-wall regions, the transfer of radiation from the central regions of the thermal plasma provides a high concentration of excited sodium atoms Na(3P), the relative population of which is characterized by the excitation temperature T^*=4500 K. The main mechanism for the formation of charged particles is associative ionization with the participation of excited atoms sodium Na(3P). The electron temperature takes the value Te=2500 K in the resulting chemically nonequilibrium plasma, the electron concentration and conductivity in the near-wall regions significantly exceed the equilibrium values. The plasma parameter reaches values realized in photoresonant plasma. The ionization flux is approximately equal to the heat flux removed to the wall due to the thermal conductivity of the neutral gas. The heat flow provides the necessary rate of thermal emission from the cathode surface, which increases the magnitude of the short circuit current. The predicted plasma parameters are favorable for achieving high direct photovoltaic conversion efficiency.

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