ELECTRON DENSITY MEASUREMENTS IN SUPERSONIC FLOWING DISCHARGES*

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Local measurements of the electron density in high pressure discharges have commonly been performed through use of an electrical probe, such as a Langmuir probe, or by the Stark broadening of the hydrogen lines. However in supersonic flowing discharges electrical probes can cause shocks to form, which is unwanted. In addition, these types of discharges do not often contain the hydrogen needed to determine the electron density through Stark broadening where the measurements are hampered by the lack of intensity and breadth of the hydrogen Balmer lines. An alternative approach is to use the intensity of the rotational bands of the N_2 second positive system. We performed detailed measurements of the population densities of the N_2 $C^3\Pi_u$-$B^3\Pi_g$ system and the hydrogen Balmer lines in a supersonic flow of weakly ionized Ar/H_2/Air. Gases were premixed in the stagnation chamber at room temperature by adding up to 10% hydrogen and up to 45% air to pure argon. A cylindrical cavity was used to sustain a discharge in the pressure range of 100-700 Pa. Absolute emission spectroscopy was used to determine the gas temperature in the flow from the N_2 system. Comparison was made between the results obtained from the N_2 band intensity technique and Stark broadening of the hydrogen Balmer lines. The difference between line broadening technique and the nitrogen band absolute intensity technique is found to be by a factor of two to three.

The nitrogen band intensity method was also applied to the supersonic flowing discharge in Martian stimulant air (CO_2, N_2, Ar). The results show the electron density values lower by more than order of magnitude compared to the Ar/H_2/air mixtures, consistent with the EEDF calculations.

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