EXPERIMENTAL AND KINETIC STUDY OF THE MARTIAN ATMOSPHERIC ENTRY PLASMA*

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In this paper we discuss the properties of the hot, ionized gas behind the bow shock during the Martian descent and/or aerobraking mostly from the perspective the system being a plasma reactor that processes large volume of the dilute atmospheric weakly ionized gas in the freestream. It becomes compressed, heated, and ionized in the shock layer. There are a few concepts of small subsystems that could be used to harvest a part of the kinetic energy converted during the entry or aerobraking phase, or to redistribute the heat flux, thereby acting as a thermal protection system.

We describe the results of a kinetic model created based on free stream gas temperature, density, and velocity data from the Viking, Pathfinder, and MER Opportunity Landers. Altitudinal distribution of atmospheric composition was taken from Viking data. The density and temperature across the shock front were calculated for each probe. A temperature spread was observed due to the imprecision in the atmospheric models and data for the free stream temperature. Conditions in Mars ionosphere provide seeding electrons, which contribute to the formation of the ionizing wave in Martian atmospheric entry plasma (MAEP). Electron energy distribution function was calculated for the Martian atmosphere by solving the Boltzmann transport equation. For atmospheric gas mixtures, electron temperature and dissociation rate coefficients were then calculated. The electron density was determined from the Saha equation for a simple model with the main species for the ionized gas. A gas composition model was then used to estimate the dissociation of CO_2 in the Martian atmosphere for steady state and non-steady state conditions and a comparison was made. All this triggers many ideas for subsystems utilizing MAEP as plasma reactor.

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