Abstract Submitted
for the GEC06 Meeting of
The American Physical Society

Experimental and spectroscopic study of flow actuation phenomena using DC discharge at a Mach 3 flow. J. SHIN, V. NARAYANASWAMY, L. RAJA, N. CLEMENS — A study of flow actuation phenomena of DC discharge will be presented. An array of pin-like electrodes is flush mounted on a co-planar ceramic actuator that is inserted in the test section. The different discharge structures – diffuse, constricted, and mixed mode – are observed in the presence of a flow. A discernable actuation, as visualized by schlieren imaging, is achieved by diffuse discharge, whereas the constricted discharge does not show detectable flow perturbation at the same current. The flow actuation in the form of an induced oblique shock occurs within one frame of laser schlieren imaging at 4.5 kHz. Rotational (gas) and vibrational temperatures are measured by fitting spectra of N2 and N2+ bands near 365-395 nm. Electronic temperatures are measured using Boltzmann plot of Fe (I) lines. Gas temperatures of diffuse discharges drop from ∼1500 K to ∼500 K in the presence of a flow while vibrational and electronic temperatures remain almost the same at ∼3000 K and ∼1.25 eV, respectively. Gas temperatures of constricted discharge are found to be similar with diffuse discharge whereas only diffuse discharge shows an actuation. An examination of spatial extent of the plasma reveals that the diffuse discharge occupies a larger region of the flow than the constricted discharge. This indicates that the flow actuation is dependent on flow dilatation which is governed by temperature rise as well as the spatial extent over which the temperature rise is observed.

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Date submitted: 14 Jun 2006 Electronic form version 1.4