Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

**Chemistry-Vibration Coupling in $CO_2$ system for High Enthalpy Nozzle Flows** SRIRAM DORAISWAMY, University of Minnesota - Twin Cities, DANIEL KELLEY, University of Missouri -St. Louis, GRAHAM CANDLER, University of Minnesota - Twin Cities — The present work investigates the complex process of vibrational relaxation and its subsequent coupling with the chemical processes in high enthalpy nozzle flows. High enthalpy $CO_2$ nozzle expansion in reflected shock tunnels shows significant difference in shock standoff distance between computational and experimental results. $CO_2$ being a linear triatomic molecule has three modes of vibration - bending, symmetric stretch and antisymmetric stretch modes. To better model the vibrational relaxation, the bending and the symmetric stretch modes were coupled into one mode due the fact that these modes are strongly coupled through Fermi resonance. Furthermore, to simplify the analysis, this coupled mode was assumed to be in equilibrium with the translational mode. For the $CO_2$ only the antisymmetric mode is considered. A vibrational state-specific model was devised by considering the first few vibrational states of the diatomic species in a $CO_2$ system, i.e. $CO_2$, CO and $O_2$. The rate constants for the vibrational relaxation processes were obtained from experimental data. This vibrational model is then coupled with a chemistry model to run the full flowfield nozzle simulation, and also to obtain the shock standoff distance.

Sriram Doraiswamy
Univerisity of Minnesota

Date submitted: 07 Aug 2009 Electronic form version 1.4