Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Vibrational excitation for Argon-Nitrogen mixed gaseous thermal plasma SAHADEV PRADHAN, A. K. KALBURGI, Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai-400085, India. — The main objective of the present work is to investigate the vibrational excitation for Argon-Nitrogen mixed gaseous thermal plasma using Direct Simulation Monte Carlo (DSMC) simulations. Here, the harmonic oscillator model is applied to the vibrational mode with the characteristic vibrational temperature θ_v =3371 K corresponding to Nitrogen molecules, and vibrational excitation is integrated with the rotational excitation. It is assumed that there is only one vibrational mode associated with each diatomic Nitrogen molecule. The DSMC simulations are carried out for temperature dependent vibrational relaxation collision number $Z_v = (C_1/T^?)\ exp\ (C_2 T^{-1/3})$with the constants $C_1 = 9.1$ and $C_2 = 220,$ and for rotational relaxation collision number $Z_r = 7.5$ associated with the Nitrogen molecule with viscosity temperature index ? = *0.75* (VHS model), ? = *1.0* (Maxwell model), and ? = *0.5* (HS model). An important finding is that the rotational mode comes to the equilibrium value with the translational mode very quickly. However, the vibrational relaxation slows as the temperature decreases The DSMC simulation result ensures that the collisiontemperaturedependent vibration rate is consistent with the principle of detailed balance. The vibrational distribution function sampled in the DSMC simulations is in excellent agreement (error within 2%) with the Boltzmann distribution.

Sahadev Pradhan
Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai-400085, India.

Date submitted: 14 Aug 2020 Electronic form version 1.4