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Direct Numerical Simulation Study of Thermochemical Nonequilibrium Effect on Mixing and Combustion ROMAIN FIEVET, STEPHEN VOELKEL, HEESEOK KOO, VENKAT RAMAN, PHILIP VARGHESE, The University of Texas at Austin — Nonequilibrium of internal states of molecules is an important physical phenomenon that could affect flow behavior in supersonic flows. Translational nonequilibrium, where molecular velocities do not conform to the Maxwell distribution could impact dissipation processes in turbulence. Similarly, vibrational and/or rotational nonequilibrium will lead to marked changes in mixing and combustion. In this study, these nonequilibrium effects are explored using direct numerical simulation of a supersonic hydrogen jet issuing into a coflow of air. Nonequilibrium reaction rates derived using detailed computational chemistry methods are used in the flow simulations. It is shown that underpopulation of vibrational states leads to significant change in flame stabilization. Hence, the processing of the incoming air by the bow shocks formed ahead of a scramjet could lead to significant ignition delay.

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