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Two-Stage Energy Thermalization Mechanism in Nanosecond Pulse Discharges in Air and Hydrogen-Air Mixtures IVAN SHKURENKOV, SUZANNE LANIER, IGOR ADAMOVICH, WALTER LEMPERT, The Ohio State University — Time-resolved and spatially resolved rotational temperature measurements in air and H2-air, by purely rotational Coherent Anti-Stokes Raman Spectroscopy (CARS), are presented. The experimental results demonstrate high accuracy of pure rotational psec CARS for thermometry measurements at low partial pressures of oxygen in nonequilibrium plasmas. The results are compared with modeling calculations using a state-specific master equation kinetic model of reacting hydrogen-air plasmas, showing good agreement. The results demonstrate that energy thermalization and temperature rise in these plasmas occur in two stages, (i) "rapid" heating, occurring on the time scale $\tau_{rapid} \sim$ 0.1-1 μs·atm, caused by collisional quenching of excited electronic states of N_2 molecules by O_2, and (ii) "slow" heating, on the time scale $\tau_{slow} \sim$ 10-100 μs·atm, caused primarily by N_2 vibrational relaxation by O atoms (in air) and by chemical energy release during partial oxidation of hydrogen (in H_2-air. Both energy thermalization mechanisms have major implications for plasma assisted combustion and plasma flow control.

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