The following article "Hyperthermal Atomic Oxygen Source for Near-space Simulation Experiments" appeared in Review of Scientific Instruments 80, 093104 (2009) and may be found at: http://rsi.aip.org/search

Abstract

A hyperthermal atomic oxygen (AO) beam facility has been developed to investigate the collisions of high-velocity AO atoms with vapor-phase counterflow. Application of 4.5-kW, 2.4-GHz microwave power in the source chamber creates a continuous discharge in flowing O_2 gas. The O_2 feed stock is introduced into the source chamber in a vortex flow to constrain the plasma to the center region, with the chamber geometry promoting resonant excitation of the TM_{011} mode to localize the energy deposition in the vicinity of the AlN expansion nozzle. The approximately 3500-K environment serves to dissociate the O_2, resulting in an effluent consisting of 40% AO by number density. Downstream of the nozzle, a SiC skimmer selects the center portion of the discharge effluent, prior to the expansion reaching the first shock front and rethermalizing, creating a beam with a derived 2.5 km s^{-1} velocity. Differential pumping of the skimmer chamber, an optional intermediate chamber, and reaction chamber maintains a reaction chamber pressure in the mid-10^{-6} to mid-10^{-5} Torr range. The beam has been characterized with regard to total AO beam flux, O_2 dissociation fraction, and AO spatial profile using time-of-flight mass spectrometric and Kapton-H erosion measurements. A series of reactions AO + C_2H_{2n} (n = 2-4) has been studied under single-collision conditions using mass spectrometric product detection, and at higher background pressure detecting dispersed IR emissions from primary and secondary products using a step-scan Michelson interferometer. In a more recent AO crossed-beam experiment, number densities and predicted IR emission intensities have been modeled using the direct simulation Monte Carlo (DSMC) technique. The results have been used to guide the experimental conditions. IR emission intensity predictions are compared to detected signal levels to estimate absolute reaction cross sections.