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ISOLATING EXCITED NITROUS OXIDE ENERGY STATES TO ENHANCE DISSOCIATION

Abstract

There have been numerous experiments focusing on the use of nitrous oxide as a propellant because of its exothermic dissociation properties, its classification as a non-toxic chemical (green monopropellant), its ability to remain stable under normal conditions, and its ability to be stored in space. The dissociation of nitrous oxide results in individual N2 and O molecules, but due to the high reactivity of oxygen molecules, they re-combine to form O2. This releases thermal energy that can be converted into kinetic energy using an expansion nozzle, and initiate self-sustained dissociation. Research conducted in the Space Power and Propulsion Laboratory (SPPL) at the University of Maryland, College Park focuses on the use of nitrous oxide in developing a green propellant station-keeping thruster using a dielectric barrier discharge (DBD). The DBD was used as an alternative to catalysts, thereby removing materialistic limitations due to high temperatures. In order to minimize the power input of DBD system, the hypothesis is to push nitrous oxide into an excited state as opposed to direct ionization. The ionization energy for nitrous oxide is approximately 12.8 eV. Therefore, the system needs to successfully dissociate nitrous oxide at energy levels below the ionization energy. Two common excited nitrous oxide energy levels at rest at 8.5 eV and 9.6 eV. Furthermore, various dissociation paths resulting excited-state products have also been identified. A field electron emission (FEE) system will be built to create a mono-energetic beam of electrons based on specific energy levels to test these dissociative paths. An emission spectroscopy system involving a fiber optic cable connected to a spectrograph will be used to provide identify various excited species present in the system. Identifying emission lines correlating to nitrous oxide vs. oxygen/nitrogen emission lines will confirm if dissociation is occurring at the certain energy level. A minimum power state correlating to the highest dissociation rate with the least amount of nitrous oxide ionization can then be confirmed. This state might refer to a parent nitrous oxide excited state that is lower than the ones stated above. Using the emission-spectroscopy system as a guideline, the DBD system will be calibrated to the minimum power setting found above. Comparing results between DBD and FEE systems will present cases for which power system will isolate power input into nitrous oxide dissociation. This will help reach self-sustained dissociation at much lower power levels.