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OPTICAL DIAGNOSTICS FOR CHARACTERIZATION OF HYPERGOLIC IGNITION IN A PARAFFIN-BASED HYBRID ROCKET

Abstract

Recent progress in the investigation of hypergolic ignition for in-space propulsion has shown the potential of analytical reagent grade nitric acid (69.3% concentration) and lithium aluminum hydride (LAH) as oxidizer and fuel, respectively;[1,2,3] the latter being leveraged as both a dopant to paraffin wax and as the fuel itself. That body of previous work has shown surprising repeatability of LAH/nitric acid ignition delay times over a wide range of pressures from strong vacuum to over 20 atm and resulted in ignition delays on par with the state-of-the-art for hydrazine/NTO. High-speed imaging has helped elucidate some of the steps involved in the chemical reaction of LAH and nitric acid, but a more detailed study is now underway to better understand the ignition process.

The current study leverages emission spectroscopy and high-speed imaging (1200 fps) to determine the presence of specific intermediate and product species which are involved in the ignition process. Two types of tests are conducted with pure LAH and nitric acid: (1) high-pressure tests which yield sub-10 ms ignition delays and exhibit state-of-the-art performance and (2) low-pressure tests which are characterized by lengthy ignition delays, which are deliberately chosen as such to provide more insight into the ignition process. In the past,[1] lengthy ignition delay testing has shown that ignition generally begins with the ejection of hot solid particles from the fuel sample into an ignitable gas mixture above the sample, but spectroscopy will assist in determining the chemical makeup of the ejecta and gas phase mixture and yield evidence of the chemistry prior to particle ejection.

References

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