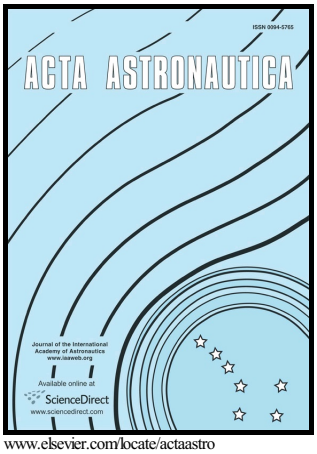

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Synthesis and Testing of Hypergolic Ionic Liquids for Chemical Propulsion

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Abstract

Synthesis of new highly energetic ionic liquids (ILs) is described, and their hypergolic ignition properties are tested. The synthesized ILs combine the advantages of conventional rocket propellants with the energy characteristics of acetylene derivatives. To this end, N-alkylated imidazoles (alkyl = ethyl, butyl) have been synthesized and alkylated with propargyl bromide. The desired ionic liquids have been produced by metathesis using Ag dicyanamide. Modified hypergolic drop tests with white fuming nitric acid have been performed for N-ethyl (IL-1) and N-butyl propargylimidazolium (IL-2) ionic liquids. In the modified drop tests, high-speed shadowgraph imaging is used to visualize the process, and the temperature rise due to ignition is monitored with a two-color photodetector. It is shown that the ignition delay is shorter for IL-1 as compared to IL-2. The ignition of IL-1 occurs in two stages, whereas the combustion of IL-2 proceeds smoothly without secondary flashes.

Keywords:
Ionic liquid
Hypergolicity
Ignition
Propulsion

Introduction

Energetic ionic liquids (EILs) can be viewed as a subclass of the broader class of high-energy materials (HEMs). By the most general definition, HEMs are chemical compounds containing large amounts of stored chemical energy that can be released when the materials are subjected to certain stimuli (e.g., heat, impact, friction, or electrostatic discharge). Typical HEMs include explosives, pyrotechnic compositions, jet fuels, and rocket propellants. In view of increasing concerns about environmental and safety issues, great effort has been invested in the