Electrical Solid Propellants:

A Safe, Micro to Macro Propulsion Technology

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In this work we developed three high performance families of plastisol solid propellants that are IM-capable and highly manufacturable, using benign processes and "green" ingredients. Highly aluminized Electric Solid Propellant (ESP) "igniterless" rocket motors have been demonstrated at 4-inch diameter scale. These igniterless rocket motors use inert metal electrodes for direct ignition of the electric solid propellant, thereby eliminating the need for pyrotechnic ignition systems. A fast cook-off Insensitive Munitions test of a 4-inch diameter aluminum-cased ESP motor yielded a Type-V reaction, with no materials ejected from the burn pit. We successfully demonstrated pyrogen-free, igniterless electrically-initiated ignition of 200 lbf thrust class static tests in three separate firings conducted during the development program. In related activities, both nonmetalized minimum signature formulations and reduced-signature boron-fueled plastisol ESP compositions continue to undergo qualification testing for technology transfer applications in defense and commercial endeavors.

Nomenclature

BADB	=	Boron-filled Alternate Double-base propellant
DOT	=	U.S. Department of Transportation
ESP	=	electrical solid propellant
HAN	=	hydroxylammonium nitrate, CAS 13465-08-2
HIPEP	=	High Performance Propellant
IM	=	insensitive munitions criteria per MIL-STD-2105D specification
PETN	=	pentaerythritol tetranitrate, CAS 78-11-5
RDX	=	1,3,5-Trinitro-1,3,5-triazacyclohexane, cyclonite, hexogen, CAS 121-82-4
TNT	=	2,4,6-trinitrotoluene, CAS 118-96-7

I. Introduction

The development of Electric Solid Propellants (ESP)[1,2,3,4] over the last twelve years is opening the door for completely new ways of controlling solid rocket motors. We have developed an extensive range of low hazard, ESPs with unique features, not previously known for energetic materials. When an ESP is fitted with electrodes and the required voltage and current are applied, the solid propellant ignites and continues to burn until the voltage is removed, causing extinguishment. Once extinguished, the electrically controlled propellant can then be re-ignited electrically at will. Throttling of the propellant burning rate is accomplished by changing the electrical power input (Sawka, 2007). Baseline ESPs are also insensitive to ignition by spark, bullet impact and flame, so they are safer to transport and expect to be classified under DOT as Class 1.4S explosives.

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