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STUDY OF THE INFLUENCE OF THE ELECTRIC FIELD ON THE INCIDENTAL IGNITION OF ALUMINIZED COMPOUND SOLID PROPELLENT VIA ELECTROSTATIC DISCHARGE

Abstract

Electrostatic discharge is recognized as a form of ignition of energetic materials and unanticipated events of this nature get attention due to the magnitude, delay in the development of projects and loss of life. Studies have established the correlation between metallic aluminum present in formulations and the sensitivity of solid propellants o electrostatic discharge (ignition and cracking). New work indicates that electric fields can affect the stability of the energy material leading to the reduction of the activation energy to decompose one of the components of the composite. The stability of ammonium perchlorate under the action of electric fields was studied in molecular dynamics simulations using LAMMPS software, capable of modeling sets of particles using intermolecular forces and boundary conditions. With this it was possible to obtain the activation energy through the Arrhenius equation of diffusivity, and to compare the total energy of the system in the presence and absence of electric field. The results indicate that higher values of the electric field imply greater stability of the AP, however, analyzes of the chemical species resulting from its thermal decomposition under electric field influence show that mechanical stresses can occur inside the grain favoring the formation of hot spots. There is also a decrease in EA indicating greater susceptibility of the energy material to the ignition that is not predicted when subjected to an electric field. To evaluate the influence of the electric field on the formation of cracks in the composite, models were used in the software COMSOL Multiphysics relating the amount of aluminum and the sensitivity to ESD. An experimental design for simplex network mixtures with pseudocomponents was adopted and electrical permittivity was the property observed in hypothetical AP/HTPB/Al mixtures. A model built in the COMSOL simulated external and internal discharges in a rocket motor indicating sensitive points load accumulation - in its structure, represented by the superficial density of load. Furthermore, a model assigned by the Hong group of mechanics and structural materials from Iowa State University was used to evaluate crack formation and its relation to electrical permissiveness. The results associated to the equation obtained from the experimental planning show that the model presented for the study of rupture is in accordance with the literature. The studies carried out presented a new methodology for the study of the influence of electric fields on aluminized solid composites indicating the possibility of ignition via ESD.