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DETERMINATION OF COMPOSITE SOLID PROPELLANT RELAXATION MODULUS MASTER CURVES FROM DYNAMIC MECHANICAL ANALYSIS

Abstract

Composite Solid Propellants are inherently viscoelastic materials due to its polymeric matrix that acts as a binder for oxidizer and fuel particles. Since propellant grain failures, such as cracks or debondings, may compromise the rocket motor operation, structural analysis is often conducted to predict the occurrence of such events. The relaxation modulus master curve is an essential input for viscoelastic analysis, but its construction from uniaxial tensile stress relaxation tests is a time and resource consuming task. In the present work, the relaxation modulus master curves were obtained from the properties measured by Dynamic Mechanical Analysis (DMA). This was accomplished by fitting the storage and loss modulus according to a Generalized Maxwell model for viscoelastic behavior, and then calculating the relaxation modulus. This method allowed great reduction of time and resources otherwise required to obtain the propellant relaxation master curve. The results showed good agreement with those obtained directly in tensile tests. It is expected that this method could be applied to a range of composite propellants and other viscoelastic materials as well, making the conduction of structural analysis of propellant grains in several phases of solid rocket motor development faster and easier.