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Failure Criteria of Three-component HTPB Composite Solid Propellant at Low Temperature Under Dynamic Loading

QIANG Hong-fu, WANG Zhe-jun, WANG Guang, GENG Biao

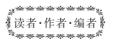
(Xi'an Hi-Tech Institute, Xi'an 710025, China)

Abstract: Based on uniaxial and quasi-biaxial tensile tests and microscopic damage observation experiments of three-component Hydroxyl-Terminated Polybutadience (HTPB) composite solid propellant at different thermal accelerated aging time (0, 32, 74, 98 d), temperatures (−50, −40, −30, −20, 25 ℃) and strain rates (0.40, 4.00, 14.29, 42.86, 63 s⁻¹), the effects of loading conditions on the initial elastic modulus, strength and the corresponding strain have been analyzed. Moreover, failure criteria of the propellant under the tests have been determined. It has been indicated that HTPB propellant fails more easily due to tensile stress under dynamic uniaxial loading, and the thermal aging can further reduce this capability. Thus the strain at maximum tensile stress can be considered as the uniaxial failure criterion. In addition, tensile-compressive strength ratio can better reflect the different properties of the propellants under dynamic uniaxial loading. This value is 0.4 and 0.2−0.3 at room temperature and low temperatures, respectively. The strain at maximum tensile stress of HTPB propellant under quasi-biaxial tension is significantly lower than that in uniaxial tension. Furthermore, the extent of reduction increases with extended aging time and decreased temperature. The proportion for unaged and aged propellants is 60%−85% and 40%−60%, respectively. Finally, this strain is independent of stress state and strain rate at the lower temperature and higher strain rates. Thus the strain at maximum tensile stress under dynamic biaxial tension can be considered as the failure criterion of HTPB propellant. It can also be used to analyze the structure integrity of propellant grains for tactical missiles during ignition of solid rocket motor (SRM). Moreover, its value can be determined with the master curves and aging models.

Key words: Hydroxyl-Terminated Polybutadience (HTPB)propellant; failure criteria; low temperature; dynamic loading; thermal accelerated aging

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