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The Mechanical Response of a Composite Propellant under Harsh Conditions

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Abstract : The aim of this paper is to study the mechanical properties of HTPB (Hydroxyl-terminated polybutadiene) composite propellant under harsh conditions. It describes two tests involving uniaxial tensile tests of various strain rates (ranging from 0.0005 s⁻¹ to 1.5 s⁻¹), temperatures (ranging from 223 K to 343 K) and high-cycle fatigue tests under low-temperature (223 K, frequencies were set at 50, 100, 150 Hz) using DMA (Dynamic Mechanical Analyzer). To highlight the effect of small pre-strain on fatigue properties of HTPB propellant, quasi-static stretching was carried out before fatigue loading, and uniaxial tensile tests at constant strain rates were successively applied. The results reveal that flow stress of propellant increases with reduction in temperature and rise in strain rate, and the strain rate-temperature equivalence relationship could be described by TTSP (time-temperature superposition principle) incorporating a modified WLF equation. Moreover, the rate of performance degradations and damage accumulation of propellant during fatigue tests increased with increasing strain amplitude and loading frequencies, while initial quasi-static loading has a negative effect on fatigue properties by comparing stress-strain relations after fatigue tests.

Keywords : fatigue, HTPB propellant, tensile properties, time-temperature superposition principle
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