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应变控制下NEPE推进剂非线性疲劳损伤

Nonlinear fatigue damage of nitrate ester plasticized polyether propellant for strain-control

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中文关键词: 硝酸脂增塑聚醚推进剂 疲劳损伤模型 应变控制 应力松弛 脱湿

英文关键词:nitrate ester plasticized polyether (NEPE) propellant fatigue damage model strain-control stress relaxation dewetting

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中文摘要:

为研究高能硝酸酯增塑聚醚(NEPE)推进剂的非线性疲劳损伤特性,基于损伤力学和黏弹性理论,建立了一种非线性疲劳损伤模型.该模型考虑了材料疲劳过程中刚度衰减的特征.建立的疲劳损伤模型,通过动态热机械分析仪(DMA)进行5组不同应变水平下的疲劳实验,获得模型参数,并对模型进行验证,利用电荷耦合器件图像传感器(CCD)进行显微观察,分析了应变加载历史对NEPE推进剂微观上的影响.结果表明:提出的损伤演化模型能够很好地描述NEPE推进剂应变控制下的非线性疲劳损伤;定应变往复拉伸造成了推进剂颗粒与基体的脱湿,在循环初期脱湿速度较快,随着循环周期增加,脱湿程度逐渐趋于稳定.

英文摘要:

In order to explore the nonlinear fatigue damage characteristics of nitrate ester plasticized polyether (NEPE) propellant, a nonlinear fatigue damage model was proposed based on damage mechanics and visco-elasticity theory, which took into account the stiffness degradation in the fatigue process. With dynamic momechanical analysis (DMA) apparatus, NEPE propellant fatigue tests were conducted under five kinds of strain levels, the model parameters were obtained and the presented model was verified. A morphology analyze was conducted with charge coupled device (CCD), the effect of strain loading history on the mechanical properties of the NEPE propellant was analyzed. The result shows that the presented model is capable of describing micro-mechanically the nonlinear fatigue damage evolution of NEPE propellant properties; the repeated tensile leads to dewetting between the particles and matrix propellant. At the initial stage of the cycle phases, the velocity of dewetting is fast. With the increased number of cycles, the extent of dewetting tend to become stable.

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