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Modeling Ratchet Growth as Porosity Creep YEHUDA PARTOM, Retired — Irreversible thermal cycling growth (or ratchet growth) of insensitive explosive formulations has been known for years. Traditionally it's attributed to material texture and to anisotropic thermal expansion. Although this understanding has been accepted for a long time, we're not aware of any model on the macroscale to connect these material properties to ratchet growth behavior. Thompson et al. [1] have observed that they also get growth from a long hold time at high temperature, and that such growth resembles creep response. Following their findings we propose here a predictive model for ratchet growth on the macroscale, where we assume that when temperature is increased, growth comes about by porosity (or volume) creep. As is well known, PBXs are prepared by die or isostatic pressing, and at the end of such pressing the material is left at porosity of about 2%, and with a substantial residual or internal stress fluctuations in self-equilibrium. We model ratchet growth by assuming that: 1) increasing temperature decreases porosity (or volume) strength in tension (negative pressure), causing the material (in a control volume) that is in tension to creep (slowly increase), and 2) increasing temperature increases the internal pressure/tension fluctuations because of thermal expansion anisotropy, thereby enhancing the rate of porosity creep and ratchet growth. We write down equations for porosity creep and the resulting ratchet growth, and we demonstrate that our modeled ratchet growth results are similar to test data. We do not calibrate the free parameters of our model to reproduce specific data, as we do not own such data.

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