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Fatigue Damage Assessment of Unfilled Polymers including Self-Heating Effects

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ABSTRACT

Cyclic plasticity and fatigue damage mechanisms dissipate part of the supplied strain energy to the system to induce either inelastic deformations and/or microflaws within the material system. Polymer material systems exhibit lower lifetimes when the self-heating phenomenon become significant that may lead to heat softening and thermal damage. Self-heating effect in cyclic loading of polymers can be correlated to the cyclic dissipative mechanisms. This work aims at developing a fully coupled elastic, plastic, thermal, and fatigue damage computational tool for unfilled polymers to investigate the role of self-heating in lifetime prognoses. The thermodynamics principles are incorporated to formulate the coupling between dissipative energies and thermomechanical constitutive laws. Continuum Damage Mechanics (CDM) is utilized to link microscale damage mechanisms to macroscale failures. The computational framework is implemented into a commercial FEA code (Abaqus) through user-defined coding. It is shown that the developed computational platform correlates well with the observed experimental data and it may constitute a powerful design tool for future developments.

1. Introduction

Fatigue failure modes in unfilled polymers and polymer matrix composites (PMCs) have been under intensive research for some decades. In general, the fatigue damage in polymers

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