Accepted Manuscript

A three-dimensional finite-strain phenomenological model for shape-memory polymers: formulation, numerical simulations, and comparison with experimental data

Elisa Boatti, Giulia Scalet, Ferdinando Auricchio

PII: S0749-6419(16)30057-2

DOI: 10.1016/j.ijplas.2016.04.008

Reference: INTPLA 2045

To appear in: *International Journal of Plasticity*

Received Date: 14 October 2015

Revised Date: 14 March 2016

Accepted Date: 15 April 2016

A three-dimensional finite-strain phenomenological model for shape-memory polymers: formulation, numerical simulations, and comparison with experimental data

Elisa Boatti*[,a], Giulia Scalet[a], Ferdinando Auricchio[a]

[a]*Department of Civil Engineering and Architecture, University of Pavia, via Ferrata 3, 27100 Pavia, Italy*

Abstract

Shape-memory polymers (SMPs) represent a class of smart materials able to store a temporary shape and to recover the original shape upon an external stimulus, such as temperature. The present paper proposes a three-dimensional finite-strain phenomenological model for thermo-responsive SMPs, which distinguishes between two material phases presenting different properties and is based on a rule of mixtures. The proposed model is motivated by the earlier work of Reese and coworkers (2010) and it considers several significant material features that had not been addressed in previous phenomenological approaches. Specifically, the model reproduces both heating-stretching-cooling and cold drawing shape-fixing procedures and it takes into account the non-ideal behavior of realistic SMPs (i.e. imperfect shape-fixing and incomplete shape-recovery). Several numerical tests are reported to assess model performances, from simple uniaxial and biaxial tests to complex simulations of biomedical devices. Comparisons with experimental data taken from the literature are also provided to validate the model. The proposed improvements increase the model applicability over a wide range of polymer types and operating conditions.

Key words: Phase transformation (A), thermomechanical processes (A), constitutive behavior (B), finite strain (B), shape-memory polymers.

*Corresponding author: elisa.boatti@unipv.it