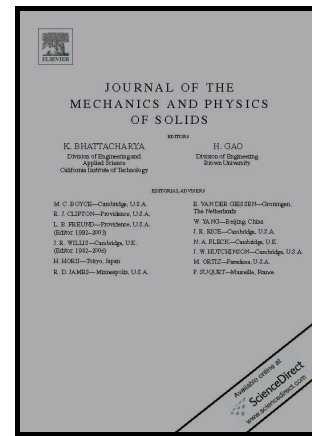


Author's Accepted Manuscript

A Top-down Multi-scale Modeling for Actuation Response of Polymeric Artificial Muscles

Qianxi Yang, Guoqiang Li



PII: S0022-5096(15)30353-7
DOI: <http://dx.doi.org/10.1016/j.jmps.2016.04.007>
Reference: MPS2860

To appear in: *Journal of the Mechanics and Physics of Solids*

Received date: 16 December 2015
Revised date: 10 March 2016
Accepted date: 5 April 2016

Cite this article as: Qianxi Yang and Guoqiang Li, A Top-down Multi-scale Modeling for Actuation Response of Polymeric Artificial Muscles, *Journal of the Mechanics and Physics of Solids*, <http://dx.doi.org/10.1016/j.jmps.2016.04.007>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and a review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

A Top-down Multi-scale Modeling for Actuation Response of Polymeric Artificial Muscles

Qianxi Yang and Guoqiang Li*

Department of Mechanical & Industrial Engineering, Louisiana State University, Baton Rouge, LA 70803, USA

*Corresponding author. Tel.:001-225-578-5302; Fax: 001-225-578-5924; E-mail: lguoqi1@lsu.edu

Abstract

A class of innovative artificial muscles made of high-strength polymeric fibers such as fishing lines or sewing threads have been discovered recently. These muscles are fabricated by a simple “twist insertion” procedure, which have attracted increasing attention due to their low cost and readily availability, giant tensile stroke, record energy density, and easy controllability. In the present paper, we established a multi-scale modeling framework for the thermomechanical actuation responses by a top-down strategy, spanning from macro-scale helical spring analysis down to molecular level chain interaction study. Comparison between modeling results and experimental results exhibited excellent agreement. The effect of the micro-, meso- and macro-scale parameters on the actuation responses of the artificial muscle was further discussed through a parametric study per the validated model. This work helps understand the physical origin behind the remarkable tensile actuation behavior of the twisted-then-coiled polymeric artificial muscles and also provides inspirations for optimal design of advanced artificial muscles made by twist-insertion procedure.

Keywords: Artificial muscle; Multi-scale modeling; Actuation; Fiber; Top-down analysis.

1. Introduction

Artificial muscles are a class of biologically inspired materials or devices that can reversibly contract, expand, or rotate by external stimuli, such as voltage (Ohm et al., 2010; Pelrine et al., 2002; Zhang et al., 1998), pressure (Chou and Hannaford, 1996; Daerden and Lefeber, 2002), current (Baughman, 1996; Lima et al., 2012; Shahinpoor et al., 1998), or

Download English Version:

<https://daneshyari.com/en/article/7177764>

Download Persian Version:

<https://daneshyari.com/article/7177764>

[Daneshyari.com](https://daneshyari.com)