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ACCEPTED MANUSCRIPT

Design and analysis of a smart soft composite structure for various modes of actuation

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KEYWORDS: A. Polymer-matrix composites (PMCs); A. Smart materials; C. Finite element analysis (FEA); Soft morphing actuator

ABSTRACT:

This article describes a novel design for a smart soft composite structure, capable of four actuating modes, with three different types of scaffold structures, and two shape memory alloy wires embedded above and below the scaffold structures. Each component is combined with polydimethylsiloxane (PDMS) so it has the advantage of a soft morphing motion. Actuating modes, consisting of symmetric, anti-symmetric, asymmetric, and torsional motion, and the associated end edge displacement and twisting angle, were measured according to different ply combinations, which were symmetric, anti-symmetric, and asymmetric. The 60-mm actuator is capable of end edge displacement up to 67 mm and twisting up to 85° in a bend-twist coupled motion. In the torsion-only motion, without bending, 108.4° deformation was achieved. Next, a finite element method (FEM) model, based on the Lagoudas shape memory alloy (SMA) model, is presented to predict the actuating performance of the actuator according to the scaffold stacking sequence. Using the FEM model, end edge displacement and twisting angle are compared with experimental data in the four modes of actuation. The actuating trajectory expected from the FEM model is compared with the experimental data.

1. Introduction

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