7th ECCOMAS Thematic Conference on Smart Structures and Materials
SMART 2015
A.L. Araújo, C.A. Mota Soares, et al. (Editors)

Abstract ID-090

AN ANALYTICAL STUDY ON PIEZOELECTRIC-BISTABLE LAMINATES WITH ARBITRARY SHAPES FOR ENERGY HARVESTING

[1]Mehdi Tavakkoli, [2]Paul M Weaver, [1]Christopher R. Bowen, [3]Daniel J Inman, [1]H Alicia Kim

[1]Department of Mechanical Engineering, University of Bath, UK
s.m.tavakkoli@bath.ac.uk ; c.r.bowen@bath.ac.uk ; h.a.kim@bath.ac.uk

[2]National Physical Laboratory, UK
paul.weaver@npl.co.uk

[3]Department of Aerospace Engineering, University of Michigan, USA
daninman@umich.edu

Keywords: Bistable Laminates, Piezoelectric, Energy Harvesting

Summary: Due to large deformations of bi-stable laminates arising from asymmetric lay-ups, they have been identified as good candidates to combine with piezoelectrics for broadband energy harvesting. Fast transitions from one stable state to another, or 'snap-through', is used to repeatedly deform the surface-bonded piezoelectric and generate electrical energy. Existing studies, both experimental and numerical, have been limited to laminates of rectangular shapes, restricting the scope for improved energy harvesting performance. In this paper, an analytical model for piezoelectric-bistable laminates with arbitrary shapes is developed. The electromechanical governing equations of the system are derived based on Hamilton's principle and solved using the Runge-Kutta method. In order to model arbitrary shapes, the domain of interest is discretized into small elements and the density of each element is considered to be one for solid areas and zero for voids; the stiffness of the void elements are assumed to be zero. In order to verify the model, the obtained results are compared with experimental measurements. The effect of using different laminate geometries on harvested power are discussed by considering square, cruciform (+) and saltire (x) shaped examples.