**11th World Congress on Structural and Multidisciplinary Optimisation**
07th -12th, June 2015, Sydney Australia

# Topology Optimization Applied to the Dynamic Design of the Laminated Piezocomposites Structures (LAPS) Used for purposes of Energy Harvesting

**Ruben A. Salas[1], Emilio C. N. Silva[1], and J. N. Reddy[2]**

[1] University of São Paulo, Brazil
[2] Texas A&M University, United States of America

## Abstract

Laminated Piezocomposite Structures (LAPS) are multi-layer structures composed by piezoelectric, metal and composite materials (epoxy matrix with carbon or glass fiber). These structures have improved features over conventional piezoelectric materials because their characteristics cannot be achieved by any of its components isolated, for example less weight and more generated power. Therefore, this work aims to develop a methodology for dynamic design of LAminated Piezocomposite Structures (LAPS) used in energy harvesting applications. Energy harvesters are devices used for supplying portable and low power devices, being of great interest the improvement of its dynamic characteristics and performance. Thus, LAPS dynamic design for purposes of energy harvesting can be systematized by using the Topology Optimization Method (TOM), which is a method based on the distribution of material in a fixed design domain with the purpose of optimizing a cost function subjected to constraints inherent to the problem. TOM combines the optimization algorithms and the finite element method (FEM). In this work, the TOM formulation aims to find out together, the optimal topology of the materials for different layers, the polarization sign of the piezoelectric material and the fiber angle of the composite layer, in order to design a particular vibration mode for a specified resonance frequency maximizing the energy conversion. The LAPS modeling is performed by solving the governing equations using the linear FEM based on three-dimensional eight-node isoparametric elements. In the TOM formulation, several material models are used including the Simple Isotropic Material with Penalization (SIMP) for isotropic materials, the PiezoElectric MAterial with Penalization and Polarization (PEMAP-P) to describe polarization in piezoelectric material and one based on the Discrete Material Optimization (DMO) for taking into account of fiber orientation in composite materials. The objective function combines harmonic and transient FEM analysis terms to deal with generated power maximization and rise time minimization with the purpose of improving the dynamic response. The transient problem is solved with the Generalized- time integration scheme and Sequential Linear Programming (SLP) is used for solving the non-linear optimization problem. Results are shown in order to illustrate the method. Keywords: Topology optimization, laminated piezocomposite materials, Energy harvesting, transient analysis.