ABSTRACT
In this study an analytical method is developed to obtain the response of electro-magneto-thermo-elastic stress and perturbation of a magnetic field vector for a thick-walled spherical functionally graded piezoelectric material (FGPM). The hollow sphere, which is placed in a uniform magnetic field, is subjected to a temperature gradient, inner and outer pressures and a constant electric potential difference between its inner and outer surfaces. The thermal, piezoelectric and mechanical properties except the Poisson's ratio are assumed to vary with the power law functions through the thickness of the hollow sphere. By solving the heat transfer equation, in the first step, a symmetric distribution of temperature is obtained. Using the infinitesimal electro-magneto-thermo-elasticity theory, then, the Navier’s equation is solved and exact solutions for stresses, electric displacement, electric potential and perturbation of magnetic field vector in the FGPM hollow sphere are obtained. Moreover, the effects of magnetic field vector, electric potential and material in-homogeneity on the stresses and displacements distributions are investigated. The presented results indicate that the material in-homogeneity has a significant influence on the electro-magneto-thermo-mechanical behaviors of the FGPM hollow sphere and should therefore be considered in its optimum design.

Keywords: FGPM; Thick hollow sphere; Electro-magneto-thermo-mechanic; Perturbation of the magnetic field vector.

1 INTRODUCTION

FGPMs have attracted widespread attention in recent years. FGPM is a kind of piezoelectric material with material composition and properties that varies continuously and gradually along certain directions. This makes FGPM to be suitable for many specific applications such as sensors or actuators. Chen et al. [1] investigated a piezoceramic hollow sphere analytically, based on the 3D equations of mechanical and piezoelectricity. Their numerical results are performed for different boundary conditions imposed on the spherical surfaces. Lim and He [2] obtained an exact solution of a compositionally graded piezoelectric layer under uniform stretch, bending and twisting. Shi and Chen [3] presented the analytical solution for a piezoelectric cantilever beam with continuously graded properties subjected to different loadings. They proposed and determined a pair of stress and induction functions in the form of polynomials. Moreover, based on these functions, they obtained a set of analytical solutions for the beam under different loadings. WU and Syu [4] considered an exact solution of a cylindrical shell made of functionally graded piezoelectric materials under cylindrical bending using the method of perturbation. They are taken into account the transverse normal load and normal electric displacement (or electric potential), respectively, applied on the lateral surfaces of the shells. Moreover, they assumed that the cylindrical shells are considered to be

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