Two dimensional analysis of coupled non-Fick diffusion-elastodynamics problems in functionally graded materials using meshless local Petrov–Galerkin (MLPG) method

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\textbf{ABSTRACT}

In this article, the transient dynamic analysis of two dimensional coupled non-Fick diffusion-elastodynamics is carried out in functionally graded materials under shock loading using meshless local Petrov–Galerkin (MLPG) method. By using a unit step function as the test functions on small subdomains of circular shape in the local weak-form, the local integral equations (LIEs) are obtained for the problem. The mechanical properties are assumed to vary as nonlinear functions in volume fraction forms. The radial basis functions are used for approximation of the spatial variation of field variables in the analyzed domain. For treatment of time variations, the Laplace-transform technique is utilized. The molar concentration and elastic wave propagate with finite speeds through 2D-FGM domain. The effects of various grading patterns of FGMs on the propagation of molar concentration and elastic waves are discussed in details at various time instants. The profiles of molar concentration and displacements in two orthogonal directions are illustrated in FGM with various nonlinear grading patterns at various time instants. The presented results show that the MLPG method has a high capability to be employed for transient and wave propagation analysis in coupled problem of elasticity and diffusion.

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\textbf{1. Introduction}

During the last several decades, the coupled multi-field problems in engineering have been widely studied using various analytical and numerical methods, e.g. in coupled thermoelasticity \cite{1,2}, coupled heat-moisture \cite{3} and coupled diffusion–elasticity \cite{4,5}.

Although the numerical methods such as finite element (FE) and boundary element (BE) methods are very useful even for coupled problems in engineering, some mesh-free and meshless methods have been successfully developed in this area of engineering because of valuable advantages. One of the most efficient meshless techniques is the meshless local Petrov–Galerkin (MLPG) method. Recently, an overview of the principles and application of the meshless local Petrov–Galerkin method was presented by Sladek et al. \cite{8}. The MLPG method is a truly meshless method thus it involves not only a meshless interpolation of trial functions but also an element-free integration of the local weak form and as a consequence no background mesh or elements are required. The MLPG was successfully applied to lot of coupled problems including thermoelasticity analyses \cite{6}.

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