Accepted Manuscript

Dynamic modeling and vibration analysis of double-layered multi-phase porous nanocrystalline silicon nanoplate systems

Mohammad Reza Barati, Hossein Shahverdi

PII: S0997-7538(17)30323-6
DOI: 10.1016/j.euromechsol.2017.07.010
Reference: EJMSOL 3463

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 20 April 2017
Revised Date: 13 June 2017
Accepted Date: 25 July 2017

Please cite this article as: Barati, M.R., Shahverdi, H., Dynamic modeling and vibration analysis of double-layered multi-phase porous nanocrystalline silicon nanoplate systems, *European Journal of Mechanics / A Solids* (2017), doi: 10.1016/j.euromechsol.2017.07.010.

Dynamic modeling and vibration analysis of double-layered multi-phase porous nanocrystalline silicon nanoplate systems

Mohammad Reza Barati[1], Hossein Shahverdi*[1]

[1]Aerospace Engineering Department & Center of Excellence in Computational Aerospace, AmirKabir University of Technology, Tehran 15875-4413, Iran

* Corresponding author email: mrb.barati@ymail.com, mrb.barati@aut.ac.ir

Abstract

Nanocrystalline materials (NcMs) are multi-phase composites containing nanograins, nanovoids and interface. A softening mechanism due to the interface phase and nanovoids is observed in NcMs. For the first time, vibration behavior of double-layered nanocrystalline silicon nanoplates on elastic substrate is analyzed based on a two-variable refined plate model. Due to the experimentally observation of grains micro-rotation and strain gradients near interfaces, the strain gradient based couple stress theory is employed to describe the size-dependent behavior of the nanocrystalline nanoplate. A micromechanical model is employed to incorporate the effects of inclusions and their surface energies. Galerkin's method is implemented to obtain the natural frequencies of nanocrystalline nanoplate with different boundary conditions. One can see that the nanograins size, nanograins surface energy, nanovoids size, void percentage, interface region, scale parameter, foundation constants and boundary conditions have a great influence on the vibration behavior of a double-layered nanocrystalline nanoplate.

Keywords: Nanocrystalline materials; Nanograins; Couple stress theory, Porosities

1. Introduction

Nano-scaled silicon structural elements have been broadly used as nanosensors and nanoactuators with excellent mechanical performances [1]. However, nano-scale structures made of nanocrystalline silicon materials are different from conventional silicon nanostructures due to their dependency on the size and surface energy of inclusions. Generally, nanocrystalline materials are multi-phase composites with the elastic constants dependent on the size of nanograins, size and percentage of nanovoids and also interface (matrix) phase. Several investigations are performed for modeling and simulation of nanocrystalline materials. Wang et