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Farajollah Zare Jouneghani, Rossana Dimitri, Francesco Tornabene

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# Structural response of porous FG nanobeams under hygro-thermo-mechanical loadings

Farajollah Zare Jouneghani [1], Rossana Dimitri [2], Francesco Tornabene [3*]

**Abstract**

We investigate the bending behavior of functionally graded (FG) nanobeams with internal porosities and subjected to a hygro-thermo-mechanical loading. The Eringen's Nonlocal Theory (ENT) is here applied for the numerical study, while considering a uniform porosity within the nanobeam. The mechanical and thermal properties of FG materials are assumed to vary throughout the thickness. The equations of motion are derived from the Hamilton's law and solved with the Navier's procedure. A key point of the work is to explore the effect of the material length-scale, power-law index, porosity volume fraction, temperature rise, and moisture concentration on the global deflection of nanobeams, as useful for practical applications.

**Keywords:** Bending behavior, Eringen's Nonlocal Elasticity (ENT), FGM, Hygro-thermo-mechanical loading, Porous Material.

## 1. Introduction

Functionally graded materials (FGMs) are a novel class of composites, which are made by a mixture of two different materials, commonly a metal and a ceramic, with orthotropic mechanical properties. Due to the great benefits of these materials and their fundamental role in many practical applications, including aerospace, civil, automotive, optical, biomechanical, chemical applications, etc., researchers have broadly devoted their efforts for the analytical and numerical study of the mechanical behavior of FGMs. In this context, different kinds of size dependent continuum approach have been developed and applied for nano and microsystem modeling, including, micropolar elasticity, Cosserat elasticity, couple stress theory, strain gradient elasticity, stress gradient theory, surface energy theory.

Among them, the Eringen's Nonlocal Theory (ENT) represents a performing higher-order theory, which is able to describe the effects of some length-scale parameters on the material deformation of a wide range of nanostructures. For instance, Reddy [1, 2] studied the bending, buckling, and vibration of various beams by taking into account a nonlocal elasticity theory. Trabelssi et al. [3] investigated the vibrating response of a FG Euler-Bernoulli beam according to

[1] *Young Researchers and Elite Club, Shahrekord Branch, Islamic Azad University, Shahrekord, Iran.*
[2] *Department of Innovation Engineering, Università del Salento, Lecce, Italy*
[3] *DICAM Department, School of Engineering and Architecture, University of Bologna, Bologna, Italy*
* corresponding author, email address: francesco.tornabene@unibo.it (Francesco Tornabene)