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EDITORIAL

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Mechanics of size-dependent materials

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The main driving force in modern technology is to make systems of smaller dimensions and novel materials. This poses enormous technological challenges to manufacturing procedures, both at structural and microstructural levels. On the other hand, the researchers face mechanical behavior that is inherently size-dependent. Many examples in the literature show that both natural and man-made materials exhibit complicated microstructures with exceptional micro- and nano-scale phenomena. Concepts from mechanics of materials that are based on a classical, size-independent continuum description are not able to account for this complex behavior. Thus, there is a need for new mechanics able to address the size-dependent behavior of materials. As a result, various types of size-dependent models of continuum mechanics have been developed.

This Special Issue contains twenty-one papers which were written by a number of scientists with worldwide expertise and international reputation from Canada, China, Egypt, France, Georgia, Germany, India, Iran, Italy, Japan, Northern Cyprus, Poland, Qatar, Russia, Romania, Saudi Arabia, Serbia, South Korea, Sweden, Tunisia, Turkey, the UK and the USA. They have presented recent advancements in mechanics of size-dependent materials and their applications to describe the material behavior on different scales. In the following, we briefly introduce the papers published in this Special Issue.

Rizzi et al. [1] obtained analytical solutions for uniaxial extension problems in the framework of isotropic relaxed micromorphic and other isotropic generalized continuum approaches. Lurie et al. [2] presented an analytical solution for coupled problems of gradient thermoelasticity for non-inhomogeneous periodic structures. They indicated that the proposed solution can predict the possible abnormal effects that can be realized in such systems. Pinnola et al. [3] developed a well-posed non-local integral elastic model for the Euler–Bernoulli beams by enhancing the classical Wieghardt formulation without introducing any fictitious reactive forces at endpoints. The proposed model was used to solve the soil–beam interaction problem. Based on a mechanism-based spatiotemporal non-local model, Wang et al. [4] investigated the microstructural effects on the overall dynamics of unidirectional composites. In another paper, Madenci et al. [5] predicted the deformation field, damage initiation site and its progressive growth in fiber-steered composites by using a peridynamic approach. Daraei et al. [6] studied the thermo-mechanical behavior of macro-, micro-, and nano-scale beams by using the micropolar theory based on a higher-order model in the framework of the Carrera unified formulation. Qing and Cai [7] studied non-linear post-buckling behaviors of the Euler–Bernoulli nanobeam with different boundary conditions by utilizing strain- and stress-driven local/non-local integral models. El-Borgi et al. [8] investigated free and forced vibrations of a graded geometrically non-linear Timoshenko nanobeam by combining non-local and surface elasticity. Malikan and Eremeyev [9] studied the free vibration of piezomagnetic microbeams by considering the flexomagnetic phenomenon by using the generalized thermoelasticity theory of Lord–Shulman. Abouelregal et al. [10] studied vibration of thermoelastic rotating nanobeams by using

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non-local elasticity theory and a generalized thermoelastic model with two-phase delays. Eltaher et al. [11] presented closed-form solutions for the vibration of perforated viscoelastic nanobeams with different boundary conditions.

Zhang et al. [12] presented a new model for electro-elastic Bernoulli–Euler beams incorporating microstructure and flexoelectric effects. The application of space–time fractional-order operators to study the elastic wave propagation in a one-dimensional metamaterial bar resting on a viscoelastic foundation was investigated by Ding et al. [13]. Ghavanloo et al. [14] proposed a new one-dimensional metamaterial capable of generating a quasi-static band gap from zero frequency. In another study, Li et al. [15] calculated the effective mass of finite and infinite one-dimensional metamaterials exactly. Karampour et al. [16] investigated in-plane free vibration of metamaterial circular curved beams with locally resonant microstructures.

Cui et al. [17] studied the size-dependent behavior of central nanovoid embedded in high-entropy alloy films under biaxial tension using molecular dynamics (MD) simulations. In another MD simulations study, the mechanical characteristics of [110]-oriented silicon nanowires with embedded fullerene molecules were investigated by Erbas et al. [18]. Nguyen et al. [19] investigated the cure-induced size effect on the stress development and tensile transverse failure response of fiber-reinforced polymer matrix composites by using a thermo-chemo-mechanical finite element-based framework integrated with a crack band model. Colatosti et al. [20] studied the mechanical behavior of microstructured materials using micropolar and classical continuum approaches by highlighting the effectiveness of micropolar theory in the case of size-dependent problems, in both static and dynamic framework. Finally, Tian et al. [21] analyzed the frictional contact problem of a finite thickness thermoelectric layer in the framework of thermoelectricity and integral transform technique.

We hope the readership will enjoy these interesting works. The guest editors would like to thank the authors for submitting their valuable works to the Special Issue and the anonymous reviewers for their time, effort and professional comments in evaluating the papers. In addition, our special thanks to the editor-in-chief of Archive of Applied Mechanics, Prof. Jörg Schröder, for his excellent cooperation.

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