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On the mechanics of nanomaterials in micro-/nano-scale applications

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Unlike the conventional materials, the properties of nanomaterials are highlighly affected with their material structure. For example, the mechanical properties of nanocrystalline materials are highly affected with the heterogeneity nature of their material structure and the grains size. In addition, the properties of single crystal solids are directly related to their atomic structure and their dispersive behaviors. In this presentation, two approaches are presented to accurately model micro/nano-solids made of nanomaterials. In the first approach, a general nonlocal continuum theory is proposed to model micro-/nano-solids made of single crystalline nanomaterials. This general theory has the merit to model the residuals of the nonlocal fields that may exist inside the crystal structure. Three types of nonlocal fields are discussed and modeled in the context of this general theory. In the first and second types, the interatomic forces are extended over the whole crystal. These forces are electromagnetic forces that produce acoustic and external optical phonons inside the crystal with long-range effects. In the third type, the interatomic forces are only effective within the interatomic distance range. These forces are the main reason behind the nonlocal internal optical phonons of unit cells. To investigate these nonlocal fields inside the crystal structure, the crystal is modeled as a continuum consisting of repeated unit cells and each unit cell is modeled as a deformable micro-body. In the second approach, a nonclassical continuum model is integrated with a size-dependent micromechanical model. The micromechanical model has the merit to estimate the properties of the material considering the grain size effects and accounting for the grain boundaries, the triple junctions, the quadratic nodes, and porosities inside the material structure. Then, one of the nonclassical continuum theories is utilized to model grains as volume elements capturing the discrete nature of their atomic structures.

Biography

M Shaat is a PhD student in the Department of Mechanical and Aerospace Engineering at New Mexico State University under the supervision of Prof. Abdessattar Abdelkefi. He earned his Master of Science in Mechanical Engineering from Zagazig University, Egypt. His main research interests are in the fields of mechanics of nanomaterials, mechanics of micro-/nano-solids, MEMS and NEMS, nanocomposites, and functionally grade materials. He has published more than sixteen papers in international journals, such as *International Journal of Mechanical Sciences, Microsystem Technology, and International Journal of Engineering Science.* He has served as a reviewer in more than seven international journals.

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