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Accurate modeling and analysis of mechanical nano-resonators

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Nowadays, mechanical nano-devices are widely used for biological, chemical, and physical applications. These devices are composed of mechanical nano-resonators with high sensitivities. The operating principle of a nano-device to detect a physical quantity is based up on an induced property change of the attached resonator as a response for the detected physical quantity. These devices should be integrated with accurate mathematical models to relate the induced property change with the physical quantity. The accuracy of the measurement is strictly related to the accuracy of the mathematical model to represent the mechanical behaviors of the resonator. To satisfy the size constraints, these mechanical resonators are made of nano-materials. Therefore, the developed models for these resonators should account for the unique behaviors of nano-materials. Furthermore, these developed models should account for the resonators' size effects. In this presentation, a discussion on the accurate modeling of mechanical nano-resonators is presented. Different modeling schemes for mechanical resonators made of single crystalline materials, nano-crystalline materials, and CNTs are discussed. These modeling schemes will enhance the accuracy of nano-devices to detect the physical quantity. To accurately model single crystalline materials and CNTs-based resonators, a general nonlocal continuum theory is presented. This continuum theory has the merit to account for the nonlocal dispersions of the crystal structure accounting for the resonators' size effect. For nano-crystalline materials-based resonators, a continuum model integrated with a size-dependent micromechanical model is proposed. The micromechanical model has the merit to account for the heterogeneity nature of the material structure and the grains' size effects. This micromechanical model is integrated with an atomic lattice model to estimate the effective properties of the grain boundary. The continuum model is based up on one of the micro-field theories depending on the nature of the material structure.

Biography

Mohamed Ibrahim 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 nano-materials, mechanics of micro-/nano-solids, MEMS and NEMS, nano-composites and functionally grade materials. He has published more than sixteen papers in international journals, such as *International Journal of Mechanical Sciences, Micro-system Technology and International Journal of Engineering Science.* He also served as a reviewer for more than seven international journals.

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