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Abstract

This paper investigates nonlinear vibrations of the nanoplates for a high resolution mass identification. As background, the paper is furnished with a succinct review of the applications of the nanoplates, along with recent studies on nanoplate vibrations. In spite of a number of published works related to vibrations of nanoplates, their nonlinear behaviors have not been fully characterized. Accordingly, we present a mathematical model to examine nonlinear vibrations of nanoplates based on the nonlocal theory postulating nonlinear Winkler foundation. Besides, external force is taken into account to scrutinize nanoplate vibrations.The developed mathematical model consists of the assumption of a tiny mass stuck on the nanoplates. Utilizing the Galerkin's method considering multiple scales method provides the primary mode of nanoplate oscillations. In view of that, parametric sensitivity analysis depicts that the frequency response of the nanoplates significantly changes by adding minuscule mass. Two different methods are developed for identification of the added mass. The first method works based on the jump phenomenon in nonlinear oscillators due to the added mass. In the second method,an adaptive parameter identifier estimates the added tiny mass based on a parametric dynamic model of the structure and its vibrational response to a periodic applied force. The effectiveness and straightforwardness of both developed methods are illustrated. Furthermore, a comparison with the molecular dynamics simulation is provided to verify the developed nonlocal model of nanoplate vibrations. It is concluded that the developed method can be considered as consequential and potential tools for high resolution mass sensing. The proposed approaches have the potential to be used in virus, enzyme and also humidity sensing.

Keywords: Nonlinear vibrations, nanoplate, small scale factor, mass sensor

Nomenclature

α_{om} Coefficient of $\ddot{P}$ with considering mass

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