Thermoelastic Vibration Behaviors of Nanofilms

***Z.Q. Wang[1], Y.P. Zhao[2], and J.G. Lv[1]**

[1] School of Engineering and Technology, China University of Geosciences, Beijing 100083, China.
[2] State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, China.

*Corresponding author: zqwang@cugb.edu.cn

Nanoelectromechanical system (NEMS) resonators using thin film structures have been considered for numerous applications such as biochemical sensors, mass sensors, and electrical filters due to their unprecedented high sensitivity and fast response. Many studies have shown that surface effects play a dominant role in the thermomechanical properties of nanostructures. This manuscript investigates the thermoelastic vibration characteristics of nanofilms with surface effects numerically and theoretically. In the absence of external loading, the residual surface stress will induce an initial stress field in the bulk of nanostructures. Molecular dynamics simulations are used to study this residual stress field in the nanofilms. In addition, a continuum model, which involves the residual surface stress and the residual stress field in the bulk, is proposed to analyze the thermoelastic behaviors of nanofilms. Both the numerical and the theoretical results show that surface stress and residual surface stress have significant effects on the thermoelastic vibration characteristics of nanofilms.

Keywords: Surface elasticity, Size effects, Thermoelastic vibration