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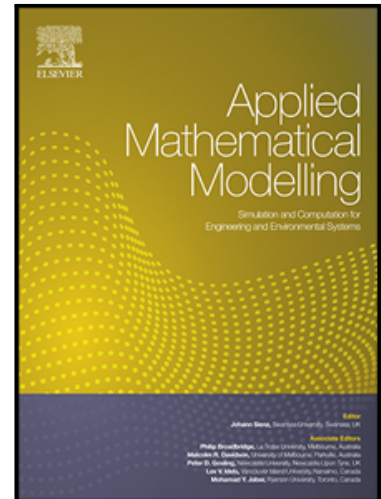
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Effect of three types of piezoelectric cantilever on the topography quality in the vicinity of rough surface in a fluid ambient

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Highlights

1. Advanced mathematical modeling for different types of piezoelectric micro cantilever
2. Utilizing modified couple stress theory
3. Advanced liquid modeling
4. Predicting the piezoelectric non uniform micro cantilever vibration behavior in fluid
5. Tapping and non-contact topography in liquid

Abstract

The use of higher vibration modes and different geometries of the atomic force microscopy (AFM) piezoelectric micro cantilever (MC) is affected by the surface topography quality in a liquid medium. Therefore, utilizing an appropriate MC geometry and vibration mode is of a great importance. This paper analyzes the effect of different types of AFM MCs on the surface topography quality in the noncontact and tapping modes in a liquid medium. The modified couple stress theory (MCS) in a liquid based on the Timoshenko beam theory is used in order to enhance the accuracy of MC dynamic modeling. In addition, the differential quadrature (DQ) method has been used to discrete the equations. Identification of environmental forces helps to measure the accurate MC vibration amplitude. Investigating the effect of geometric and force parameters on the MC vibration behavior leads to understanding the system to design it properly in a liquid medium. Based on the advanced dynamic modeling, the best MC geometry for the specific surface roughness has been determined in the liquid for the surface topography. Also, due to oscillating the MC near the sample surface, the effect of interaction forces between the sample surface and the MC, including van der Waals, contact and squeeze forces is analyzed in a liquid medium in addition to the hydrodynamic forces. Furthermore, due to the reduction of the MC amplitude caused by the squeeze force; the MC is angled in proportion to the horizontal surface.

Keywords: AFM, Piezoelectric micro-cantilever, Amplitude mode, Modified couple stress, Timoshenko beam, Liquid medium

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