A fundamental study for the beat phenomenon in metal nanowires[1]

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Abstract

With the rapid progress of nano science and technology, metal nanowires have been widely explored. As building blocks in nanoelectromechanical devices, metal nanowires have unique electronic, thermal, mechanical and optical properties. There have been a number of experimental, theoretical and computational studies on the vibrational properties of metal nanowires [1-3].

In this paper, a novel beat phenomenon of metal nanowires is investigated by using the large scale molecular dynamics simulations. Actuations imposed along any directions are decomposed into two orthogonal vibrational components based on the actuation angle relative to two elementary directions, which depend on the lattice arrangement of the metal nanowire. The displacements of a typical atom in the nanowire are used to show the dynamical characteristics of beat phenomenon in vibration experiments. Based on the displacement of the atom, a discrete model is presented to explain the displacement characteristics of beat phenomenon. Most importantly, a reasonable mechanism analysis is given for the generation mechanism of beat phenomenon by analyzing the relation of excitation frequency between the two elementary directions. It is also observed that the beat phenomenon exists not only in the vibration of FCC nanowires of different materials (Cu, Au, Ni, Pd and Pt), but also in the vibration of the BCC nanowires (Fe). In addition, the beat phenomenon driven by a single actuation along one of the elementary directions has also been observed. It is suggested the existence of stacking fault at the beginning of vibration leads to the decomposing of the initial actuation.

Keywords: beat phenomenon, metal nanowires, molecular dynamics, elementary directions, vibration, excitation frequency.

Reference

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