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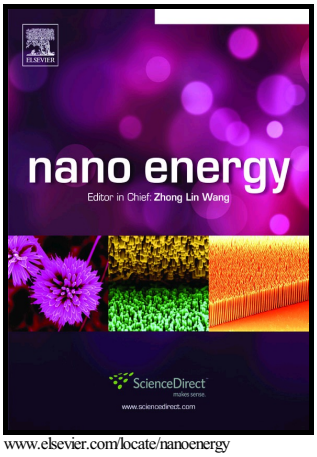

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Study on the influence of semiconductive property for the improvement of nanogenerator by wave mode approach

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Abstract

Some piezoelectric materials, such as zinc oxide, are semiconductors simultaneously. Usually, the semiconductive property of these materials is omitted in the study of piezoelectric characteristics. However, due to the small sizes of some piezoelectric devices, such as nanogenerators, the semiconductive property may have an appreciable impact on the wave motion characteristics and potential output. In this paper, we study the influence of semiconductive property for the improvement of nanogernerators through the propagation of shear-horizontal waves in a piezoelectric semiconductor plate of 6mm class crystals by using wave mode approach. Some interesting results are observed from the points of both mechanical and electrical views. Mechanically, the semiconductive property will reduce the frequencies of waves (decrease the kinetic energy of waves), and cause new size-dependent wave modes due to the drift of electrons and holes. Meanwhile, a size-dependent acoustic loss is generated, where the acoustic loss becomes greater when the size gets smaller. Electrically, by comparing the magnitudes and distributions of potential between the cases with and without semiconduction, it is presented that energy can be harvested not only when the deformations are generated but also when the deformations are recovering. Further, the potential output in piezoelectric semiconductor can be improved by increasing strain and reducing conductivity. These results are useful for the design of piezoelectric semiconductor devices. They are also good corrections to the theoretical analyses of some piezoelectric devices in which semiconductive property is omitted, especially for the devices with small sizes.

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