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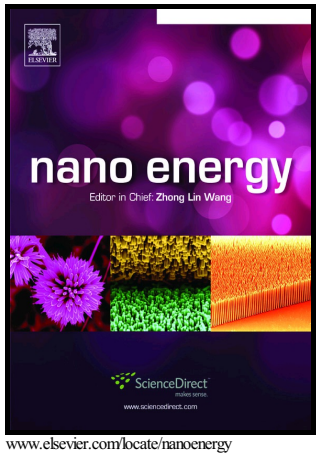

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Enhanced Energy Harvesting through Nanowire Based Functionally Graded Interfaces

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Abstract

Vertically aligned nanowire (NW) arrays are a promising material architecture for the development of electromechanical transducers. The high aspect ratio of the nanowires (NWs) allows large deformation of the nanoscale functional constituents, which leads to an efficient electro-mechanical energy conversion in miniaturized sensors and energy harvesting devices. Another unique advantage of vertically aligned NWs is their use in creating a functional gradient which acts to blend the mechanical properties of two dissimilar materials. Here the performance of piezoelectric energy harvesters, which utilize a functionally graded NW interface rather than a discrete film interface, are studied. After a thorough device characterization, it is revealed that the NW-based power harvesters produce 7.2 times more power than the film-based devices with the same piezoelectric volume. The enhanced performance and improved durability of the energy harvesters composed of nanowire interface are explained by the hierarchical structure and different operation modes of the piezoelectric constituents. This work establishes the importance of the interface mechanics on the electromechanical properties and the performance of piezoelectric transducers and is applicable to any bonded piezoelectric device, whether it is an energy harvester, sensor or actuator.