

Piezoelectric Nanogenerators for Self-powered Nanosystems

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Developing novel technologies for wireless nanodevices and nanosystems are of critical importance for in-situ, real-time and implantable biosensing, biomedical monitoring and biodetection. An implanted wireless biosensor requires a power source, which may be provided directly or indirectly by charging of a battery. It is highly desired for wireless devices and even required for implanted biomedical devices to be self-powered without using battery. Therefore, it is essential to explore innovative nanotechnologies for converting mechanical energy (such as body movement, muscle stretching), vibration energy (such as acoustic/ultrasonic wave), and hydraulic energy (such as body fluid and blood flow) into electric energy that will be used to power nanodevices without using battery. It also has a huge impact to miniaturizing the size of the integrated nanosystems by reducing the size of the power generator and improving its efficiency and power density. We have demonstrated an innovative approach for converting nano-scale mechanical energy into electric energy by piezoelectric zinc oxide nanowire (NW) arrays. By deflecting the aligned NWs using a conductive atomic force microscopy (AFM) tip in contact mode, the energy that was first created by the deflection force and later converted into electricity by piezoelectric effect has been measured for demonstrating nano-scale power generator. The operation mechanism of the electric generator relies on the unique coupling of piezoelectric and semiconducting dual properties of ZnO as well as the elegant rectifying function of the Schottky barrier formed between the metal tip and the NW.

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[2] P.X. Gao, Y. Ding, W.J. Mai, W.L. Hughes, C.S. Lao and Z.L. Wang* “Conversion of Zinc Oxide Nanobelt into Superlattice-Structured Nanohelices”, *Science*, 309 (2005) 1700-1704.
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