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Editorial

Multi-Effects Coupled Nanogenerators

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Nanoenergies, including mechanical, thermal and solar energies, can be found in our surroundings. The Wang term $\partial P_s/\partial t$ has been utilized as the driving force in nanogenerators for scavenging various mechanical energies such as those from human motions, water droplets and wind [1]. The piezoelectric nanogenerator was reported in 2006 and the triboelectric nanogenerator was invented in 2012 [2,3]. These two nanogenerators have been extensively utilized in self-powered sensors, high-voltage power sources and blue energy [4–6]. The purpose of developing the hybridized nanogenerators is to obtain a stable energy-scavenging capacity via integrating different energy-scavenging units. The integration of triboelectric nanogenerators and electromagnetic generators can effectively increase the conversion efficiency from mechanical energy into electricity [7], which can be used in various modes of mechanical motions.

Multi-effects coupled nanogenerators are based on using one multifunctional material with the same electrodes to individually or simultaneously scavenge mechanical, thermal, and solar energies [8]. Many ferroelectric materials such as BTO, BFO and BNT can be utilized to fabricate multi-effects coupled nanogenerators [9–11], and coupling enhancement has been observed in a piezoelectric–photovoltaic coupled nanogenerator when simultaneously harvesting vibration and solar energies [12]. Some new physical effects such as the ferro-pyro-phototronic effect and the thermo-phototronic effect have been invented in these coupled nanogenerators [13,14]. The development of high-performance coupled nanogenerators is still an important step for pushing the practical applications of coupled nanogenerators in to multifunctional sensor uses [15]. A high piezoelectric coefficient, a narrow band gap, and a high pyroelectric coefficient are needed in the ferroelectric materials for the development of these coupled nanogenerators.

The research of multi-effects coupled nanogenerators will focus on finding new ferroelectric materials with larger coupling coefficients, increasing the coupling efficiency among different nanogenerators, and realizing the applications of coupled nanogenerators combined with artificial intelligence in multifunctional sensors. Multi-effects coupled nanogenerators will become more and more important in the nanoenergy field, where the new physical effects and key applications may be found in the future.

Conflicts of Interest: The author declares no conflict of interest.

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