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Multi-type energy-scavenging nanogenerators based on the coupling of piezoelectric, triboelectric, and thermal properties

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Energy conversion from the environment is a core technology for future wireless/portable electronics and global environmental problems. To harvest the energy at anytime and anywhere, it is important to explore innovative technologies that utilize diverse forms of energy such as mechanical vibrations, acoustic energy, and thermal energy. Furthermore, the multiple-type energy scavenger based on flexible soft materials could have a variety of implications on flexible electronics. As the first issue of this talk, the extremely stable high-power generation from hybrid piezoelectric nanogenerator (HP-NG) based on a composite of single-crystalline piezoelectric perovskite $ZnSnO_3$ nanocubes and PDMS without any electrical poling treatment will be presented. Very interestingly, the HP-NG generates large power output under only vertical compression, while there is negligible power generation with other configurations of applied strain, such as bending and folding.

In the second part, triboelectric NGs (TNGs) based on double layer, triple layer and few layers of graphene have been fabricated and their output voltage and current were measured under various mechanical strains and applied frequency. Monolayer based graphene TNG exhibits high power compared to other randomly staked graphene layer based TNG, while output voltage and current from conventional staked few layers based TNG reached up to maximum value of 8 V and 800 nA, with conversion efficiency up to 6.7 %. The variations of electric output among monolayer, double layer, triple layer, quadruple and few graphene layer based TNG is explained in term to friction, electron affinity, and different interlayer repulsion.

Finally, I will report on stretchable and flexible hybrid energy scavenger NG device based on micro-patterned piezoelectric P(VDF-TrFE) polymer, micro-patterned PDMS-CNT composite and graphene electrode. I will present a highly robust and stable performance of piezoelectric-pyroelectric hybrid stretchable NG (HSNG) even after a number of stretching and releasing cycle, which confirm the robustness of device. The output voltage of fabricated HSNG was measured under various mechanical strains and temperature gradient separately, which further successfully integrated together and we achieved a recordable high power generation from HSNG under mechanical and thermal energy at same time.