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Zhong Lin Wang[1,2]

[1]Georgia Institute of Technology, USA

[2]Beijing Institute of Nanoenergy and Nanosystems, CAS, China

Nanogenerators for self-powered systems and piezotronics for artificial intelligence

Developing wireless nanodevices and nanosystems is of critical importance for sensing, medical science, environmental/infrastructure monitoring, defense technology and even personal electronics. It is highly desirable for wireless devices to be self-powered without using battery. Nanogenerators (NGs) have been developed based on piezoelectric, trioboelectric and pyroelectric effects, aiming at building self-sufficient power sources for micro/nano-systems. The output of the nanogenerators now is high enough to drive a wireless sensor system and charge a battery for a cell phone, and they are becoming a vital technology for sustainable, independent and maintenance free operation of micro/nano-systems and mobile/portable electronics. An energy conversion efficiency of 55% and an output power density of 500 W/m^2 have been demonstrated. This technology is now not only capable of driving portable electronics, but also has the potential for harvesting wind and ocean wave energy for large-scale power application. This talk will focus on the updated progress in NGs. For wurtzite and zinc blend structures that have non-central symmetry, such as ZnO, GaN and InN, a piezoelectric potential (piezopotential) is created in the crystal by applying a strain. Such piezopotential can serve as a "gate" voltage that can effectively tune/control the charge transport across an interface/junction; electronics fabricated based on such a mechanism is coined as piezotronics, with applications in force/pressure triggered/controlled electronic devices, sensors, logic units and memory. By using the piezotronic effect, we show that the optoelectronic devices fabricated using wurtzite materials can have superior performance as solar cell, photon detector and light emitting diode. Piezotronics is likely to serve as a "mechanosensation" for directly interfacing biomechanical action with silicon based technology and active flexible electronics. This lecture will focus on the updated progress in the field and its expansion to 2D materials.

Biography

Zhong Lin Wang is the hightower Chair in Materials Science and Engineering, Regents' Professor at Georgia Tech, and Director of Beijing Institute of Nanoenergy and Nanosystems. He has made original and seminal contributions to the synthesis, discovery, characterization and understanding of fundamental physical properties of oxide nanobelts and nanowires, and their applications in energy sciences, sensors, electronics and optoelectronics. His discovery and breakthroughs in developing nanogenerators establish the principle and technological road map for harvesting mechanical energy from environment and biological systems for powering mobile sensors. He first showed that the nanogenerator is originated from the Maxwell's displacement current, revived the applications of Maxwell's equations in energy and sensors. His research on self-powered nanosystems has inspired the worldwide effort in academia and industry for harvesting ambient energy for micro-nano-systems, which is now a distinct disciplinary in energy science for future sensor networks and internet of things. He coined and pioneered the fields of piezotronics and piezo-phototronics by introducing piezoelectric potential gated charge transport process in fabricating strain-gated transistors for new electronics, optoelectronics, sensors and energy sciences.

zlwang@gatech.edu

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