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**Piezophototronic based sensors and applications****Junyi Zhai**

Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Science, Beijing, China

**M**ultifunctional micro/nano devices and systems are of important applications in smart electronics for health care, human-machine interfacing, infrastructure monitoring and security. In recent years, piezophototronic effect is developed fast since it offers a new method to improve/tune the optoelectronic properties dramatically. The key characteristic of the piezophototronic effect is that the carrier generation, transport, separation and/or recombination at the heterojunction/interface can be tuned by modulating the piezopotential which created and further tuned by externally applied strain. Therefore, one method to enhance piezo-phototronic effect is increasing piezoelectric charge at the interface. Another method to improve piezo-phototronic effect is reducing charge carrier recombination probability, the design of semiconductor composites heterojunction/interface should take into account their band positions and band gap. By interface engineering the p-n junction, piezo-phototronic effect can be improved. Piezophototronic effect can enhance the sensitivity of photodetector dramatically. Here, we show a self-powered GaN flexible film-based metal-semiconductor-metal (MSM) UV photoswitch. The asymmetric MSM structure was designed to suppress carrier recombination and enhance carrier transport. At self-powered condition (no external bias voltage), its UV on/off ratio reaches up to  $4.67 \times 10^5$  with high reliability of on/off switching response. Also its UV detection shows an excellent sensitivity ( $1.78 \times 10^{12} \text{ cm}^2/\text{Hz} \cdot \text{W}$ ). In particular, strain modulation can improve the UV on/off ratio ( $\sim 154\%$ ) by piezo-phototronic effect. When combine piezophototronics effect with magnetostriction, multi-field couplings can be realized. For example, magneto-optics and electro-optics, magneto-electrics and magneto-mechanics, piezotronics and piezophototronics, which could be of interest for fabricating functional devices in the fields of energy conversion, magnetic/optical imaging, high-density optical communication and information storage, smart sensing, and so on. Besides photoelectric conversion and electroluminescence, photoluminescence can be tuned by piezoelectric charge as well. Here have developed a new method of pressure sensing by using pressure/strain induced piezoelectric charge to tune PL intensity of InGaN/GaN MQW under small strain ( $0 \sim 0.15\%$ ). Such modulation effect is distinct, linear and ultrafast. Based upon it, an all optical pressure sensor array by the piezo-phototronics effect has been developed to measure dynamic pressure distribution without the need of electricity. Beyond the limitations of electrical connection, our all-optical device offers a novel and suitable way for large-area, high-uniform, high resolution, ultrahigh speed pressure/strain distribution sensing.

**Biography**

Junyi Zhai is a professor in the Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Science, leading the group of Micro/Nano Piezoelectric Materials and Devices. He was a Director's postdoctoral fellow in Los Alamos National Laboratory. He received his B.S. in Chemistry from Tsinghua University; M.E. in Materials Science and Engineering from Tsinghua University; Ph.D. from Virginia Tech in Materials Science and Engineering. His main research interests are fundamental and technological investigation of functional materials and multi-fields coupling for applications in electronics, sensors and energy. Prof. Zhai has authorized or co- authorized 70 papers with over 3000 citations.

jyzhai@binn.cas.cn

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