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Advanced ZnO Based Piezo-Phototronic Optoelectronics

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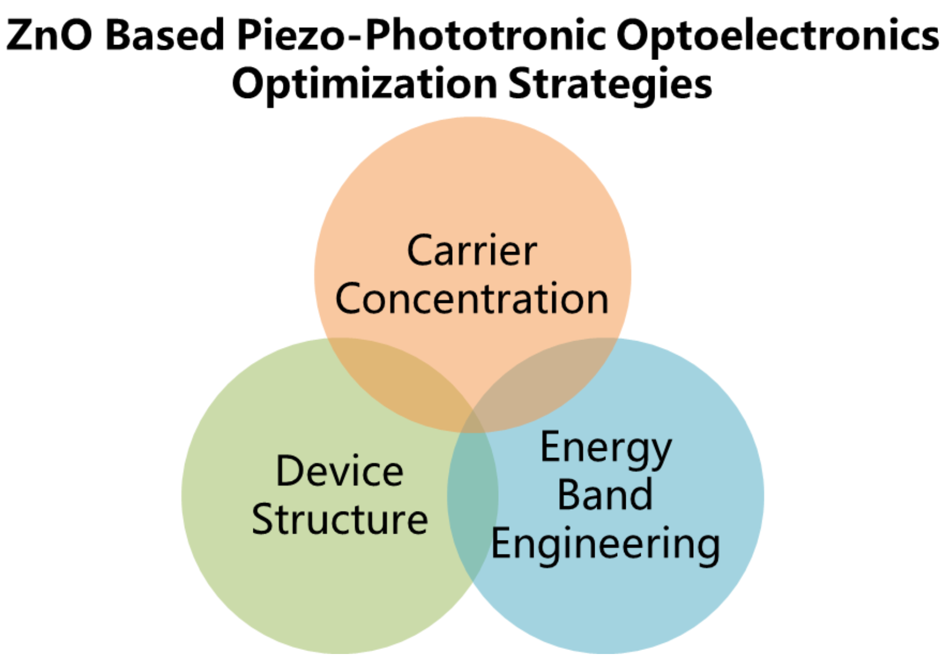
Graphical Abstract



Abstract

Since its invention in 2010, piezo-phototronic effect has been widely used in piezoelectric semiconductor materials and optoelectronic devices, e.g., solar cells, light-emitting diodes, and photodetectors, for both fundamentally physical research and potential applications. However, so far, the most related researches are mainly focused on whether piezo-phototronic effect could modulate the devices' performance, and the reported piezo-phototronic effect induced enhancement is varying from a few dozen percent to thousands percent. Why the piezo-phototronic effect could induce such different performance improvements in different optoelectronic devices? In some special cases, the piezo-phototronic effect even causes performance degradation. Therefore, it is of great significance to carefully investigate the role of the piezo-phototronic effect plays in different optoelectronic devices, which might possibly give us more clear understandings of the piezo-phototronic effect and further constructive suggestions of how to utilize it more effectively. In our recent works in the past a few years, we have systematically studied the piezo-phototronic effect in optoelectronic devices using ZnO as the piezoelectric semiconductor material, including: photodiodes with different device structures [**1**], thin-film

transistors with different charge carrier concentrations [**2**], and heterojunctions with different energy band diagram alignments [**3**], to reveal the underlying physics in piezo-phototronic effect. Our experimental and theoretical results indicate that: (1) the charge carrier concentration in ZnO is of great importance, should not being too small or too large; (2) compared to isotype photodiodes, anisotype photodiodes are preferred; (3) energy band diagram alignment is also preferred since misalignment would cause negative effects when introducing the piezo-phototronic effect. At last, we give a systematic instruction on how to utilize the piezo-phototronic effect more effectively.

Keywords: ZnO; piezo-phototronic; optoelectronic.

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