Characterizations of Semiconductor Photodetectors for UV Detection

Linghui Li and Ping Yu*
Department of Physics and Astronomy, University of Missouri, Columbia, Missouri 65211, USA
*yuping@missouri.edu

Wide band-gap semiconductors have shown great potential in UV light detection as modern optoelectronic devices. During the past decade, wide-bandgap GaN and AlGaN photodetectors have been developed and their UV characterizations have been extensively studied. However, these devices suffer from the problem of persistent photoconductivity due to defects, grain boundaries and surface states in the material. ZnO is a direct wide band-gap II-VI semiconductor that exhibits excellent photosensitive properties at the UV wavelength. It is more radiation-resistive than other semiconductors and is therefore a strong candidate for fabricating photonic devices that can operate in extreme environments and conditions such as space and nuclear reactors. In this work, we summary our recent studies on several ZnO structures including metal-semiconductor-metal photodiodes and p-n junctions. The devices are fabricated by the MOXtronics, Inc. The spectral responsivity provides the spectrally resolved conversion efficiency over a wide spectral range. It determines not only the above bandgap photoresponsivity, but also the responsivity in the visible range, giving the UV/Vis rejection rate that is an important parameter for UV detectors. The time response is measured using a short pulse laser with photon energy above the band-gap of the semiconductor and a 1GHz fast oscilloscope. A series of load resistors are used to extend to the limit of external resistance where only the carrier recombination and device structure (capacitance and internal resistance) are the mechanisms for explaining the time responsivity. The frequency responsivity is measured by using both lock-in amplifier and spectrum analyzer. Theses characterizations will be helpful for designing, modeling and fabricating ZnO devices for UV applications.