

DEVELOPMENT AND ANALYSIS OF ZNO-BASED SEMICONDUCTOR PHOTODETECTOR FOR UV DETECTION

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ABSTRACT

The objective of this thesis is to develop ZnO-based semiconductor photodetectors for UV detection with low dark current, high responsivity, and fast response time. To achieve this objective, an understanding of carrier recombination and transport mechanisms of the devices is necessary by investigating their electrical properties and optical properties. The photoresponse under continuous wave excitation and pulse excitation along with the frequency photoresponse provide characterizations and useful mechanism information of the devices. These measurements are also helpful to the optimization of the structures in the UV detectors.

In this thesis, various ZnO UV detectors are investigated, including ZnO photoconductors, metal-semiconductor-metal (MSM) ZnO photodetectors with Ohmic contacts, post-processed MSM ZnO photodetectors with Schottky contacts, and p-i-n ZnO photodetectors. Experimental data and analysis give four unique results: (1) Very high photoelectric gain was confirmed in ZnO photoconductors. Persistent photoconductivity was observed in these detectors, which is due to carriers trapped in surface states. (2) A high gain and high speed photo-detection was validated in ZnO MSM photodetectors with Ohmic contacts. (3) A extremely low dark current and very high UV-Visible rejection was observed in ZnO MSM photodetectors with Schottky contacts. (4) Two photocarrier processes were found for the first time in ZnO p-i-n photodetectors. Our results show that semiconductor photodetectors based on ZnO are a promising candidate for UV detection.