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ZnSe-based solar-blind ultraviolet photodetectors with hybrid Ag-nanowire and Ni/Au contacts

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Zinc selenide is a wide bandgap semiconductor which is attractive for the fabrication of many optoelectronic devices, including ultraviolet (UV) photodetectors, due to its large bandgap energy (2.67 eV at 300 K), high electric breakdown field strength (~ 1 MV/cm), as well as high resistance to intense UV and X-ray radiation. Most commercial UV-photodetectors are based on Si or GaAs semiconductors, which require a filter to eliminate visible and infrared light. To solve this issue, bulk high-resistivity ZnSe could be used for fabrication of a stable UV photodetectors with metal-semiconductor-metal (MSM) structures. In this work, we report on fabrication and characterization of ZnSe-based UV photodetectors with hybrid Ag-nanowire (Ag-NW) and Ni/Au contacts. High resistivity bulk ZnSe crystals grown were used as an active layer. ZnSe-based UV photodetectors with hybrid contacts have been fabricated: one of contacts is a conventional Ni/Au contact and the second one is Ag-nanowire contact. The Schottky contacts were fabricated by e-beam evaporation of 25 nm Ni followed by a thermally evaporating of 140 nm Au, and performing standard photolithographic and lift-off processes. A 500 nm dielectric SixNy passivation layer was placed above the metallic structure in order to prevent electric breakdown. A simple spin coating method was used to distribute a commercially available Ag-NWs with diameter of 120 nm over the ZnSe substrate. The alignment of the Ag-NWs has been performed using dielectrophoresis method. The current-voltage characteristics of fabricated UV photodetectors in the dark and under UV illumination were measured using a Keithley 2612 multimeter. The applied bias voltage was varied from 0 V to 15 V. The photocurrent was excited by a 325-nm Cd-He laser with output optical power of 56.5 mW. The current-voltage characteristics of the UV photodetectors with hybrid Ag-NW and Ni/Au contacts in the dark and under illumination with the UV laser were measured. It is found that the dependence of dark current increases exponentially with the increase of bias voltage up to 2.5 V, and then it increases practically linearly when the bias voltage is above 2.5 V. When a bias voltage of 15 V is applied, the maximum dark current is equal to 0.36 nA. Under UV illumination, the behavior of I-V characteristics shows significant changes and becomes non-linear indicating carrier multiplication effects. The responsivity of photodetector with hybrid contacts has a similar character to the photocurrent dependence of the respective device. A maximum value of responsivity of 0.58 A/W at bias voltage of 15 V for light with a wavelength of 325 nm is found for this device. A maximum values of detectivity of $5.49\times10^{1}0cmHz^{1}/2W^{-1}$ and photocurrent on/off ratio of 5006 at bias voltage of 15 V were obtained for this device. Thus, the ZnSe-based UV photodetector with hybrid Ag-NW and Ni/Au contacts could be attractive for high-speed UV telecommunications and UV-Tomography applications.

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