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2P51 - Comparison of Lateral and Vertical Photoconductive Semiconductor Switches Fabricated on 4H-SiC

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Silicon carbide (SiC) based photoconductive semiconductor switches (PCSSs) are interesting because of their potential for higher voltage operation originating from the excellent material properties of SiC. However, the experimentally demonstrated performances of the SiC based PCSSs are still far inferior to those of the GaAs counterpart. To harness their potential inherited from the excellent material properties, more researches are required to improve the device performances.

In this study, the lateral- and vertical-type 4H-SiC PCSSs are fabricated and their performances are compared. The 500-μm-thick, high purity semi-insulating 4H-SiC substrates are utilized to fabricate two different types of PCSS devices. The optoelectronic conversion characteristics of the two types of PCSS devices were measured by using 532-nm-wavelength triggering laser under the applied bias voltages up to 3 kV. The vertical-type PCSS outperforms the lateral type PCSS in various aspects. The vertical-type PCSS exhibits 12-times higher output voltage and 3-times wider full-width-half-maximum (FWHM) pulse width when compared with the lateral-type PCSS for same bias voltage and same irradiation conditions. The vertical PCSS enjoys longer optical path length leading to higher photocurrent. The current conducting channel is formed in the bulk of the vertical PCSS, but the dominant channel of the lateral-type PCSS is formed along the top surface of the device. The high recombination velocity at the SiC surface makes the electron-hole pairs generated close to the surface hard to be collected by the anode and cathode electrodes, which lowers the peak voltage and shortens the output pulse width. It is also noted that the vertical-type PCSS outperforms lateral-type PCSS in terms of high voltage operation capability. The vertical PCSS structures effectively suppress the effect of the imperfect SiC surface and achieves better performance compared with the lateral PCSS structures. This work was supported by KEPCO (R18XA06-79) and Korea Agency for Defense Development

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