Application of High-Resistivity Silicon Substrates for Fabrication of MOSFET-based THz Radiation Detectors

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MOS transistors have been used as THz detectors since many years. The detection mechanism is demonstrated by a generation of a DC drain-source voltage in the illuminated MOSFET with the open drain terminal. This effect was theoretically predicted by Dyakonov and Shur [1]. It brought several applications in imaging and, more recently, in telecommunication areas. An important problem in such devices is the radiation energy dissipation. It may be reduced using lenses made of high resistivity (HR) silicon attached at the backside of the detector (for illumination from the backside), by manufacturing of the MOSFETs on HR silicon or by a suitable thinning of the detector substrate.

Measurements of the photoresponse of MOSFETs equipped with monolithic antennas, manufactured on different substrate types were reported in [2]. The initial results obtained for MOSFETs on thinned HR (111) wafers indicated that they could be a promising alternative for the most sensitive MOSFETs on SOI wafers. In order to verify this hypothesis further experiments have been carried out based on thinned SOI and two types of HR Si wafers. Interestingly, the measurements results have shown that, if the MOSFETs are manufactured on membranes formed in the HR silicon wafers, then their THz responsivity is high, even higher than of the MOSFETs manufactured on SOI wafers with HR substrates.

The recent results have also demonstrated, that a proper design of a layout defining the MOSFET channel stopper area has a strong effect on the detector THz sensitivity. The responsivity may be efficiently increased if the channel stopper (the strongly doped region preventing a formation of parasitic channels) is removed below antennas, contrary to the requirements of the standard NMOS technology requirements.

[1] M. I. Dyakonov, M. S. Shur, IEEE Trans. Electron Devices **43**, 380 (1996)
[2] K. Kucharski, P. Zagrajek, D. Tomaszewski, A. Panas, G. Głuszko, J. Marczewski, P. Kopyt, *Acta Phys. Pol.* **130**, 1193 (2016)