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Reversible Alteration of Reverse Current in Mo/n-Si Structures Under Ultrasound Loading

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It is known, that controlled modification of the defect subsystem, so-called the "defect engineering" is one of methods of semiconductor structure and device performance improvement. Certainly, irradiation and thermal treating are the commonly used for achieving of these goals. The alternative ways of influencing on defects is the use of ultrasound (US) waves [1]. Thus potentialities of US treatment were shown to impact on the semiconductor material defect subsystem as well as to change integrally the properties of semiconductor barrier structures [2]. At the same time the effects appearing under US loading and vanishing after elastic oscillations turn off, are poorly investigated, although it should be of interest; in particular, such dynamic phenomena might be used to create a new class of acoustodriven devices.

The results of the experimental investigations of the reverse current-voltage characteristics of the Mo/$\boldsymbol{n}$-$\boldsymbol{n}^{+}$-Si Schottky structures are presented. We used the structures of n-Si:P epitaxial layer (0.2 μm thick) on n^{+}-Si:Sb. The thickness and the free carriers concentration of the substrate were 250 μm and 4.2×10^{22} m^{-3} respectively. A molybdenum Schottky contact, 2 mm in diameter, was fabricated on the epi-layer surface. The structures were irradiated by γ-rays ^{60}Co, the cumulative doses were equal to 0, 10, and 100 kGy. The investigation has been carried out in the temperature range 120–330 K and for the ultrasound loading condition (vibration frequency was 9.6 MHz, intensity of the longitudinal wave was up to 1.3 W/cm^2). The forward and reverse ***I-V*** characteristics were measured in the dc current range from 10^{-9} to 2×10^{-2} A.

It was established that the main charge transport mechanisms are the thermionic emission, the direct tunneling through deep center and the tunneling stimulated by phonons; the last one appeared after irradiation only. For the first time the acousto-stimulated reversible increase (up to 50%) of the reverse current has been revealed. The possibility of a creation of a γ-irradiation sensor based on this effect was considered. It was shown that effect's features can be explained by an ionization of the interface defects due to an interaction between ultrasound and dislocations or point radiation defects in the non-irradiated or irradiated structures respectively.

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