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Electrically active defects in 4H-SiC

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We present a study of electrically active radiation-induced defects formed in 4H-SiC epitaxial layers following irradiation with fast neutrons, 600 keV H+ and 2 MeV He++ ion implantations. The Schottky barrier diodes (SBD) were formed by evaporation of nickel through a metal mask with patterned quadratic apertures of 1 mm × 1 mm, while Ohmic contacts were formed by nickel sintering at 950 ℃ in Ar atmosphere on the back side of the silicon carbide substrate. The low leakage current of the order of pA (1 mm2 active area) have been measured even for the highest applied reverse biases of up to 500 V.

We have combined Laplace-Deep Level Transient Spectroscopy (Laplace-DLTS) measurements and density functional theory (DFT) calculations to study the carbon vacancy (VC) in n-type 4H-SiC. The Vc is known as the main "lifetime killer"in 4H-SiC. Using Laplace-DLTS we were able to provide sub-lattice resolved spectra of the broad DLTS peak at 290 K commonly observed in n-type 4H-SiC. This peak, previously ascribed to two closely related traps referenced as Z1/2, has two components with activation energies for electron emission of 0.58 eV and 0.66 eV. We compared these results with the acceptor levels of VC obtained by means of hybrid density functional supercell calculations. The calculations support the assignment of the Z1/2 signal to a superposition of emission peaks from double negatively charged VC defects. Taking into account the measured and calculated energy levels, the calculated relative stability of VC in hexagonal (h) and cubic (k) lattice sites, as well as the observed relative amplitude of the Laplace-DLTS peaks, we assign Z1 and Z2 to VC(h) and VC(k), respectively.

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