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Effect of nitrogen doping on characteristics of pad detectors irradiated with high proton fluences

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The current-voltage characteristics of pad detectors made on high-resistivity FZ Si wafers and irradiated with 23-MeV protons are compared. The studies were performed using the detectors with the active region material of various properties: N-free, N-rich, and O-rich. The nitrogen was introduced during the growth of FZ Si crystal used for producing the substrate wafers. The oxygen was incorporated by the in-diffusion at 1150 oC for 24 h from the oxide layer deposited in the process of detectors fabrication. The detectors were irradiated with the proton fluences of 5E13, 1E14, 5E14, 1E15, and 5E15 n(eq)/cm^2. It is shown that after the irradiation with each of these fluences, the active region material of detectors becomes semi-insulating with nearly the intrinsic resistivity. The leakage current is dependent either on the proton fluence or on the material properties. For the lower fluences, 5E13 and 1E14 n(eq)/cm^2, the minimal values of the leakage current are observed for the N-rich material, while for the higher fluences, 5E14 and 1E15 n(eq)/cm^2, the minimal values of the leakage current are observed for the O-rich material. The results of infrared absorption measurements indicate that the concentration of N-N pairs in nitrogen-enriched FZ Si decreases with increasing the fluence above 5E14 n(eq)/cm^2. The properties and concentrations of radiation defect centers in the material of detectors active region have been studied by HRPITS technique. The dependences of the centers concentrations as a function of the proton fluence are demonstrated.

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