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Evolution of scintillation and electrical characteristics of AlGaN during hadron irradiation

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The wide direct-bandgap AlGaN is one of the most promising materials for fabrication of radiation hard, double response particle detectors for future collider facilities. However, formation of defects during growth and fabrication of AlGaN based devices is unavoidable. Furthermore, radiation defects are formed in detector structures during operation at extreme conditions.
Study of defect evolution in-situ during hadron irradiation has been performed in this work. GaN and AlGaN (with various Al concentrations) epi-layers grown by metalorganic chemical vapour deposition technique on sapphire substrate have been examined. Electrical signals were registered (using the barrier evaluation by linearly increasing voltage method) simultaneously with the hadron induced luminescence spectra, recorded using signal integration regime. To evaluate the parameters of thermal emission in Schottky barrier structures and cross-sections of the photon-electron coupling, ascribed to technological and radiation defects in the AlGaN crystals, the complementary ex-situ measurements were performed by deep level transient and pulsed photo-ionization spectroscopy techniques.
It has been shown that these combined methods of the in situ-and ex-situ measurements enable ones to trace evolution of the electrical and scintillation characteristics of AlGaN layers with fluence of hadron irradiations. Variations of spectral and electrical parameters could be applied for remote dosimetry of large hadron fluences.

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