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Degradation of InGaN LEDs by Proton Radiation

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Abstract
Light-emitting diodes (LEDs) made of nitride are appealing because they can withstand high temperatures and be used in harsh environments. The degradation behaviour of the device performance on Indium Gallium Nitride (InGaN) LEDs (light emitting diodes) irradiated by 2-MeV protons with the fluence of 1×1013 cm-2 is studied. The electrical and optical characteristics of three commercially available LEDs, VLHW4100, OVLAW4CB7 and VAOL-3GWY4, were compared before and after radiation. The results show a considerable degradation in the LED electrical performance. After irradiation, the reverse leakage current increases in all three devices. The degradation in OVLAW4CB7 is for the entire reverse bias voltage range, while the degradation is prominent at lower reverse bias voltages for the other two devices. However, while calculating the increase in dark current at a reverse bias voltage of 5 volts, it is found that the dark current increases the most in VAOL-3GWY4, which is around 22 times. The traps and the bulk defect are believed to contribute to the increased leakage current. The forward Current-Voltage and the Capacitance-Voltage characteristics do not change much after radiation. The optical intensity corresponding to different wavelengths is obtained for the device's optical characterization. The results show that the optical intensity of the devices increased after radiation. This increase is because of the increase in carrier lifetime in the active region after radiation and radiation-induced annealing of defects. In this research quantum well LEDs are used. When using these devices based on InGaN in harsh conditions or open spaces, the degradation characteristics described in the present study can assist scientists and engineers in making well-informed decisions, as little is known about the degradation of InGaN LEDs after proton radiation. © 2023 IEEE.

Author Keywords
Degradation; Indium Gallium Nitride (InGaN); Light Emitting Diodes (LEDs); Proton; Radiation

Index Keywords
Aluminum gallium nitride, Bias voltage, Capacitance, Carrier lifetime, Defects, Gallium alloys, Gallium nitride, III-V semiconductors, Indium alloys, Semiconductor alloys, Semiconductor quantum wells; Current increase, Gallium nitride light emitting diode, Highest temperature, Indium gallium nitride, Light emitting diode, Lightemitting diode, Optical intensities, Proton radiations, Reverse bias voltage; Light emitting diodes

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