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Irradiation-induced improvement in crystalline quality of epitaxially grown InGaN thin films: A preliminary study

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Abstract content
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Group III-nitride semiconductors, aluminium nitride (AlN), gallium nitride (GaN), indium nitride (InN) and related alloys are obtained by combining group III elements (Ga, Al, In) with the group V element, N. The III-V nitrides are an unparalleled material system with many prominent features such as wide bandgap, high mechanical and thermal stability, large piezoelectric constants, and excellent electro-optical properties. The energy gap of ternary III-nitride alloys like indium gallium nitride (InGaN), aluminum gallium nitride (AlGaN), or indium aluminum nitride (InAlN), can be adjusted to conform to light emission in the whole visible spectrum and into the deep ultraviolet (UV) region. In principle, the bandgap energy of the alloys can be varied continuously from 0.7 eV (pure InN) to 6.2 eV (pure AlN). Therefore, III-nitride alloys are ideal building blocks for numerous optoelectronic devices for use in many applications such as UV photo-detectors, visible light emitting diodes (LEDs) and blue laser diodes (LDs).

This work was carried out on the 5UDH-2 Pelletron Tandem Accelerator at Experimental Physics Department, National Centre for Physics (NCP), Islamabad, Pakistan. In this work, we focused on InGaN material for investigation of the effects of Phosphorus (P⁺) irradiation on its structure, optical and electronic properties. Presently, there are a limited number of reports on InGaN:P in the literature. Therefore, it was necessary to investigate the effects of P⁺ incorporation into InGaN thin films. Preliminary results from Rutherford backscattering spectrometry and channeling (RBS/C) indicate that the quality of the InGaN thin films is improved by ion irradiation. Irradiation with 0.7 MeV P⁺ ions to 1 x 10¹⁴ ions/cm² at room temperature reduces the channeling minimum yield (X_{min}) from about 60% to about 30%, but X_{min} increases considerably above this dose. Detailed experimental investigations will be carried out to obtain more information on the observed irradiation-induced-improvement in crystalline quality of InGaN thin films.

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