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Rapid thermal annealing and structural properties of lattice-matched InGaPN on GaAs (001) grown by MOVPE

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Effects of rapid thermal annealing on the structural properties of InGaPN layers grown on GaAs (001) substrates by metal organics vapor phase epitaxy (MOVPE) have comprehensively investigated by using high resolution X-ray diffraction (HRXRD) and Raman spectroscopy, scanning electron microscopy (SEM) and atomic force microscopy (AFM). To obtain the lattice-match InGaPN on GaAs, flow rates of trimethylindium (TMIn, In precursor), trimethylgallium (TMGa, Ga precursor) were respectively kept at 14.7 and 8.6 μmol/min for all the samples. While, the N content was controlled by varying flow rate of dimethyhydrazine (DMHy), which is the N precursor, from 300, 700 and 1,100 μmol/min. Based on HRXRD and Raman scattering results, the In content was examined to be ˜56.2 at%. The N content was estimated to be 1.1 at%, 1.6 at% and 1.9 at% with increasing DMHy flow rate. Lattice-mismatch lower than 0.3% was confirmed for all the samples, corresponding to a lattice-matching condition. Each samples were cut into small pieces and, then, annealed by rapid thermal annealing (RTA) process. Annealing temperature was fixed at 650 ^{o}C, which is an optimum growth temperature of GaAs buffer layer. Annealing time was varied from 0, 30, 60, 120 and 180 s, in order to verify a composition uniformity and crystal ordering. With increasing annealing time up to 120 s, the N content was slightly increased, while for higher annealing time, the N content was dramatically reduced. Also, root mean square (RMS) roughness was observed to be reduced, when annealing time is lower than 120 s. Raman scattering results demonstrated a lowering of b/a ratio with an increasing N content, resulting in a higher crystal ordering. Furthermore, b/a ratio also decreased after RTA. This implies that the N content was increased due to RTA, which is agreed to the HRXRD results. As a result, the RTA process with optimal annealing time significantly improve the structural properties of the lattice-matched InGaPN layers on GaAs (001) substartes.

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