Strain Effect of AlGaN Layer in AlGaN/GaN Heterostructures

김준오[1], 권기중[1], 이상준[1], 김창수[1], 노삼규[1]*, 최정우[2], 정관수[2], 이규석[3]
[1]한국표준과학연구원, [2]경희대학교 전자컴퓨터공학부, [3]한국전자통신연구원
* E-mail : sknoh@kriss.re.kr

Owing to superior structural and physical characteristics of nitride material systems, the III-N compounds and their related heterostructures have attracted tremendous interest not only in applications of devices widely ranged from short-wavelength optoelectronics to high power-high frequency electronics but also in fundamental studies on strained heterointerfaces. In particular, the AlGaN ternary is well known to be the most promising system applicable to ultra-violet emitter/detector and high-power devices due to direct bandgap tunability from 3.4 to 6.2 eV (l = 200 360 nm) and strong thermal durability. However, few result has been reported for strain-related effects in GaN matrix influenced by AlGaN overlayer with uncontrollably large strain. In this study, we report unusual splittings of GaN peaks observed in x-ray diffraction (XRD) and photoluminescence (PL) spectra taken from AlGaN/GaN heterostructures with high Al mole-fraction, which has been interpreted as an influence of strained AlGaN overlayer extended to GaN matrix layer. The reciprocal space mapping (RSM) technique of XRD were introduced for quantitative evaluation of Al contents and qualitative analysis on crystallineity. As the Al mole fraction increases, a single GaN peak splits into three peaks in both XRD and PL spectra, and the GaN PL peak due to donor-bound exciton moves to higher energy in parallel with a pair of extrinsic peaks. The peak splittings and the blue shift may be possibly associated with different crystalline domains of GaN matrix layer separated by a strong tensile stress of AlGaN overlayer. It implies that the crystallinity of GaN matrix near AlGaN/GaN heterointerface can be influenced by strained AlGaN overlayer. The peak splitting and the blue shift of GaN PL spectra are discussed in contrast with the XRD peak splitting at viewpoint of partial strain relaxation arisen near the AlGaN/GaN heterointerfaces