AlGaN/GaN HEMT sub-bands study using Low-temperature Photoluminescence

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Abstract

$Al_{0.15}Ga_{0.85}N$/GaN HEMTs (High Electron Mobility Transistor) structures with different δ-doping concentration and spacer thickness grown on sapphire by MOCVD are studied. The hall mobility is as high as 1333 $cm^2/V \bullet s$. at room temperature and 6330 $cm^2/V \bullet s$ at 77 K respectively. Obvious 2-DEG phenomena not identified in literatures before are observed by PL spectra measured at low temperature (Fig 1). The influences of δ-doping concentration and spacer thickness on the 2-DEG phenomena are discussed. Sub-bands in 2-DEG well calculated by WKB method are compared with the PL spectra observed.

Peak red-shift due to temperature variation are observed in 2-DEG sub-bands as well as at the band-edge emission (Fig 2). This is caused by the band-gap discontinuity at the interface. Bias was applied across the 2-DEG wells to change the sub-bands' energy levels. Different PL spectra were also obtained for different well potentials.

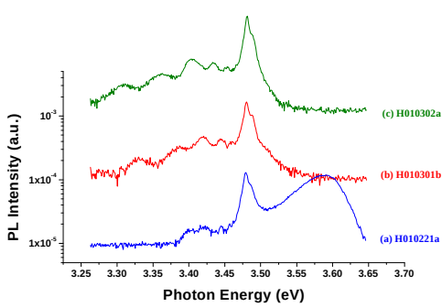

Fig1. PL Spectra at 10 K for different structures of $Al_{0.06}GaN_{0.94}N$ / $Al_{0.1}Ga_{0.9}N$ / δ-doping /$Al_{0.15}G_{0.85}N$ / GaN HEMT with different thickness (a)300Å/200Å/30Å/30Å/2 μm, (b) 100Å/100Å/30Å/30Å/2 μm, and (C) $Al_{0.06}GaN_{0.94}N$ /$Al_{0.1}Ga_{0.9}N$/ δ-doping /$Al_{0.2}G_{0.8}N$ / GaN with thickness of 100Å/100Å/30Å/30Å/2 μm

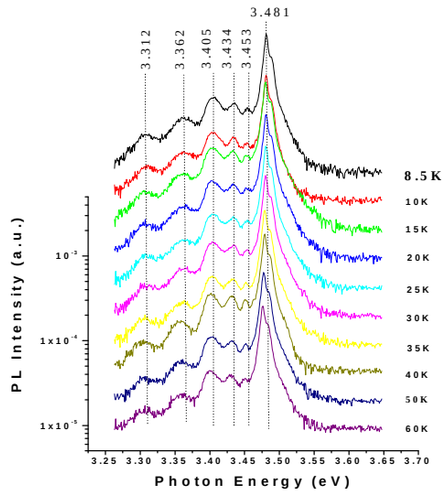

Fig2. Temperature dependent PL spectra for H010302a.