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Si-Doped $In_{0.23}Ga_{0.77}N$/GaN Short-Period Superlattice Tunneling Contact Layer used on InGaN/GaN Laser Diode

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Abstract

Si-doped n^+-$In_{0.23}Ga_{0.77}N$/GaN short-period super-period superlattice (SPS) tunneling contact layer were used on InGaN/GaN multiple-quantum-well laser diode (LD) structures which were grown on c-face sapphire substrate by metalorganic vapor phase epitaxy (MOCVD). The $In_{0.23}Ga_{0.77}N$/ GaN(n+)-GaN(p) tunneling junction, which used the low-resistivity n^+-$In_{0.23}Ga_{0.77}N$/GaN SPS instead of the high-resistivity p-type GaN as a top contact layer, allows the reverse-biased tunnel junction to form a “quasi-ohmic” contact. Experimental results have clearly indicated that the insertion of the n^+- $In_{0.23}Ga_{0.77}$ N/GaN SPS tunneling contact layer between contact metal and p-type GaN layer provides the excellent ohmic and current spreading characteristics. The lower threshold current of the LD with SPS contact layer was achieved. LDs were operated above the threshold current under pulsed injection with a pulse width of 300 ns, the LD with an SPS layer exhibited a longer lasing duration than that of LD without an SPS layer. When the widths of input pulse were lengthened from 300 ns to 2 s, the lasing duration of the LD with Pt contact was three times longer than that of the LD with Ni/Au contact. Therefore, one would like to conclude that nitride-based LDs with an SPS tunneling contact layer will significantly reduce the contact resistance of an anode electrode and thereby increase the thermal stability of the device reliability.

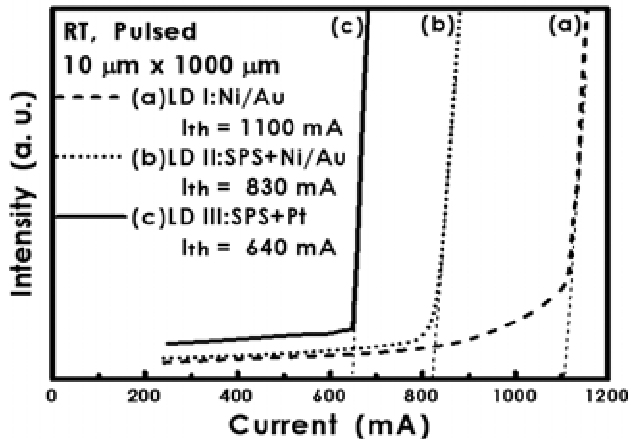

Fig. 1. Room-temperature L-I characteristics of the (a) LD I, (b) LD II, and (c) LD III.

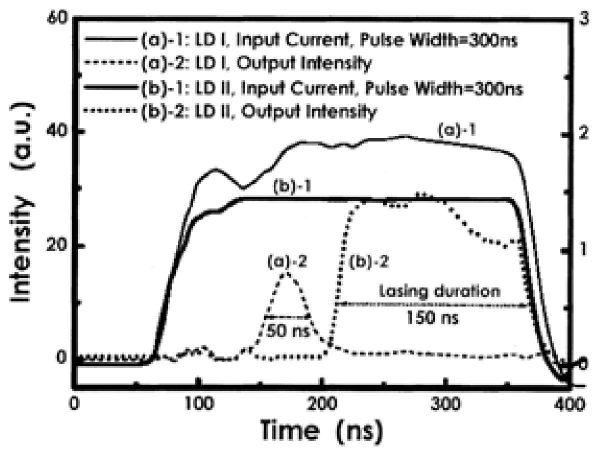

Fig. 2 Lasing duration characteristics of (a) LD I and (b) LD II. Both LDs were measured undera pulse width of 300 ns at room temperature.

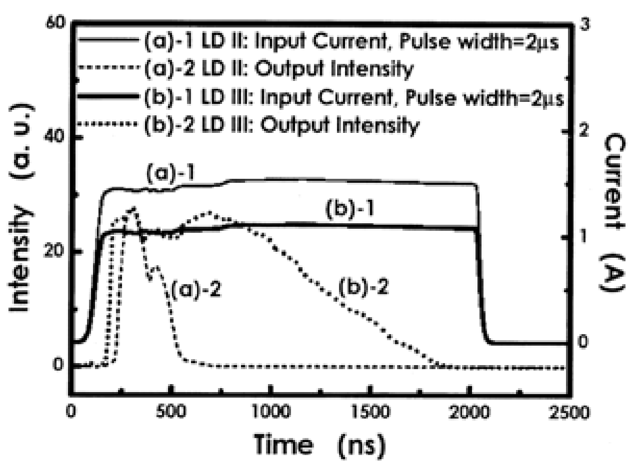

Fig. 3. Lasing duration characteristics of the (a) LD II and (b) LD III. Both LDs were measured under pulse width of 2 _s at room temperature.