Growth by MOVPE of AlGaN/GaN structures with intersubband transitions in the 1.2-1.7μm region of the spectrum

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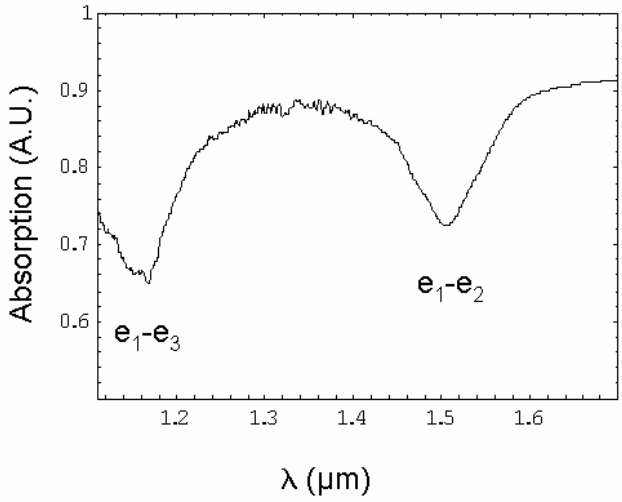
Abstract

We report the growth of very small period superlattices of $Al_xGa_{1-x}N$ with high aluminium content (x=0.7) designed to have intersubband transitions in the telecommunication laser wavelength range (1.3-1.5μm). The samples were grown on sapphire substrates using an AlN buffer layer. The basic sample design was aimed to have a ground state to first excited state transition (e1-e2) at 1.54μm. A self consistent solution to the coupled schrodinger and poisson equation incorporating strain and piezoelectric effects was used to calculate sample parameters. Previous researchers have concentrated on using the maximum possible offset in this system by growing AlN/GaN heterostructures by MBE. However for MOVPE growth there is a significant difference between optimal growth conditions for high x $Al_xGa_{1-x}N$/GaN and GaN. Therefore for the present study a compromise x=0.7 was adopted and very thin 1nm-1.2nm thick GaN layers were attempted to achieve large intersubband energies. A series of samples were grown with differing dopant levels. The infrared absorption spectrum of one of the resulting samples is shown in the figure right. The sample shows clear intersubband transitions at 1.5μm. Samples with slightly differing periods show different transition energies, whilst heavy doping broadens the absorption lines. The absorption lines are significantly narrower than those reported by other groups working with the AlN/GaN system. In addition the improved quality of our samples allows the observation of the e1-e3 transition at 1.18μm, the shortest wavelength intersubband transition reported in any material system. The application of such transitions to ultra-fast communication wavelength switching using THz sources will be discussed. We also conclude that the improvements in nitride growth technology over recent years make the realization of a working 1.5μm intersubband laser a very real possibility and that such a device would have widespread commercial applications.



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