Chapter 8

Conclusions

In this thesis, we mainly investigated the mechanism of annealing of dilute nitride materials, with the intention to explore the relation between structural and optical properties and the annealing processes. The main results include:

1. The GaAsN/GaAs MQWs samples have atomic and sharp interfaces. Based on the measurement of PL, TEM and Raman spectroscopy, we concluded that the RTA processes for these samples can be divided into 3 regions according to the RTA temperatures:

    - at low temperature (T<750°C), the main mechanism involved is the annihilation of point defects, which formed during low temperature growth and are caused by the N plasma ion implantation.
    - At T≈750°C, we found a negative annealing stage, where As short-range ordered clusters are formed in the alloy.
    - At higher temperatures (T>750°C), we observed by TEM that dislocations formed on RTA at this temperature. The formation of dislocations is related to the origin of the PL intensity decrease.

2. EXAFS study of the microstructural changes of InGaAsSbN samples under annealing. The main conclusions are:

    - Under the analysis of In K-edge fluorescence EXAFS signals, the fractions of the Sb and N atoms as first neighbors of In atoms were determined to be in the range of 0 % - 4 % and 0 % - 11 % respectively.
    - There is a feature in the EXAFS spectra that is believed to be due to a defect-related complex. By simulations, it was shown that this is a complex with a mass close to the atomic mass of Sb at a distance of around 2.04 Åto the In atom. We propose that it is the combination of an (N-N) split defect and a (N-As) defect. Under annealing, the (N-N) complex converts to a (N-As) complex.

For future work, the various defects and their evolution under annealing need to be identified. In addition, if the atomic structure could be investigated together with the

detailed optical properties or electronic structures of the same samples, this will provide further valuable information for the fabrication of devices based on this group of materials.