Chapter 1 Introduction

InN is the least studied nitride compound because of the difficulty in growing high-quality epitaxial film, due to the low dissociation temperature and the extremely high vapor pressure of nitrogen for InN, as compared with those for AlN and GaN. The band-gap energy of wurtzite (hexagonal) InN had been believed to be about 2 eV in the early years [1]. But in recent reports, the controversy of InN band gap was resolved and was accepted to be about 0.7 eV [2] [3]. The discrepancy in the band-gap energy might be attributed to the oxide effect and the strong Burstein-Moss [3] effect due to the high unintentional doping concentration. It attracts a lot of attention because the use of InN and its alloys with GaN and AlN can extend the emission wavelength of nitride-based materials from ultraviolet to near-infrared spectral range, making it very suitable for the fabrication of light emitting devices operating in optical communications wavelengths, 1.3–1.55 μm, and visible range.

However, the high density of misfit dislocations at the InN and GaN heterointerface due to large lattice mismatch between InN and GaN remains a problem. The high defect density could drastically deteriorate the device performance. Utilization of quantum dot (QD) structures in the active region for optoelectronic devices can avoid this problem. The defect density in QDs can be greatly reduced due to the self-assembled growth mechanism. Furthermore, the quantum confinement effect for carriers in QDs is beneficial to improve device performances and has the possibility to tune the wavelength by controlling the QDs' size for various applications.

There are only a few papers that have been reported about the growth of

InN dots by molecular-beam epitaxy (MBE) [4] and metal organic chemical vapor deposition (MOCVD) [5]. It was reported that the highest density of InN dots was the order of 10^{11} cm^{-2} [4]. Moreover, only B. Gil reported optical properties of InN QDs [5]. According to B. Gil's report, the photoluminescence (PL) peak energy was weakly dependent on the temperature, dot sizes and substrates but more sensitive to the materials of capping layer. Therefore, it is urgent to further develop a different growth technique to improve the crystal quality and also to elaborately investigate optical properties for a better understanding and future device applications of InN QDs.

In chapter 2, we briefly introduce the process of PL in semiconductors. In chapter 3, details of sample preparations and experimental setups, including atomic force microscopy (AFM) and PL systems, are presented. In chapter 4, experimental results about morphology, size-dependent PL spectra and temperature-dependent PL spectra are discussed. Finally, we summarize experimental results in Chapter 5.