Study on Growth of High-Quality InN by RF-MBE toward Device Application

Daisuke Muto

This is a doctoral thesis that discusses the crystal growth of InN toward device application. InN and its related alloys are considered to be promising materials for future infrared optical and high-speed electronic devices. To realize these devices, however, there still remain various issues to be solved. For example, improvement of crystal quality, control of heterointerface, realization of p-type conduction, and suppression of electron accumulation at the surface are required to realize these devices. In this thesis, these issues were studied from a viewpoint of InN crystal growth.

At first, to grow high-quality InN films on sapphire substrates, the effects of low temperature nitridation process on sapphire were studied. InN films with small tilt distribution and low screw dislocation densities were obtained by smooth and uniform nitridation of the sapphire surface. Also, it was found that regrowth on micro-facetted InN template is an effective way to obtain high-quality InN films with low dislocation densities.

Secondly, to grow p-type InN, Mg was doped to the high-quality InN films. These high-quality films were grown based on the above results. P-type InN films are very difficult to characterize due to the surface accumulation layer. Therefore, the effects of the surface accumulation layer on the characteristics of InN films were investigated. Also, it was found that the carrier type of Mg-doped InN films were p-type which was determined by CV measurement using electrolyte for the contacts.

Thirdly, GaN/InN structures were fabricated to study the intermixing of In and Ga at the heterointerface. The intermixing was occurred mainly under the growth process of GaN. Therefore, growing GaN at lower temperature and higher growth rates is the effective way to suppress the intermixing.

Thus, this doctoral thesis is summarizes the studies of these issues to realize InN-based devices.