MBE Growth and Characterization of Thick N-polarity InN

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Growth of high-quality thick InN epilayer is still a challenge due to its low dissociation temperature. The physical properties of InN are also very obscure due to the unavailability of epitaxial InN films with high structure perfection.

Until now we have pointed out that the crystalline polarity plays a very important role in the epitaxy control of InN growing on c-plane sapphire and/or c-plane GaN templates. It was found that the epitaxy temperature in N-polarity growth can be about 100 deg higher than that in In-polarity case. That is, N-polarity growth is much better than In-polarity growth, because the higher epitaxy temperature results in higher growth rate, thicker epilayers, and higher crystalline properties due to the enhanced surface migration at higher temperatures. Further, we have pointed the precise control of surface stoichiometry in slightly N-rich condition is very important also.

These behaviors are slightly different compared with those observed for the epitaxy of other typical III-nitrides such as GaN and AlN, where the cation-polarity, i.e., Ga and/or Al-polarity, and cation rich growth conditions are believed much better than the anion-polarity, i.e., N-polarity, and anion rich growth conditions.

Those important results when growing InN epilayers were obtained by using our sophisticated radio-frequency plasma assisted MBE system equipped with several in-situ and real time monitoring/controlling instruments, such as in-situ coaxial impact collision ion scattering spectroscopy (CAICISS), in-situ spectroscopic ellipsometry (SE), and real time analyzer for the signals/patterns obtained by reflection high-energy electron diffraction (RHEED). That is, our MBE system is specified to study the effect of polarity and the surface stoichiometry on the epitaxy of nitrides including InN with the real time observation of several surface phenomena taking place on the growing surface.

The highest growth rate achieved until now was about 1.4 um/h and we grew thick InN epilayers up to 8 um on 2-inch sapphire with the growth rate of about 0.7 um/h.

In this paper, the unique growth behaviors observed for the MBE growth of InN epilayers and properties of thick InN epilayers are reported.