Growth and properties of InN, the low bandgap III-nitride

We have studied the growth of InN on GaN (0001) by radio-frequency plasma-assisted molecular beam epitaxy (RF-MBE) considering all the factors that affect the growth process: the InN decomposition, the mobility and re-evaporation of In and N adatoms on the surface, the role of the In/N atomic ratio on the surface and the role of the substrate temperature. The results revealed a general trend of InN growth to proceed, in such a way, that stoichiometry between In and N atoms on the growing InN front surface is established. Thus, the growth mode and morphology of InN epilayers depend strongly on the In/N atomic flux ratio on the surface, which is determined by the incident In and N fluxes and the temperature dependent generation of In adatoms due to InN decomposition. The growth mode is three-dimensional for N-rich surface conditions, two-dimensional for stoichiometric conditions, while the growth is not sustainable for In-rich conditions. .

Based on measurements of the growth rate along the [0001] axis, we established a growth model of InN growth on GaN (0001) for a wide range of growth conditions. According to this model, four growth regimes of different In-adatoms' mobility are distinguished and exhibit different InN growth properties.

Careful tuning of the InN growth conditions, according to the developed growth model, has allowed us to grow InN films with step-flow morphology, good crystalline quality and optimized electrical properties; rms roughness of 3Å, X-ray diffraction rocking curve linewidth equal to 365 arcsec and 370 arcsec for the symmetric (0004) and the asymmetric $(10\bar{1}5)$ reflections, respectively, and electron mobility equal to 1500 $cm^2/V\cdot sec$ for an electron density equal to $1\times10^{19} cm^{-3}$ at room temperature.

All samples exhibited intense photoluminescence with clear evidence of the Burstein-Moss effect. Transitions to acceptor states were identified around 0.67eV in several samples.