Growth and characterization of β-InN films on MgO: The key role of a β-GaN buffer layer.

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Abstract

InN films were grown on MgO substrates with a β-GaN buffer layer by gas source molecular beam epitaxy (GSMBE). Typical growth rates varied from 0.09 to 0.28 ML/sec (controlled by the In cell temperature) and 500 °C of substrate temperature. The growth was performed in a layer by layer way as was revealed by *in situ* reflection-high-energy-electron-diffraction (RHEED) technique. Depending on the In cell temperature, either nanocolumnar InN or flat cubic final films are grown, as can be corroborated by scanning electron microscopy (SEM). After the critical thickness, the InN films starts a relaxation process going from 2D growth to 3D as evidenced by the transformation of the RHEED patterns that change from streaky to spotty.

A critical thickness of ~ 5 mono-layers (ML) in InN pseudomorphic layer was measured by frame by frame analysis on RHEED patterns recorded on video. The experimental critical thickness is compared with values calculated from different critical thickness models.

Infrared room temperature (RT) reflectance and low-temperature (LT) transmittance measurements were performed by using fast Fourier transform infrared spectrometry (FFT-IR). Reflectance fittings allowed to establish that β-InN films have large free-carrier concentrations present (>10^{19} cm^{-3}), a result that is corroborated by Hall effect measurements. The Varshni parameters that describe adequately the optical absorption edge responses with temperature are obtained for the set of samples studied. The observed temperatures changes, from LT to RT, are the lowest reported for III-V semiconductor binary compounds. The temperature coefficient of the conduction band depends on the strength of the electron-phonon interaction (e-ph-i), as well as on the thermal expansion. It has been predicted that cubic InN has one of the smallest e-ph-i of all III-V compounds, which is corroborated by these results. The variation in values of absorption edges is clearly consistent with

the Burstein-Moss (BM) and band renormalization effects, produced by high free electron concentrations. It is shown that the conduction band in β-InN, analogous to wurtzite InN, follows a non-parabolic behavior.

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