

Growth and electron transport studies of InAlN/GaN two-dimensional electron gas

K. Jeganathan¹, M. Shimizu¹, Y. Yano², N. Akutsu² and H. Okumura¹

¹) Power Electronics Research Center, National Institute of Advanced Industrial Science and Technology, Central 2, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan.

²) Taiyo Nippon Sanso corporation, 10 Okubo, Tsukuba, Ibaraki 300-2611, Japan.

E-mail : k.jeganathan@aist.go.jp

InAlN/GaN is a promising heterostructure for use in high-speed, high frequency transistors because of high-sheet-charge-carrier-density and large conduction band offset. $\text{In}_x\text{Al}_{1-x}\text{N}$ ($x=17\%$) is lattice matched to GaN and also polarization charges induced by tensile and compressive strain can be engineered through varying the In content in the heterostructure. However, the large difference in thermal stability between InN and AlN is a major issue for the growth of good crystalline quality InAlN barrier layer. Due to weak In-N bonding energy (1.98 eV), low temperature growth is preferred for In containing compounds, however controlling In in $\text{In}_x\text{Al}_{1-x}\text{N}$ layer is not easy task because of high bonding energy (2.88 eV) of AlN. Here, we describe the successful growth of InAlN/GaN heterostructure on 2- μm -thick MOCVD grown GaN template by plasma-assisted molecular-beam epitaxy with In compositions ranging from 4% to 23%. Nearly lattice-matched InAlN to GaN has been found to grow pseudomorphically in two-dimensional form at optimized growth conditions. The variable temperature Hall measurements were performed in the range of 20 - 300 K. Figure 1 shows the 2DEG mobilities and sheet carrier densities as a function of inverse temperature. As seen in Figure.1, for samples containing 4% and 16 % In content, the sheet carrier density and mobility are nearly independent of temperature upto 140 K, a typical behavior of 2DEG structures. The room temperature mobility and sheet carrier density for nearly lattice-matched structure were $440 \text{ cm}^2/\text{Vs}$ and $3 \times 10^{13} \text{ cm}^{-2}$, respectively, The high sheet density even in the absence of tensile strain induced piezoelectric charges can be due to the differences in spontaneous polarization and higher band offset. The problems associated with growth optimization and various scattering process dominated in InAlN/GaN structures will be presented in detail.

