

The new material wurtzite $\text{AlP}_y\text{N}_{1-y}$

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This work introduces a new member of the Nitride family, wurtzite $\text{AlP}_y\text{N}_{1-y}$ on GaN. This new material system is aimed as barrier layer in high electron mobility transistors (HEMT). Current commercial HEMT use $\text{Al}_x\text{Ga}_{1-x}\text{N}$ barriers, but a barrier with higher polarization induced carrier concentration would enable higher operation frequencies and lower losses. $\text{Al}_{1-x}\text{In}_x\text{N}$ and $\text{Al}_{1-x}\text{Sc}_x\text{N}$ have been both researched for this purpose, but $\text{Al}_{1-x}\text{In}_x\text{N}$ has challenges in mass production due to Ga carrier over and necessary growth interruption and for Sc no suitable metal-organic precursor exists. $\text{AlP}_y\text{N}_{1-y}$ can be grown on GaN at 1100°C , without a long growth interruption, and for growth both PH_3 as well as tertiary butyl-phosphine (tBP) are available, the latter a liquid precursor. tBP has been choosoen for this work.

Since the convalent radius of P is 50% larger than N but only 15% smaller than Al, compressive strain must be avoided or P will incorporate on the Al sublattice as well. Since $\sim 11\%$ of P gives lattice matching to GaN, the accessible range of P content is from 0...11%. However, due to the very large change in lattice constant between wurtzite AlP and AlN, the critical thickness tends to be small, e.g. 15 nm for 5% P content. This poses challenges for characterization, together with the weak X-ray scattering.

We have measured two dimensional electron gases on simple test structures with 10^{13} cm^{-2} sheet carrier density and $400\text{ cm}^2/\text{Vs}$ mobility (fig. 1), showing the potential of AlPN. Current work focuses on the determination of fundamental properties like the band edge using room temperature cathodoluminescence. The result indicates a huge bowing of the band edge, with a bowing parameter of 20 eV (fig. 2). Further studies are on the way.

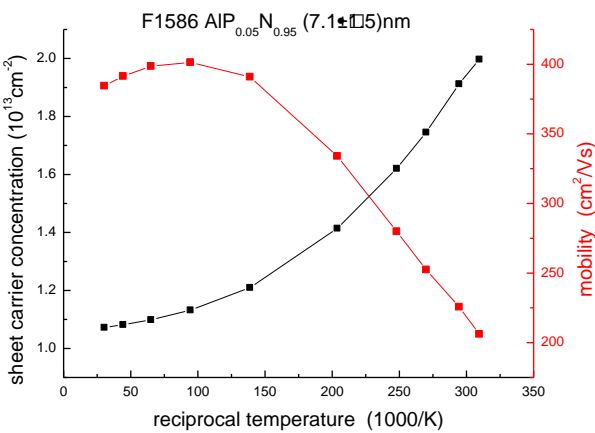


Fig 1: Hall measurement of $\text{AlP}_{0.05}\text{N}_{0.95}$ on GaN

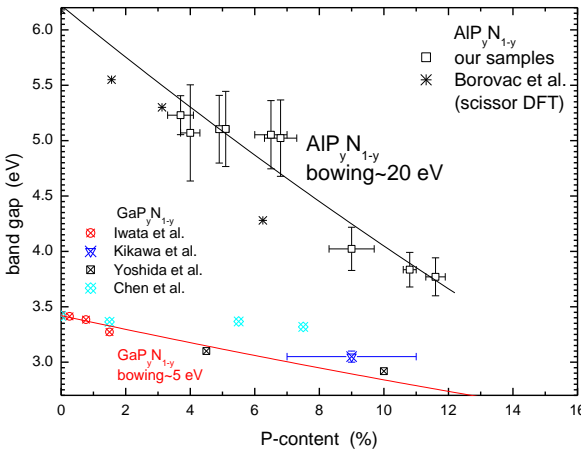


Fig 2: band gap of AlPN (together with GaPN data)