InAlN is an attractive candidate for high frequency transistor applications and InAlN can also be lattice matched with GaN when the In composition is ~18% which makes it a strong contender for high electron mobility transistors (HEMTs) [1].

The production of high quality InAlN/GaN HEMTs faces many growth challenges such as phase separation, composition fluctuations and even growth discontinuity. Recently unintentional Ga incorporation in the InAlN layers has been reported which adds to the list of growth challenges of InAlN thin films [2].

The objective of this work is to use a multi-pronged approach to understand the structural, compositional and electrical properties of InAlN/barrier/AlN/interlayer/GaN HEMT structures (where Ga has been unintentionally incorporated in both the barrier and interlayer) using various characterization techniques. We will also discuss the role of unintentional Ga incorporation on the 2-DEG properties.

### Results and discussion

**Motivation**
- InAlN is an attractive candidate for high frequency transistor applications and InAlN can also be lattice matched with GaN when the In composition is ~18% which makes it a strong contender for high electron mobility transistors (HEMTs) [1].
- The production of high quality InAlN/GaN HEMTs faces many growth challenges such as phase separation, composition fluctuations and even growth discontinuity. Recently unintentional Ga incorporation in the InAlN layers has been reported which adds to the list of growth challenges of InAlN thin films [2].

**Results summary for sample-A**

**AFM**
- Surface roughness: 1.2 nm
- Defect density: 1.6 × 10^10 cm⁻²

**SEM**
- Surface roughness: 1.2 nm
- Defect density: 1.6 × 10^10 cm⁻²

**ECCI**
- Surface roughness: 1.2 nm
- Defect density: 1.6 × 10^10 cm⁻²

**TEM**
- Surface roughness: 1.2 nm
- Defect density: 1.6 × 10^10 cm⁻²

**RBS/C**
- Random and <0001> aligned spectra: The inset images show the spectra for the In signal in the 1300-1400 keV energy range in the RBS spectrum whereas the Al signal is at 855-890 keV and the Ga signal at 1270 keV.

**Summary and conclusions**
- The presence of unintentional Ga in the barrier as well as in the interlayer for samples grown using both showever and horizontal MOVPE reactors is reported.
- The existence of unintentional Ga in the HEMT structures does not appreciably affect the 2-DEG properties, however it could be a problem during device processing.
- Producing a HEMT structure with InAlGaN as a barrier and AlGaN as an interlayer, with appropriate alloy composition, may be a possible route to optimization as it might be difficult to avoid Ga incorporation while producing a HEMT structure with InAlGaN as a barrier and AlGaN as an interlayer, with appropriate alloy composition.

**References**