GaN on SOI substrate: strain and defects

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GaN is widely used in optoelectronic devices like LEDs which are epitaxially grown mostly onto sapphire substrates. For cost reasons, silicon is studied as a possible contender. In order to cope with issues related to lattice and thermal mismatch between the nitrides and silicon, strain engineering during growth is necessary. This is usually carried out through the insertion of strain compensating layers before the growth of the active regions. A possible alternative consists in using compliant substrates such as Silicon-on-Insulator substrates (SOI) for strain accommodation during growth and/or upon cooling down.

GaN epilayers were grown on SOI substrates and compared to reference samples grown onto bulk silicon. In order to assess a possible elastic compliant effect, the distribution of strain was measured by TEM for each layer of the sample: GaN, AlN and SOI or Silicon. TEM was chosen to get strain information accurately and for a given direction of interface, with the technique of nanobeam electron diffraction in precession mode. This technique permits to obtain 2 nm spatial resolution combined with 2.10^{-4} strain precision.

More specifically, the compressive strain measured in the top silicon layer of the SOI permitted to conclude about some elastic compliance with SOI substrates. Also, strain maps and profiles gave us information about the evolution of stress into the nitride layers during and after growth.