Multi-technique nanoscale structural analysis of III-nitrides

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From the early studies of III-nitride semiconductors, numerous analyses have focused on the structural aspects, and especially the detailed investigations of extended defects. Nowadays, the development of nanostructured nitride-based materials in the domain of photonics or optoelectronics requires us to go a step further and to obtain quantitative information at the nanometerscale of the structure, strain state, and/or composition. This is particularly true when extended to ternary or quaternary systems and in that case a multi-technique approach is necessary.

Recently, we have investigated nm-size AlGaN/GaN multilayers, used for THz intersubband (ISB) optoelectronics [1], which require a precise control of the alloy composition (down to 0.5%) and of the layers thicknesses. For that purpose, we have used a combination of Energy Dispersive X-ray Spectroscopy (EDX) coupled to Transmission Electron Microscopy (TEM), Atom Probe Tomography (APT), Time of Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) and X-ray diffraction in order to cover macroscopic as well as nanometer scale ranges.

The different techniques will be presented and compared in terms of spatial and composition resolution.

[1] M. Beeler, C. Bougerol, E. Bellet-Amalric, E. Monroy, APL**105**, 131106 (2014)