Lattice-matched AlInN/GaN distributed Bragg reflectors for nitride microcavities

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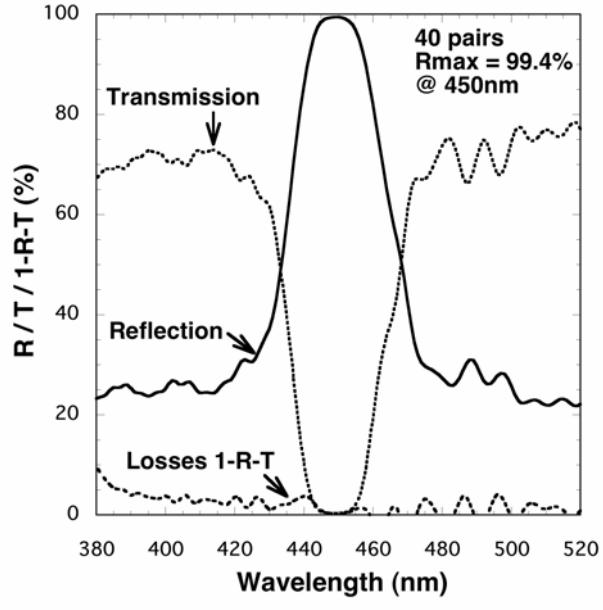
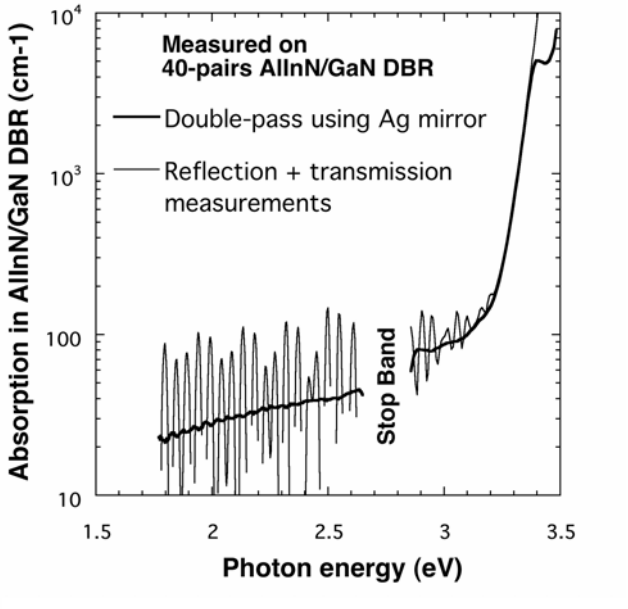
Distributed Bragg reflectors (DBRs) are necessary building blocks for advanced optoelectronics. AlGaAs/GaAs proved to be an excellent material system for DBRs in III-arsenides, but its equivalent in III-nidrides, AlGaN/GaN, greatly suffers from the high lattice mismatch between AlN and GaN. The two usual approaches are either to keep a low Al-content in AlGaN at the price of a low refractive index contrast, so a reduced stop-band and a larger number of DBR pairs, or to use high Al-content with strain-engineered solutions to avoid cracks.

We explored an alternative, the use of $Al_{.83}In_{.17}N$ for low-index material. This alloy is still poorly known, because phase separation issues and poor incorporation of indium make its growth difficult, but $Al_{.83}In_{.17}N$ is lattice-matched to GaN, which is a key advantage over AlGaN alloys. We could grow AlInN epilayers using MOCVD with high structural quality, as demonstrated by high resolution X-ray diffraction and transmission electron microscopy.



Experimental reflectivity and transmission of a 40-pairs lattice-matched AlInN/GaN DBR



Evaluation of the optical absorption out of the stop-band, in the 40-pairs AlInN/GaN DBR

We will show that this alloy is indeed very attractive: Its optical index contrast with GaN is about 7% in blue wavelengths, which is equivalent to $Al_{.5}Ga_{.5}N$. A 40-pairs-thick DBR was grown with no cracks and exhibits a 99.4% reflectivity at 450 nm. We estimated that the residual optical absorption in the DBR at this wavelength was as low as 50 cm^{-1}. To our knowledge, III-nitride DBR with peak reflectivity sensibly higher than 99% has never been reported so far.

More information on AlInN material parameters will be presented, as well as first applications toward resonant cavity light emitting diodes.