Improved (Al,Ga)As-AlAs microcavities grown by MBE with *in-situ* simulated reflection spectra

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Studies of interactions between photons emitted from e.g. quantum dots and optical cavity modes in a monolithic microcavity grown epitaxialy require samples with high finesse microcavity. This in turn requires a high precision of distributed Bragg reflectors (DBR) control during epitaxial growth. Various instabilities of epitaxial MBE equipment oppose this requirement when the precision of thicknesses of subsequent layers in DBRs should be better than 0.5-1%. We report on the method of improvement of DBR's growth control essentially consisting of a comparison of reflection spectra *in-situ* measured and simulated one during epitaxial growth. Such approach allowed us to significantly improve control of thickness of subsequent layers constituting DBRs during MBE growth, and consequently improve the finesse and repeatability of microcavities.

We show examples of monolithic AlAs/GaAs microcavities with finesse of about 2500 estimated from measurements of reflectivity and photoluminescence at T = 4K from quantum dots embedded in the λ-cavity for wavelength λ = 940-950nm. Microcavities have well-defined side minima and maxima and flat reflection band with cavity mode visible in reflection spectra even at room temperature. As another example of the capability of the method we show microcavity consisting of alternating layers of $Al_{0.5}Ga_{0.5}As$/AlAs proper for shorter wavelengths λ = ~ 750nm.

Further improvement of microcavity finesse grown using this method is possible assuming that wavelength- and temperature-dependence of refractive indexes are known with high accuracy [1], which is rather scarce in literature. Here, refractive indexes at growth temperatures, which are important for improved control of MBE growth, were determined experimentally for several wavelengths by an analysis of optical reflectivity oscillations during MBE growth for trial samples grown, whose thicknesses were measured after the growth with an uncertainty of about 0.2% using x-ray double-crystal diffraction.

Usually the photon-cavity mode interactions are studied at low temperatures, like 10K, while the MBE growth takes place at temperatures about 860K higher. Therefore even if microcavity is tuned well at growth temperature, the match of optical thicknesses of low and high refractive index layers in DBRs, like AlAs and GaAs, at low temperatures can be not optimal, if the temperature variations of refractive indexes are not taken into account properly.

[1] B. Zhang, G.S. Solomon, M. Pelton, J. Plant, C. Santori, J. Vučković, and Y. Yamamoto, *J. Appl. Phys.* **97**, 073507 (2005)

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