(Cd,Zn,Mg)Te Microcavity based on Distributed Bragg Reflector and a Monolithic Subwavelength Grating

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High Contrast Gratings (HCG) are diffraction gratings with subwavelength spatial dimensions [1]. They are able to provide a broadband, close to unity reflectivity, which makes them highly attractive for applications in integrated photonics. Moreover, in its monolithic version, a HCG is deposited/etched directly on the top of the semiconductor layer. This allows one to replace a top mirror in conventionally used microcavities based on distributed Bragg reflectors (DBR) with HCG. This enables a strong reduction of a size of the whole structure, while preserving all the advantages of a monolithic stack. In this work we aim at developing of the design and technology enabling production of II-VI microcavities involving a DBR and a monolithic HCG.

The studied sample is grown by MBE and it contains a 3λ/n microcavity embedding 5 (Cd,Mn)Te quantum wells deposited on the top of a DBR made of 18 pairs of $Cd_{0.72}Zn_{0.04}Mg_{0.14}Te/Cd_{0.6}Mg_{0.4}Te$ λ/4n layers. Photoluminescence spectra recorded as a function of the detuning between microcavity mode and the QW exciton (emitting at 1.61 eV) confirm that the system operates in the strong light-matter coupling regime.

The optimal parameters of the monolithic HCG (grating period = 690 nm, filling factor = 0.38 and a height of the stripes = 162 nm) providing a mirror with a stopband centered at 1.61 eV are determined by calculations performed within plane-wave admittance method. It is assumed that dimensions of the mirror are infinite in the sample plane. Realistic refractive indices are used in the calculations.

The MHCG designed that way are next etched on the sample surface by focused ion beam. Scanning electron microscopy and atomic force microscopy measurements confirm that the obtained MHCGs are close to what was intended on the design stage.

The reflectivity study suggests narrowing of the optical mode of the microcavity due to a fabrication of the monolithic HCG, thus increasing of its quality factor. The study confirms also a high selectivity of the optical response of the structure to linear polarization of the incident light.

The presented study shows a feasibility of fabrication of a II-VI semiconductor microcavity based on a DBR and a monolithic HCG. It opens a perspective of realization of ultra-compact vertical-cavity surface-emitting lasers operating either in the strong coupling (polariton) or weak coupling light-matter coupling regime.

[1] M. Gębski et al., Optics Express **23**, 11674 (2015).