Growth and spectroscopy of coupled ZnTe planar microcavities

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Coupled photonic structures have recently attracted much attention, mostly due to perspective of applications in fields of quantum information and laser technology.

We demonstrate results of spectroscopy experiment on samples containing two epitaxially grown coupled planar ZnTe microcavities. The structures are designed by Transfer Matrix Method calculations and characterized by scanning transmission electron microscopy.

After the ZnTe buffer layer growth, a Distributed Bragg Reflector (DBR) consisting of ZnTe (as a high refractive index material) and MgSe/ZnTe/MgTe/ZnTe superlattice (as a low refractive index material) is grown. Next, two cavities separated by 6 or 12 DBR pairs are grown with mutually perpendicular gradient of the cavities thicknesses. This enables continuous change of the detuning between energies of the cavities by adjustment of the position on the sample. The upper microcavity contains a layer of CdTe Quantum Dots and is covered with 16 DBR pairs (see Figure 1).

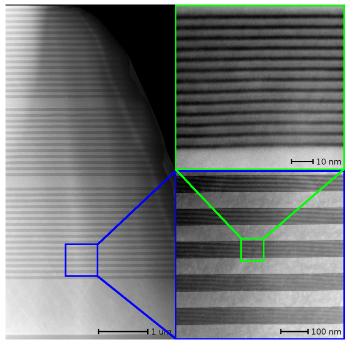

Figure 1: STEM micrographs of the sample in consecutive magnifications.

Scanning transmission electron microscopy using high-angle annular dark field imagining is carried out with acceleration voltage of 200 keV and point resolution of ~1.36 Å. Photoluminescence (E_{exc} = 3.06 eV) and reflectivity (T = 10 K and T = 300 K) mapping measurements are performed with spatial resolution down to 0.05 mm and scanned area covering a whole surface of 2-inch wafer.

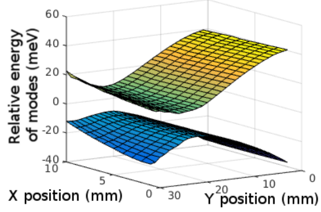

Figure 2: Energy of two optical modes as a function of spatial position on the sample.

The optical spectra reveal two cavity modes. Linewidths of the modes equal to .... point toward quality factor of the cavities Q = 1000. Energies of the modes and edges of the DBR stopband are determined as a function of the position on the sample. The energies found in the reflectivity agree well with the ones found in the photoluminescence. In regions of the sample, where cavities modes are strongly detuned the modes shift independently of each other when the position on the sample is varied. However, in a region, where cavity modes are in resonance, a clear anticrossing of the modes is visible (see Figure 2), proving their interaction. The exchange of the modes intensity in the resonance vicinity is observed, as predicted by the calculations. Energy splitting in resonance as large as 45 meV is found when cavities are separated with 6 DBR pairs. As expected, the splitting drops down to 17 meV when the separation is increased to 12 DBR pairs, indicating a possibility of control of the modes interaction strength.