Antireflective photonic structure with CdTe/(Cd,Zn,Mg)Te QDs containing single Mn ions

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Typical application of Distributed Bragg Reflectors (DBRs) is enhancement of reflectivity, but quite opposite results - very low reflectivity can be also obtained with the use of DBRs. Such antireflection (AR) structures are essential assets in optical spectroscopy requiring resonant excitation, where the reflected laser light overwhelms the investigated signal. In particular, using four-wave mixing (FWM) for probing the coherence of single quantum dots (QDs), necessitates efficient injection of the optical excitation into the hetero-structure, so as to reach the field amplitude sufficient to drive this third order optical nonlinearity. This condition is achieved by employing AR [1] or photonic structures [2]. Here, we propose to study the coherence of single dopants in an AR photonic structure, by exploiting *s,p-d* exchange interaction between a single magnetic ion and a QD exciton.

There are two basic approaches to AR structures on top of high refractive index (n) semiconductors. First, one can deposit single layer with a low refractive index equal to $\sqrt{n}$ and thickness of $\lambda/(4\sqrt{n})$. Advantage of this method is a very broad AR spectral range. Conversely, the above approach is limited by accessibility of materials with a required value of refractive index. Second, one can use symmetric microcavites composed of two DBRs. The cavity mode exhibits sharp deep in the reflectivity spectrum, which should be accurately fitted to the wavelength of interest. In this work, we implement the AR strategy with microcavites. In order to maximize spectral width of the low reflectivity deep, we have designed and grown a low Q-factor microcavites (Q ~ 30), composed of only a few DBR pairs. A particularly broad deep (FWHM 30 nm) with a reflectivity down to 2% have been obtained for half-cavities composed of one set of 3-5 DBR pairs and high index layer λ/n cavity on top (Fig. 1a).

Our structures were MBE grown from tellurium compounds. We used (Cd,Zn,Mg)Te layers with various Mg content as a low and high refractive index materials [3], and additionally, as a barrier material for (Cd,Mn)Te QDs. Mn content in QDs was set to increase the probability of finding a QD with a single Mn ion. In Fig. 1b we present a typical PL spectrum of a CdTe/(Cd,Zn,Mg)Te QDs with a single Mn ion, grown on antrireflective structure shown in Fig. 1a.

The realized structures will soon be employed in the four-wave mixing experiments involving single dopants, to investigate their coherent nonlinear response.

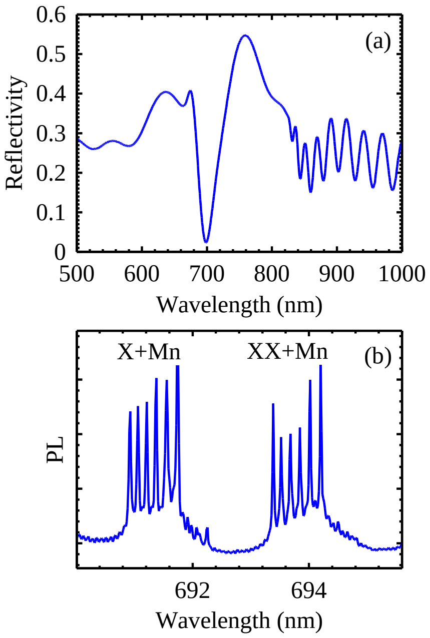

Fig. 1 a) Refl. of λ/n cavity on 4 DBR pairs. b) The same structure, PL of a QD with a single Mn ion.

[1] W. Langbein and B. Patton, *Opt. Lett.* **31**, 1151 (2006). [2] F. Albert et al., *Nat. Commun.* **4**, 1747 (2013). [3] J.-G. Rousset et al., *J. Cryst. Growth* **378**, 266 (2013).