Polarization Dependent Magneto-Photoluminescence in Type-II Quantum Dots

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Introduction

We previously reported excitonic Aharonov-Bohm (AB) Effect in type-II quantum dots (QDs) for unpolarized magneto-photoluminescence. The signal was strongly affected by the background emission. We thus performed experiments with polarized emission to determine the role of the background on the observed visibility of the AB peak. In addition, these measurements are useful to determine such important materials parameters as hole and electron g-factors and size of the type-II exciton, which we used to determine density of QDs [1].

Experimental

Experiments were performed at SCM-2, using polarization optics available at the NHMFL. A thermally stabilized 405 nm diode laser was used for excitation, while detection was done via a Princeton Instruments IsoPlane SCT320 spectrometer coupled with a PIXIS:100BR eXcelon CCD. A XYZ peso-positioners from Attocube were used to measure multiple samples without removing the probe.

Results and Discussion

We show in Fig. 1 the results of the measurements, which indicate strong polarization of the background emission, which masks the 'true' magnitude of the AB peak. As shown in inset, this magnitude can reach over 15%, which is largest reported value. We plan to use this finding in our further decoherence studies.

Another important observation is that σ+ emission is both higher in intensity and at higher energy than those for σ- one. To obtain such an unusual behavior we proposed the following. First, the g-factor of the holes in ZnTe has to be positive and larger than g-factor of electrons, as schematically shown in inset of Fig. 2 where we show the Zeeman splitting at two different temperatures. Second, the electron spin states are in thermal equilibrium, which means that the lower energy, -1/2, state, is more populated, while the heavy hole spin states are equally distributed due to the selection rules forbidding spin flip. Using this model and other data (not shown) we determined that g-factors for holes in ZnTe QDs is ~3.

Conclusions

ZnTe/ZnSe QD exhibit strong AB effect that is generally masked by strongly polarized background. In addition, this system is characterized by unusual behavior where spin-flip of heavy holes is forbidden. We also determine hole g-factor for ZnTe QDs to be ~ 3.

Acknowledgements

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References

[1] H. Ji, *et al*., J. Appl. Phys., **116**, 164308 (2014)

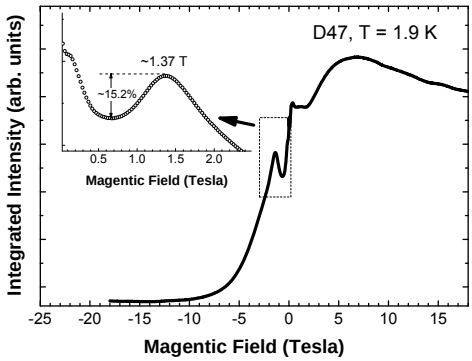

Fig.1 Polarization dependent integrated PL intensity as a function of magnetic field; inset: The magnified region where the AB is observed.

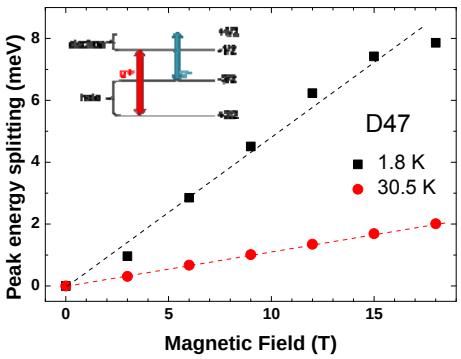

Fig.2 Peak energy splitting between σ^+ and σ^- polarized spectra as a function of magnetic field at two temperatures; inset: prosed recombination