Exciton coherence in semiconductor quantum dots

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Coherent dynamics and manipulation of excitonic transitions in semiconductor quantum dots (QDs) are of key importance in applications of QDs to quantum communications and quantum information processing[1]. In this talk we investigate the dephasing mechanism and demonstrate the ultrafast control of optically-induced exciton coherence in InAs self-assembled QDs using a polarization-dependent four-wave mixing (FWM) technique[2]. Using the *strain compensation* in the sample fabrication process, the resonant wavelengths were tuned to telecommunication wavelengths[3], which are suitable for long-distance quantum communications. In addition, the strain compensation enabled us to stack over a hundred QD layers, which plays an important role in improving a signal-to-noise ratio.

We show the measured dephasing time of the exciton ground-state transition is extremely long (Fig. 1(a)) and very close to the radiative limit at low temperature. The dephasing time shows a large anisotropy, which is influenced by the lower symmetry of an InP(311)B substrate we used. We estimated the pure dephasing with a high degree of accuracy (better than 0.1 μeV) by simultaneously measuring FWM and pump-probe signals with high signal-to-noise ratios. We discuss the pure dephasing mechanism, with a special focus on exciton-phonon interactions, by analyzing the temperature dependence of the pure dephasing. Moreover, we demonstrate time-integrated Rabi oscillations of the exciton coherence with the Rabi frequency of 1 THz by measuring the excitation intensity dependence of the FWM signal intensities (Fig. 1(b)).

This work was carried out in collaboration with K. Akahane, N. Yamamoto, M. Sasaki, M. Kujiraoka, and K. Ema. All samples were fabricated at Photonic Device Laboratory, NICT. This work was partially supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science, and Technology of Japan.

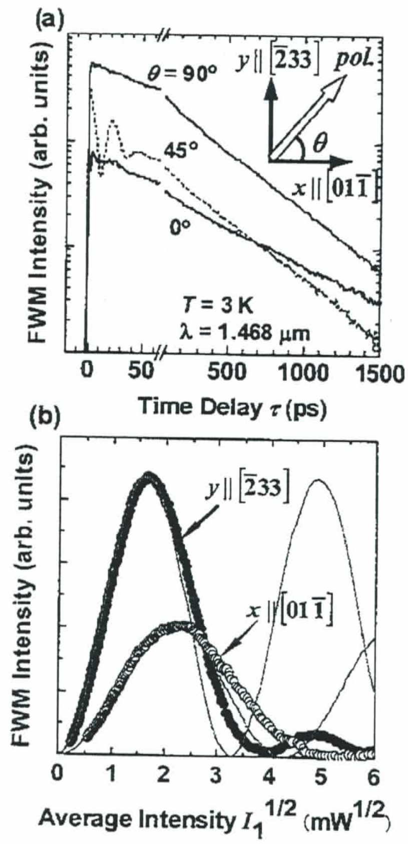

Figure 1: Polarization-dependent FWM signal intensities measured as a function of (a) time delays and (b) excitation intensities at 3 K under resonant excitation to exciton ground states.

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