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# Resident Electron Spin Polarization via Trion Dynamics in a Single Quantum Well

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The initialization of resident electron spin polarization (RESP) comes from the excitation of negative trions, which made of a spin–singlet electron pair and one hole, by the resonant absorption of the circularly polarized pulses in semiconductor nanostructures. The critical role on the intrinsic properties of RESP around time origin is generally played by instantaneous trion formation, relaxation, recombination, and transformation from excitons. Although the dynamics of trions for RESP in quantum wells (QWs) has been studied [1, 2], the RESP generation processes are not revealed clearly. We have observed and analyzed the negative initial phase shift (IPS) in Kerr signals of RESP, which gave the important information about RESP generation processes. Here, we investigate the dynamic process and the interaction of RESP, trions, and neutral excitons in detail.

In this presentation, the time-resolved Kerr rotation (TRKR) technique [3] was mainly used in Voigt geometry. The sample was a slightly n-doped CdTe/$Cd_{0.85}Mg_{0.15}Te$ single QW with the well width of 100 Å grown by MBE on a GaAs (100) substrate, which was mounted in a magneto-optical cryostat at 12 K. The intensities of the normal incident $\sigma^+$-pump pulse and the linearly polarized probe pulse were fixed at ~10 mW/cm$^2$ and ~500 μW/cm$^2$, respectively. An additional circularly polarized control pulse with different intensity excited the sample with some delay time relative to pump pulse. All the above pulses were produced by a mode-locked Ti: sapphire laser with the pulse width of 2 ps and the repetition rate of 76 MHz. The laser wavelength was tuned at 769.6 nm (1.611 eV), which was resonant with trion transitions. Then, a coherent precession of RESP disturbed by the control pulse was observed in the TRKR signal and was examined from the viewpoint of IPS.

Figure 1 shows the TRKR signals excited by $\sigma^+$ pump with $\sigma^+$ (a) and $\sigma^-$ (b) control pulses that were denoted by $\sigma^+/\sigma^+$ and $\sigma^+/\sigma^-$, respectively. The control pulse was retarded by π/2 and varied from 0.5 mW/cm$^2$ to 10 mW/cm$^2$ under $B$=136 mT for both cases. Their relative phase shifts (PSs) $\phi$ of RESP precessions are potted in Fig. 1 (c), which were derived from the fitting by $A^e \exp(-t/\tau_S^e)\, cos(\omega_L t + \phi)$ in the range of $t$=500~3000 ps. Here, $A^e$ is the original amplitude of RESP, $\tau_S^e$ is the corresponding transverse spin-relaxation time, $\omega_L$ is the electron Larmor frequency, $t$ is the pump-probe delay time. As shown in Fig. 1(c), each absolute PS $|\Phi_+|$ (green) for $\sigma^+/\sigma^+$ signal is much larger than that $|\Phi_-|$ (red) of $\sigma^+/\sigma^-$ curve under the same power of control pulse, whose symmetry centerline is far away from zero level. All of them can be confirmed to contain all the induced IPS during any RESP formation process, such as the original pump's IPS (-0.38 rad/ps), consistently deduced at the control of $I$ = 0 μW/cm$^2$, similar to the IPS of pump excited signal alone in the inset of Fig. 1(c).

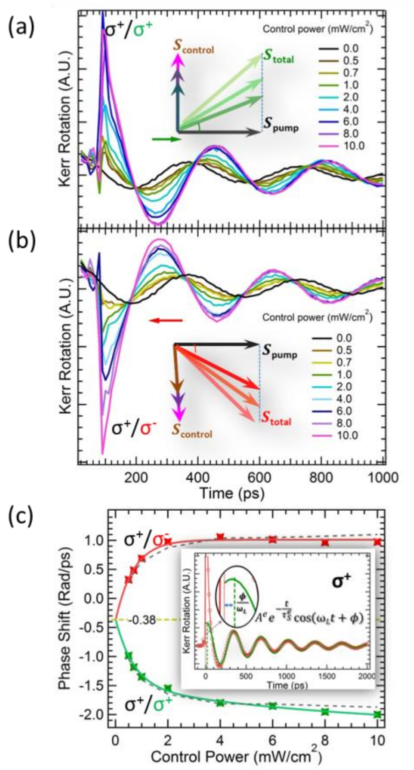


Fig. 1. TRKR signals obtained by both $\sigma^+$ pump of 10 mW/cm$^2$ and $\sigma^+$ (a) or for $\sigma^-$ (b) control with different pulse intensities and delayed by π/2 @ 12 K and 136 mT; (c) The corresponding PS from the fitting of signals (a) (green) and (b) (red), the symmetry center line is almost at -0.38 rad/ps.

In short, the control pulses are used for studying RESP dynamics to magnify and control the original signals. Furthermore, IPS was demonstrated to get larger as the pulse intensity and photon-energy increases.

[1] M. T. Portella-Oberli, J. Berney, L. Kappei, F. Morier-Genoud, J. Szczytko, and B. Deveaud-Plédran, Phys. Rev. Lett. **102**, 096402 (2009).

[2] H. Hoffmann, G. V. Astakhov, T. Kiessling, W. Ossau, G. Karczewski, T. Wojtowicz, J. Kossut, and L. W. Molenkamp, Phys. Rev. B **74** (2006).

[3] X. Z. Ruan, B. Q. Sun, Y. Ji, W. Yang, J. H. Zhao, and Z. Y. Xu, Semicond. Sci. Technol. **23**, 075021 (2008).