# Magnetically induced spin component in GaAsBi epilayer

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Dilute bismides, such as GaAsBi, are candidate materials for spin-based devices because the incorporation of Bi atoms into GaAs crystal significantly increases the spin splitting energy. However, the spin properties in diluted bismides has been investigated using only time-resolved photoluminescence measurement [1], which is an indirect method for observing spin dynamics through radiative recombination of excitons. We previously investigated the electron spin dynamics in $GaAs_{1-x}Bi_x$ using Kerr rotation spectroscopy and showed that the initial phase of optically injected electron spins continuously changes as a function of photon energy [2]. We have now investigated the unusual spin component induced by application of magnetic fields parallel to the sample plane of a GaAsBi epilayer. This magnetically induced spin signal was observable only when the photon energy of the laser was adjusted to the band gap energy of GaAsBi. One possible explanation for the magnetically induced spin component is that electron spins due to Zeeman splitting are adiabatically rotated by the laser irradiation via the spin-flip Raman process. This spin rotation process may be a fundamental operation for arbitral spin control in solid-state materials, so our findings are beneficial for future development of spintronics devices.

We grew 43-nm-thick epitaxial $GaAs_{1-x}Bi_x$ ($x$ = 1.9%) thin film on a $p$-GaAs substrate by low-temperature molecular beam epitaxy. The spin dynamics in the GaAsBi epilayer was investigated using time-resolved magneto-optic Kerr rotation measurements at 4 K. A mode-locked Ti:sapphire laser provided 150-fs pulses for injecting and detecting spins. The circularly polarized pump beam excited spin-polarized electrons, and the subsequent spin dynamics was measured through the Kerr effect of the reflected linearly polarized probe beam. Figure 1 shows time-dependent Kerr rotation signal at $\lambda$ = 886 nm; the energy corresponds to the band gap energy of GaAsBi. In the absence of a magnetic field, we observed no spin signal with the exception of a peak near 0 ns due to the pump pulse. In the presence of an in-plane 400-mT magnetic field, we clearly observed an oscillating Kerr rotation signal. The origin of this signal can be understood as shown by the inset of Fig. 1. (1) The spin polarization caused by the external magnetic field rotates around the pump beam optical axis due to the spin-flip Raman process induced by pump pulse irradiation. (2) The spin polarization then starts to precess around the external magnetic field.

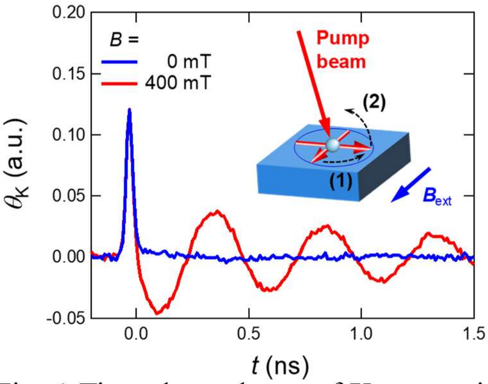


Fig. 1 Time dependence of Kerr rotation signal with and without external magnetic field. Inset indicates the spin dynamics via spin-flip Raman process.

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[2] Y. Kunihashi *et al.*, 18p-E216-6, JSAP meeting (2019).