두꺼운 GaAs에 대한 시간분해 축퇴 4 광파 혼합

Time-resolved degenerate four-wave mixing in thick GaAs

유 성규, 이 주인, 김 동호
한국표준과학연구원 분광연구그룹

We have investigated the temporal and spectral profiles of four-wave mixing (FWM) signals from a 500 ㎛ thick undoped GaAs when the excitation laser is tuned from near the excitonic resonance up to 170 meV below the band gap by using the femtosecond two-pulse self-diffracted FWM technique. We have performed time-resolved (TR), time-integrated (TI), and spectrally-resolved (SR) FWM experiments by using a tunable self mode-locked Ti:sapphire laser with a pulse width of about 65 fs and a spectral width of about 24 meV. We have also performed time-resolved pump-probe experiments to measure the transmitted pulse shapes.

We have observed rather strong FWM signals well below the band gap where no real absorption occurs. The peak intensities of the TI-FWM signals as a function of detuning below the band gap decrease rapidly because the excitonic contribution decreases significantly as detuning increases. In addition, the dephasing times become shorter as increasing detuning. At large detunings, the temporal shapes of the FWM signals are very similar to that of the input pulse. The TI-FWM signals exhibit an initial fast decay followed by a slow decay at small detuning for positive and negative time delays. These two components decay faster as detuning increases and exhibit a single fast decay far below the band gap, which is only limited by the excitation laser pulse-width. We suggest that the slow component is associated with the electronic dephasing of the exciton states, whereas the initial fast decay is attributable to the strong instantaneous contribution of the excitation laser pulses near zero time delay.

Furthermore, the SR-FWM signals are blue-shifted significantly as the time delay moves away from positive to negative. These interesting results have not been yet reported and are remarkably different from the excitonic properties. These pronounced blue-shift can be explained as due to the different group velocities at different frequencies and pulse broadening effects. The transmitted pulse shapes exhibit that the femtosecond pulse is severely distorted while propagating through a relatively thick sample near the excitonic resonance.

We will present that the interesting temporal and spectral profiles of the FWM signal and transmitted pulse shapes.