Fe ドープ InP バルクにおけるスピン緩和時間の観測

Observation of spin relaxation in Fe doped InP bulk

早大先進理工
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InP materials have found important applications, such as high-electron mobility transistors.[1] In this study, we investigated the carrier relaxation and spin relaxation in Fe doped InP bulk by time-resolved pump and probe measurement. We also compared the results with those of our previous study done on undoped InP bulk.[2]

The sample investigated in this research was a 350 μm thick semi-insulating Fe doped InP bulk (Wafer Technology Ltd.) grown by liquid encapsulated pulling method. The sample showed very weak n-type characteristics with carrier concentration between 2.6 – 2.8 × 10^8 cm^{-3}. This is due to phosphorus vacancies, which is a typical feature seen in InP bulk.[3]

In the time-resolved pump and probe measurement, spin-aligned carriers were excited by a circularly polarized optical pulse generated from a Ti-sapphire laser.[4] The photon energy was tuned slightly above the bandgap energy for resonant excitation. The time resolution of the system was about 300 fs, which originates from the pulse width being slightly widened by an EO modulator.

Figure 1 shows the carrier relaxation times of undoped (taken in previous study) and Fe doped (taken this time) InP bulk. The carrier relaxation time decreased by about a half through the doping of Fe. This is due to the introduction of deep trap levels.

Figure 2 shows the time evolutions of the reflection intensity. I^+ and I^- indicate the cocircular and anticircular polarizations, respectively. The time evolution of the spin polarization is plotted in the inset of Fig. 2. The measured spin relaxation time is 477 ps, which is obtained from a single exponential fitting (black line). Figure 3 shows the summary of the spin relaxation time. The data of undoped InP bulk is also plotted for comparison.[2] The excitation power was set to 60 mW for both experiments. At 77 K – RT, a clear negative temperature dependence can be observed, suggesting the effect of the DP mechanism.[5] While the doping of Fe had a major effect on the carrier relaxation time, the spin relaxation time remained approximately the same.

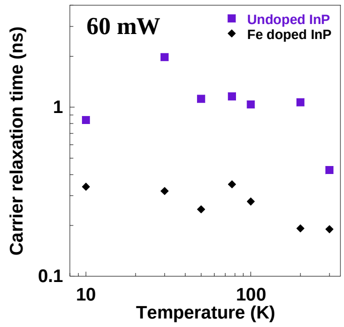

Fig. 1 Carrier relaxation times of undoped and Fe doped InP bulk.

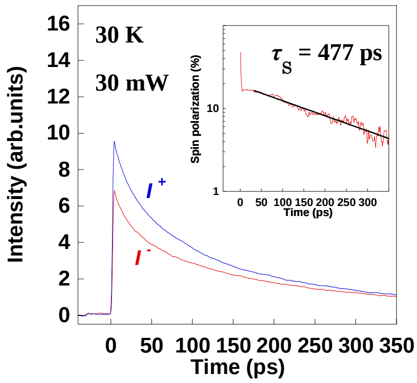

Fig. 2 Time evolutions of cocircular (I^+) and anticircular (I^-) polarization at 30 K for the excitation power of 30 mW. Inset shows time evolution of spin polarization. Black line shows single exponential fitting.

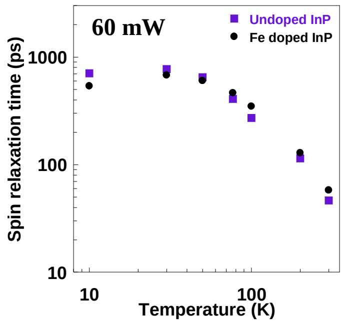

Fig. 3 Spin relaxation times of undoped and Fe doped InP bulk.

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