TERAHERTZ FIELD IONIZATION OF ACCEPTERS IN p-Ge

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The ultrafast control of bound carriers is of great interest for switching of conductivity and magnetic properties. In many cases, bound electrons (holes) at the shallow trap have narrow absorption lines in THz region and thus should be a candidate for the quantum control devices. Recently, coherent control of the donor transition has been reported in the n-type Si:P system with THz pulses from the free electron laser. However, such a high electric field of the THz pulse is potentially capable to undergo field-ionization of the bound carriers, which is inadequate for the coherent control. We demonstrate THz field ionization process in p-Ge induced by intense THz pulse.

We measured absorption spectra of the p-Ge crystal with different incident THz electric fields. Intense THz pulses were generated by a tilted pulse-front optical pulse with a high-$\chi^{(2)}$ $LiNbO_3$ crystal. A Ga-doped p-Ge crystal (resistivity: 2.67-4.46 ohm cm, thickness: 500 μm) was mounted in the liquid-He cryostat and cooled down to 9K. THz electric field was in parallel with [100] direction of the crystal.

In the low field strength limit, one can see clearly two accepter transitions around 2 THz. These two lines are attributed to (8+0)→(8-02) transition for 2.0 THz peak and (8+0)→(7-0) transition for 2.2 THz peak, respectively. Around 5kV/cm, broadening of both lines is observed. This result suggests that the excited state of the accepter level becomes unstable under the THz electric field larger than 5 kV/cm because of the tunneling ionization in the excited state. Above 15 kV/cm, both transitions are disappeared and Drude-like dispersion appears. This suggests that the accepter level should be completely ionized above 15 kV/cm and generated free carriers become responsible for the Drude dispersion. Since our THz pulse is almost half-cycle in time domain, the THz-field ionization should take place in very short time scale faster than 1 ps.