Comparative Study on THz Radiation from Various Semiconductors

Jihoon Jeong[1], Young-Dahl Jho[1*], Jin-Dong Song[2]
[1]Dep. of Info. & Comm., Gwangju Inst. of Sci. & Tech., Gwangju 500-712
jho@gist.ac.kr

Transient terahertz (THz) radiation processes from air/semiconductor interfaces as being illuminated by short pulse lasers but without external bias have been one of the central issues in condensed matter physics for the last two decades(1). These radiations have been known to be originated either from carrier accelerations from Fermi-energy pinning near the surfaces (most of the semiconductors) or from large difference of the diffusion velocities between electrons and holes (especially in the case of InAs-based materials). In this regard, the comparative studies among various serious of semiconductors are expected to provide an comprehensive insight toward the emerging THz photonics.

For the comparative purpose, we have performed terahertz (THz) radiation measurements from various groups of semiconductor materials: InGaSb, GaAsSb, InAsSb, InAlSb, InSb, InAs, and InGaAs/GaAs. Each group consists of four to eight samples with different compositions or doping densities. From the viewpoints of the radiation efficiency or how long the signals are persistent, we have carefully measured those different groups. For some semiconductor groups, after main peak weaker but much slowly decaying signal followed the main peak around zero time delay. This trend was especially notable in the case of GaAsSb and InAlSb. The radiation strength was most strong in InAs and InGaAs-based materials.

Within each group, the strongest radiation source was representatively chosen after measurements as a function of composition or as a function of doping densities. Then, in Fig.1, we

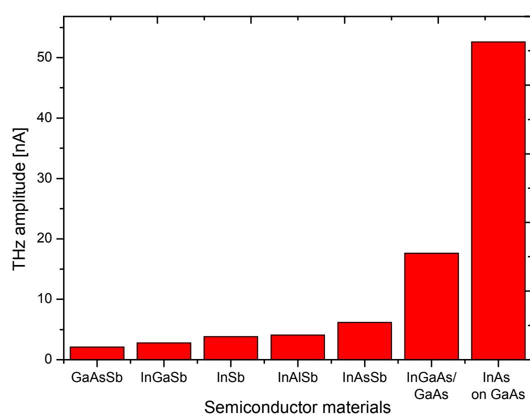

Fig.1. THz peak amplitudes among various semiconductors with different compositions.

compare the amplitude among those groups with different materials. the general tendency indicated that the InAs series on GaAs substrates was the most intense radiation source whereas GaAsSb was the weakest one.

For somes samples, we also observed unusually long-lasting radiations as representatively shown for the case of InAlSb in Fig. 2. The shortest case was observed a serious of GaAsSb. The decay time was estimated based on a fitting form including sinusoidal osillations with exponential decay component ($e^{-t/\tau}$). The eventually obtain values of τ are qualitatively summarized in . parison of the decay time, we, first, restrict our signal into the region from peak to following part, since we only interested on the decaying profile. We, then, take magnitude and smooth the signal by take the moving average filter with eight picosecond window size, to lower the influence of different peak amplitude on decay time estimation. Finally, we measure the attenuation coefficient by fitting exponential curve. The origins of those THz radiations and the decaying features are currently underway.

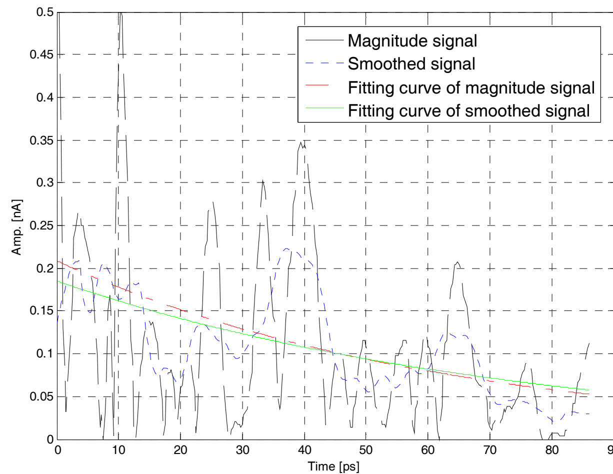

Fig.2. Time domain signals from InAlSb.

	Slow	←		decaying speed		→	Fast
slowest group	GaAsSb	InAlSb	InGaSb	InAs on GaAs	InSb	InAsSb	InGaAs/ GaAs

Table 1. Qulatitative tendency of decay time among different series of samples.

1. See, *e.g.*, K. Liu *et al.*, Phys. Rev. B 73, 155330 (2006) and references therein.