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Low Temperature-Grown GaAs Carrier Lifetime Measurements Using "Double Pump" Terahertz Time-Domain Spectroscopy Setup

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1. Introduction

Low temperature-grown gallium arsenide (LT-GaAs) has attracted a lot of research interest and is the active semiconductor material of choice for photoconductive THz emitter and detector devices due to its favorable combination of excellent optoelectronic properties such as relatively high carrier mobility, high dark resistivity, and short carrier lifetimes [1].

To measure the photoexcited carrier lifetimes of LT-GaAs and study the carrier dynamics in semiconductors, femtosecond time-resolved photoreflectance is the most commonly applied technique [2]. In this work, we propose and demonstrate "*double pump*" terahertz time-domain spectroscopy (THz-TDS) as an alternative technique to deduce the lifetime of LT-GaAs photo-excited carriers. In the "*double pump*" THz-TDS, photo-excited carriers are injected by the first pump pulse and the THz emission generated by the second pump pulse is observed. Since the surface electric field is screened by the optical carriers, the THz emission amplitude is expected to change with the time delay of the second pump pulse to the first pump pulse due to the carrier decay. The advantage of this technique compared to the transient photoreflectance technique is the relative ease of the optical alignment.

2. Results

In Figure 1, we show a comparison of data obtained by the double pump THz-TDS and by standard transient photoreflectance measurements done on the same LT-GaAs sample (grown at 310°C by MBE). The carrier lifetimes deduced from exponential curve fittings to the photoreflectance and THz emission decay curves are 3.5 ps and 3.8 ps, respectively. This shows that the double pump THz-TDS can be an alternative method for determining the lifetime of photo-excited carriers in LT-GaAs.

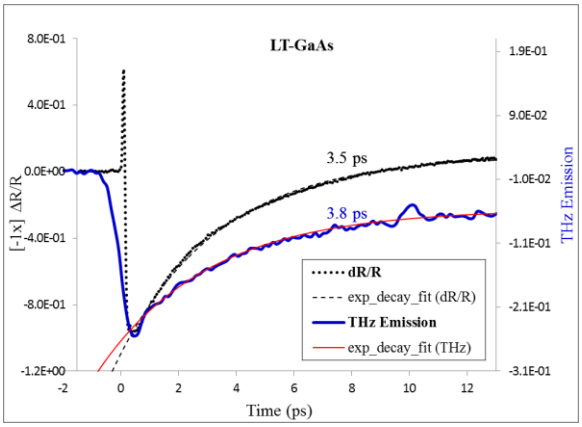

Figure 1. Comparison of double pump THz emission and transient photoreflectance data for LT-GaAs.

3. Conclusion

We demonstrated "double pump" THz-TDS measurements for evaluation of LT-GaAs carrier lifetime. We will continue to develop this work to confirm the validity of this technique for measurements of the carrier lifetime using LT-GaAs samples with various growth temperatures.

References

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