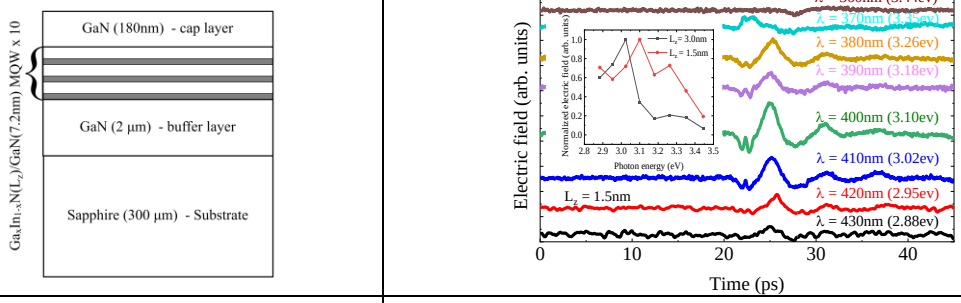
Terahertz emission from GaInN/GaN multiple quantum wells studied by wavelength-tunable terahertz emission spectroscopy

Abdul Mannan[1], Filchito Renee G. Bagsican[1], Kota Yamahara[1], Iwao Kawayama[1], Hironaru Murakami[2], Heiko Bremers[2], Uwe Rossow[2], Andreas Hangleiter[2], Dmitry Turchinovich[3] and Masayoshi Tonouchi[1]

ILE, Osaka Univ. Japan.[1], TU Braunschweig, Germany[2], Bielefeld Univ. Germany[3]

E-mail: mannan-a@ile.osaka-u.ac.jp

$Ga_xIn_{1-x}N$/GaN multiple quantum wells (MQW) are an active ingredient for enhancing the efficiency of optoelectronic devices such as light-emitting diodes (LEDs) and laser diodes (LDs) [1]. However, the lattice mismatch and piezoelectric nature of $Ga_xIn_{1-x}N$/GaN and GaN cause a strong built-in piezoelectric-field inside MQWs and a quantum-confined stark effect (QCSE) [2]. Both QCSE and built-in piezoelectric-field simultaneously reduce the overall overlap of 1h-1e electron and hole wave functions, so the 1h-2e optical transitions during optical excitation happen, which in reality are parity–forbidden transitions [3]. Dynamical screening of the built-in piezoelectric field by 1h-1e and 1h-2e transition, using ultrafast optical excitation leads to terahertz radiation [4]. In this work, we used laser wavelength-tunable terahertz emission spectroscopy to study photon energy dependence, terahertz emission at various quantum well widths (Lz) assisted by 1h-1e, and 1h-2e transitions. The detailed experimental setup is explained elsewhere [5]. Figure 1(a) shows the sample structure used in this experiment. We used three samples with a variation of only L_z (L_z = 1.5nm, 2.4nm, and 3.0nm). We observed strong terahertz emission dependence of L_z with 1h-2e optical transitions at various λ.



(a) **(b)**

Figure 1. **(a)** shows the sample schematics, and **(b)** The wavelength dependence for the MQW sample (inset) shows the comparison between different L_z = 1.5nm and L_z = 3.0nm.

References

[1] S. Nakamura *et al.*, *Jpn. J. Appl. Phys.*, vol. 36, no. Part 2, No. 12A, pp. L1568–L1571, Dec. 1997.

[2] A. Hangleiter, *et al.*, *Appl. Phys. Lett.*, vol. 83, no. 6, 2003.

[3] G. Weng, *et al.*, *Opt. Express*, vol. 25, no. 20, 2017.

[4] D. Turchinovich *et al.*, *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 68, no. 24, pp. 1–4, 2003.

[5] H. Murakami *et al.*, ," *J. Phys. D. Appl. Phys.*, vol. 47, no. 37, p. 374007, Sep. 2014.