

Luminescence of ZnO single crystal under the tunable intense terahertz pulse excitation

Xingyu Sun¹, Masaya Nagai¹, Masaaki Ashida¹, and Goro Isoyama²

¹Graduate School of Engineering Science, Osaka Univ. ²ISIR, Osaka Univ.

E-mail: sunxingyu@laser.mp.es.osaka-u.ac.jp

Field-sensitive phenomena in semiconductors under the strong low-frequency excitation, such as the high harmonic generation, Zener tunneling, and field electron emission, have attracted us in the viewpoint of novel nonlinear phenomena beyond perturbation theory. Recently, we reported the luminescence from sintered ZnO pellet under the irradiation of the micropulse extracted from tunable THz free electron laser (THz-FEL) [1]. Since our THz-FEL macropulse consisting of 150 micropulses prevents us from the ideal analysis of the phenomena [2], we extracted one micropulse of THz-FEL micropulses with the semiconductor plasma switch. However, tiny excitation frequency dependences of THz-induced luminescence from the sintered ZnO pellet indicates impact ionization via resident carriers in the sintered pellet with fast carrier scattering. In this report, we measured THz-induced luminescence from a ZnO high-quality single crystal and investigated the excitation frequency dependence of the luminescence, characteristic for the field-sensitive phenomena.

Figure 1 shows the spectrum of the THz-induced luminescence. The luminescence band appears near the bandgap energy, located at nearly 3.17 eV, implying the generation of e-h pairs under the THz pulse generation. Figure 2 shows the excitation power dependence of the luminescence for ZnO sintered pellet [1] and single crystal. One can see that the luminescence from single crystal appears at the higher threshold of electric field which indicates field-sensitive nonlinear phenomena such as the Zener tunneling.

Reference

[1] Sun et al. JAPS-OSA symposium (2017).

[2] Nagai et al. New. J. Phys. **19**, 053017 (2017).

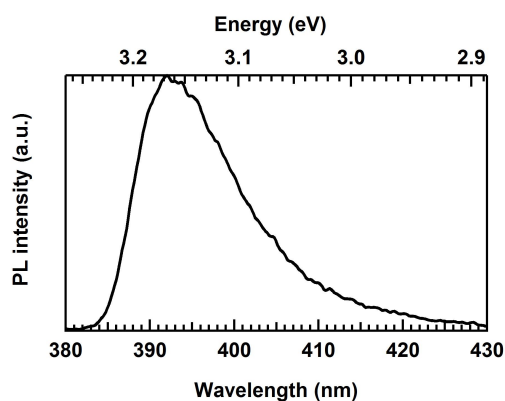


Fig.1 Spectrum of luminescence from single crystal under the excitation of 4.5 THz.

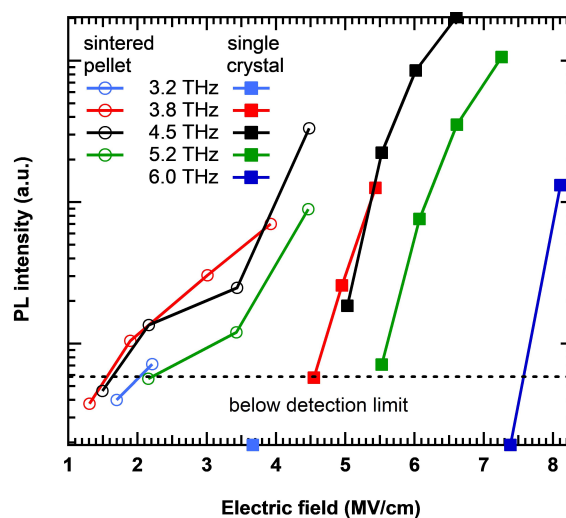


Fig.2 External electric field dependence of photoluminescence intensity of sintered ZnO pellet and single crystal.