Multi-Wavelength Yb3+:GdAl3(BO3)4 Topological Insulator Bi2Te3 Based Passively Q-switched Solid-State Laser

Jin-Long Xu[a], Chao-Yang Tu[a], and Chao-Kuei Lee*[b]

[a] *Key Laboratory of Optoelectronic Materials Chemistry and Physics of CAS, Fujian Institute of Research on the Structure of Matter, Chinese Academic of Sciences, Fuzhou, 350002, China.*

[*b] *Department of Photonics, National Sun Yat-sen University, Kaohsiung 804, Taiwan R. O. C.*

E-mail: chuckcklee@yahoo.com

Passively Q-switched solid state laser is an efficient, reliable and wide-used technique to emit ns level pulses. In 2012, Bernard et al. firstly reported that topological insulators (TIs) exhibit saturable absorption when placed in a 1550 nm laser beam. Recently, both mode-locked and Q-switched fiber laser have been successfully realized with TISAs. To date, TIs have not been used to Q-switched Yb-doped nanosecond multi-wavelength solid-state laser as our best knowledge. In this work, we prepared three TISA samples synthesized by a facile solvothermal route with different density(TISA1, TISA2 and TISA3). The saturation intensity are extracted to be 1.26 kW/cm−2, 4.96 kW/cm−2, 19.61 kW/cm−2 and the modulation depth are 10.11%, 10.95%, 13.96% for TISA1, TISA2 and TISA3 respectively. We applied as-prepared three TISA samples in Yb:GAB laser to value their Q-switching performance. The maximum output powers were obtained to be 24, 37 and 57 mW with a 3% transmission OC for TISA1, TISA2 and TISA3, respectively. The shortest pulse was 370 ns obtained by using 5% OC and TISA3, with 40 mW output power and 110 kHz repetition rate. The 370 ns pulse width is much shorter the reported TI-based Q-switched solid-state lasers. The spectral result shows the corresponding pulse trains and single pulse profile. The strong crystal field of Yb:GAB leads to a homogenously broad gain band since large splitting in the excited and ground states, therefore multiple frequencies can be stimulated equally in laser oscillation. For this reason, the Q-switched laser of each combination of OC and TISA operated simultaneously at three wavelengths around 1.04 μm. The corresponding frequency differences are 0.44, 0.25, and 0.69 THz, which may be applied to generate THz wave with further nonlinear frequency mixing. This work clearly shows that solvothermal synthesized Bi2Te3 is a promising saturable absorber for a multi-wavelength laser operation..