Chapter 7 Conclusions and future works

In this thesis, we demonstrate many techniques to generate the passive mode locking Nd-doped lasers. In passively mode locked $Nd:GdVO_4$ laser with SESAM, 15 ps and 124 MHz CW-ML pulses is performed with 550 W output peak power. The NLM $Nd:GdVO_4$ laser with 10 mm KTP can produce 37 ps and 124 MHz CW-ML with peak power of 516 W. We also predict the boundary between HML and CW-ML by the relation of unsaturated loss q_0 and the small signal gain g_0. With power dependent g_0, we can find out the theoretical pumping power to be 4.46 W which is close to the experimental observed threshold of NLM-ML of 4 W. In the above two cases, the peak power is produced at CW-ML state. In order to get the higher power, we have also considered the QML state and we obtained regular QML with mode-locking pulse of 200 ps, low repetition rate of 140 kHz, and high peak power of 1.73 kW by dual mode-locked method. Although we can get the regular QML pulse train, the drawback is too many pulses under the Q-switch envelope. Thus, we used a $Nd:LuVO_4$ laser crystal, which possesses high absorption and stimulated emission cross section with a 40% Cr:YAG absorber and have successfully reduced number of pulses under the envelope. We have achieved a really slow repetition rate of 6 kHz and much narrower pulse of 100 ps under a Q-switch pulse. Most importance of all is that we greatly reduce the pulse numbers to only six pulses. Huge peak power of 200 kW, the largest ever with high pulse energy of 0.1 mJ has also been demonstrated. Unlike other complicated and expensive mode-locking methods, our method provides low cost and stable mode locking laser.

There are still many works need to be accomplished in the future. Comparing with the reference [9] of Chapter 1, supercontinuum may be easily generated by using our last case with around 200 kW laser rather than 5.4 kHz, 600 ps, and few kW therein.

Furthermore, the high peak power excitation is convenient for stimulating the carriers in photonic materials and low repetition rate is also essential for preventing thermal heating effect. Therefore, the light source built here is quite suitable for material characterizations such as Z-scan and pump-probe spectroscopies.