Abstract

Recently, high-power and narrow-linewidth sodium-yellow laser generation has been attractive, since it may excite a laser-guide star for the application in adaptive optics, and laboratory spectroscopy. The main purpose of my project is to demonstrate and study the properties of a compact pulsed sodium-yellow intra-cavity Raman laser. Besides, we have proposed some cavity configurations for further narrowing down the linewidth of the output laser. The feasibility and effectiveness of the proposed ideas will be discussed and investigated in the dissertation.

The laser system was fabricated based on a diode-end-pumped Q-switched Nd:YVO_4 laser and stimulated Raman scattering in a Raman crystal $CaWO_4$. We used a fiber-coupled diode laser at 808nm to pump a Nd:YVO_4 crystal. The wave at 1064nm radiated from Nd:YVO_4 could be well confined in a specially designed cavity. By Q-switched operation, a pulse train at 1064 nm with a tunable pulse repetition rate up to 79.4 kHz could be generated to pump an intra-cavity Raman crystal $CaWO_4$. The Raman crystal is used as a wavelength shifter to provide a Raman shift around 910cm^{-1}. Through the stimulated Raman scattering (SRS) in $CaWO_4$, which is a 3rd order nonlinear optical process, a photon of the wave at 1064nm can be transformed into a Stokes photon at 1178nm and an excited optical phonon. Therefore a Raman laser operated at 1178nm is generated. Due to many significant thermal effects in the laser system, the resulted dynamic cavity was modeled and simulated with reference to the actual experiment. The properties and performance of the Raman laser were investigated and studied.

Furthermore, cavities with a grating feedback and an etalon coupler were proposed to narrow down the linewidth of 589nm. Linewidth of around 0.1nm at 1178nm was achieved in a linear cavity configuration with an etalon coupler. Through

the intracavity second harmonic generation (SHG) based on type I noncritical phase matching in a LBO crystal at temperature around 40 degree C, we successfully generated 589nm sodium yellow laser in another linear cavity with yellow-laser power around 360mW, corresponding to a diode-to-yellow-laser conversion efficiency of 2%. On another hand, a folded cavity configuration was proposed for using the grating feedback. The experiment about this part is still under way.