Diode-Pumped YAG:Nd^{3+} Laser at $^4F_{3/2}$ - $^4I_{13/2}$ Transition with Multi Wavelength Output

P G Zverev[1,2], I V Smirnov[1,2], and A A Sirotkin[2]

[1] *Moscow Power Engineering Institute, Krasnogvardeiskaya str., 14, Moscow, Russia.*
Contact Phone: +7(499)5038793
[2] *Prokhorov General Physics Institute of the Russian Academy of Sciences, Vavilov str., 38, Moscow, Russia.*
Contact Phone: +7(499)5038793
Contact Email: zverev@lst.gpi.ru

Multi wavelength lasers remain a popular topic in laser physics due to their enormous scope of application. Of particular interest is the development of lasers with simultaneous dual oscillation at two wavelengths, which attract more attention because of their importance for THz generation by difference frequency mixing (DFM). Many efficient nonlinear materials for THz lasers using DFM are transparent in the IR spectral region. Along with this, the efficiency of the DFM process increases when using a dual wavelength laser operating in the IR spectral region [1].

Dual- and multi wavelength oscillation can occur if the round-trip gain coefficients in the laser cavity are identical for different spectral components. By changing the reflectivity of the output coupler and fine alignment of spectrally selective elements, it is possible to introduce additional active or passive losses at certain wavelengths and, thus, equalize the gain in the cavity [2,3].

In this report, we demonstrate the oscillation of a powerful pulsed side-pumped diode-pumped solid-state YAG:Nd^{3+} laser with electro-optical Q-switch at $^4F_{3/2}$ -> $^4I_{13/2}$ transition with triple and dual wavelength spectral output at 1318.8, 1338.2 and 1356.4 nm. The spectral composition was controlled by the tilt angle of the intracavity YAG etalon with the thickness of 0.1 mm. The experimental values of the tilt angle for a certain spectral distribution were in good agreement with numerical modeling.

When pumped by diode pulses with an energy of 8.7 J, pulses of the dual wavelength laser radiation at 1318.8 nm and 1338.2 nm with an energy of 150 mJ, a slope efficiency of 3.5% and a pulse duration of 37 ns were obtained. The maximum peak power in this case reached 3.6 MW. The simultaneity of the oscillation of the spectral components of the laser was confirmed by the effective generation of the radiation with a wavelength of 664 nm by sum frequency conversion in a nonlinear KDP crystal. For three wave generation (1318.8, 1338.2 and 1356.4 nm), the total energy was 95 mJ at pump energy of 8.7 J with the slope efficiency of 2.4%. To the best of our knowledge, this is the first demonstration of a triple wavelength oscillation of a YAG:Nd^{3+} laser at the wavelengths of about 1300 nm.

References

[1] A A Sirotkin, N N Yudin, V V Dyomin and A I Gribenyukov, Laser Phys. Lett. **17**, 035402 (2020)

[2] J Q Chang, Q Bian, Y Bo and Q J Peng, Laser Phys. **33**, 055002 (2023)

[3] I V Smirnov, P G Zverev and A A Sirotkin Laser Phys. Lett. **17**, 095001 (2020)