다이오드 단면여기 Tm:YAG 레이저의 편광특성

Polarization flip in a Tm:YAG laser end-pumped with a fiber-coupled diode laser

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Diode-pumped Tm-doped solid-state lasers operating in the eye-safe 2 um spectral region have received growing interest due to their applications to remote sensing. Moreover, it can oscillate between 1.87 and 2.16 um which contains the strong absorption band of water. Therefore Tm laser is particularly promising for both laser radar and medical applications. There are other ways, such as optical parametric oscillator or Raman shifter, to get the coherent beam with this spectral region. But Tm-doped solid-state lasers are simpler, more cost-effective, and more efficient.

Tm:YAG has the attraction because quantum efficiency is almost 2 when it is doped with sufficiently high concentrations of Tm^{3+} (typecially at leat ~3% at.) due to efficient cross-relaxation with neighbouring Tm^{3+} ions. This leads to the prospect of very high lasing efficiencies(comparable to DP Nd:YAG), and also implies significantly reduced thermal loading, which is vitally important for high-power operation. Tm:YAG also benefits from a long fluorescence lifetime tf ~ 11 ms, which is attractive for high-energy Q-switched operation.(1)

We present experimental results on the operation of a fiber-coupled diode end-pumped Tm:YAG laser. The experimental setup is depicted in figure 1. The laser system is consisted of a fiber-coupled laser diode (FCLD) for optical pumping, lenses for collimation and focusing, Tm:YAG crystal, and an output coupler. Tm:YAG crystal (Scientific materials) is 3 mm in diameter and 5 mm long, with a Tm concentration of 6% and was coated for antireflection at 785 nm and high reflection at 2 um on the pumping side and antireflection at 2mm on the other side. We have used two types of output couplers, a flat mirror with 3.7% of reflection and a concave mirror with 3% of reflection and 50 mm of the radius of curvature. The crystal was mounted between two copper pieces, using indium foils to provide good thermal contact and the copper mount was cooled by a water chiller. The Tm:YAG crystal was pumped by a FCLD (Semiconductor Laser International Corp., SLI-CW-SLD-B1-785-7.5M-F) which had a maximum output power of 7.5W at 785 nm and is coupled with a 1-m long fiber with the diameter of the core of 0.63 mm and numerical aperture of 0.22.(2) The temperature of the FCLD was controlled by a thermoelectric cooler (Wavelength Electronics, MPT-10000) to tune the wavelength. We have investiged the output power, threshold, M2 as a function of pump power and cavity length and compared the results with those in the case of plane-parallel configuration. We also measured the output polarization states by changing the LD input polarization, input power, and the pump position. We have found that, in the plano-concave configuration, there exist two preferring polarization angles that are orthogonal each other and have observed these two polarization states flip when we change the position of the focusing lens and the same phenomenon occurs when we vary the pump power. The results are shown in fig.2 and 3.

1. C. Bollig, W. A. Clarkson, R. A. Hayward, D. C. Hanna, "Efficient high-power Tm:YAG laser at 2um, end-pumped by a diode bar," Opt. Commun. 154, 35-38 (1998).
2. T. M. Jeong, C.-J. Kim, H. S. Kim, H. J. Moon, K.-S. Kim and J. Jabczynski, "Output characteristics of diode-laser-pumped Tm:YAG laser," J. Opt. Soc. Kor.-Korean edition 11(4), 289-293 (2000).

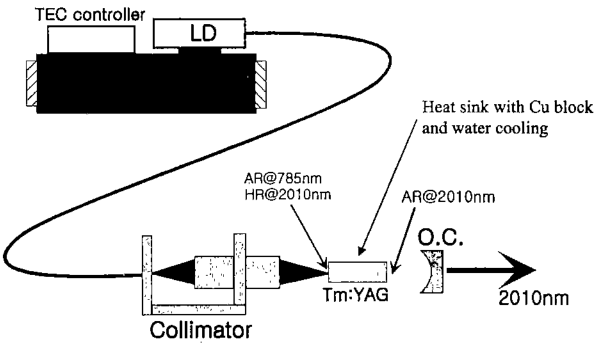
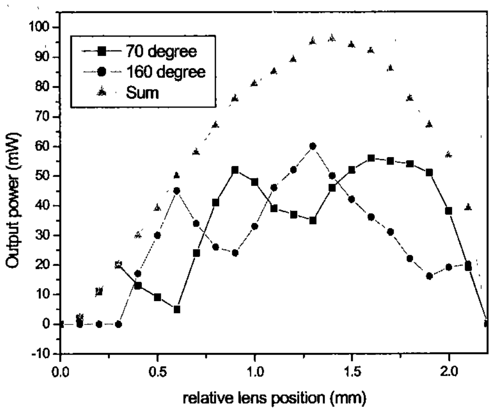


그림 1. Experimental setup



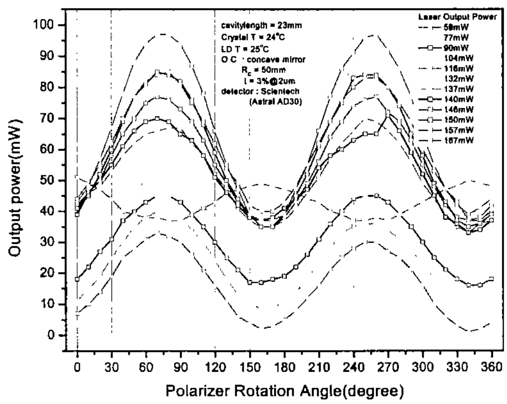


그림 2. 렌즈 위치에 따른 편광변화　　그림 3. LD 펌프 출력에 따른 편광 변화