LBO를 이용한 내부 공진기형 청색 레이저
Compact intracavity blue laser using LBO crystals

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Diode-pumped solid state (DPSS) lasers with intracavity frequency conversion provide stable visible or UV light sources for various applications, which require minimum efforts for maintenance.

We report a 457 nm cw DPSS blue laser using intracavity second harmonic generation (SHG) with $Nd:YVO_4$ as a laser material and LBO (LiB_3O_5) for second harmonic generation. To achieve a maximum output of the 914 nm fundamental wave, we used YVO_4 crystals of various Nd^{3+} doping-ratio and crystal length. Thermal lensing effect, reabsorption process, and pump-cavity mode matching were taken into account. Lasing of the 914 nm fundamental wave is a quasi-three-level process, in which threshold power depends on the population of the ground and the first excited states. Therefore, it is very important to keep the population of the first excited state at low level, and efficient cooling of the $Nd:YVO_4$ crystals is essential when pumped at high power. We employed three types of cooling scheme; (1) bare $Nd:YVO_4$ crystals, (2) $Nd:YVO_4$ crystals diffusion-bonded with YVO_4 crystals on both sides, and (3) YVO_4 crystals optical-contacted with a sapphire on one side and a YAG crystal on the other side. We optimized the pump-cavity mode matching, by varying the curvature radius of the output coupler, the pump beam size and the cavity length. An optimization of coupling efficiency, K between the fundamental and second harmonic is most important for efficient wavelength conversion[1]. Since K is a function of a SHG crystal length and a beam waist in the SHG crystal, we need to know the beam waist in the LBO crystal and internal loss, including reabsorption and scattering. The ABCD matrix method is used for estimating the beam waist with respect to pump power, and the Findlay-Clay method was used for measuring the internal loss[2]. The beam radius and internal loss were estimated to be about 60 μm and 9%, respectively. By varying the lengths of LBO crystals and the values of coupling efficiency, we obtained a maximum blue output of 543 mW with a pump power of 18.9 W (Fig. 4).

References

1. R. G. Smith, "Theory of intracavity optical second-harmonic generation", IEEE J. of QE, **QE-6 (4)**, 215 (1970).
2. D. Findlay, R. A. Clay, "The measurements of internal losses in 4-level lasers", Phys. Lett. **20**, 277 (1966).

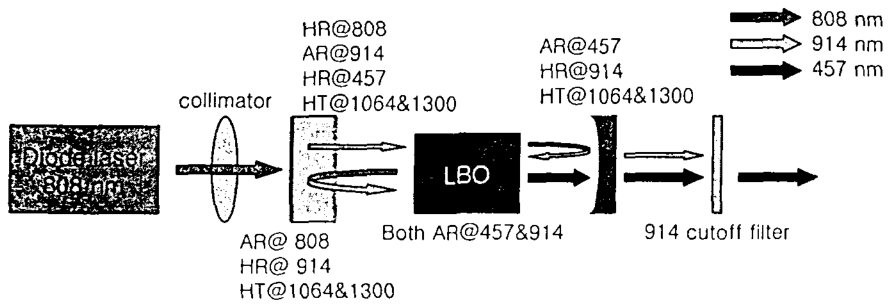

Fig. 1. An end-pumped DPSS blue laser scheme.

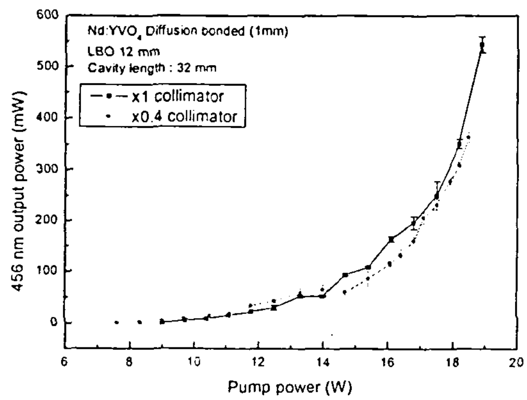

Fig. 2. Dependence of output power on pump-beam size.

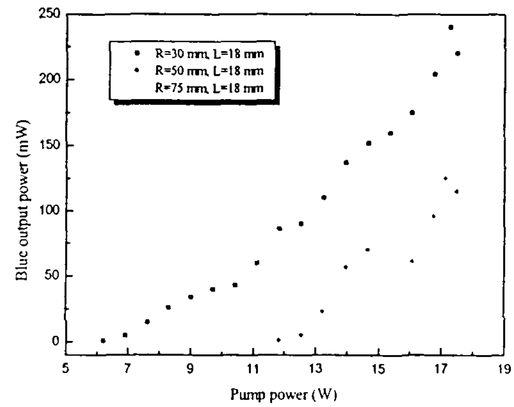

Fig. 3. Blue output power for different radius of curvature of the output coupler.

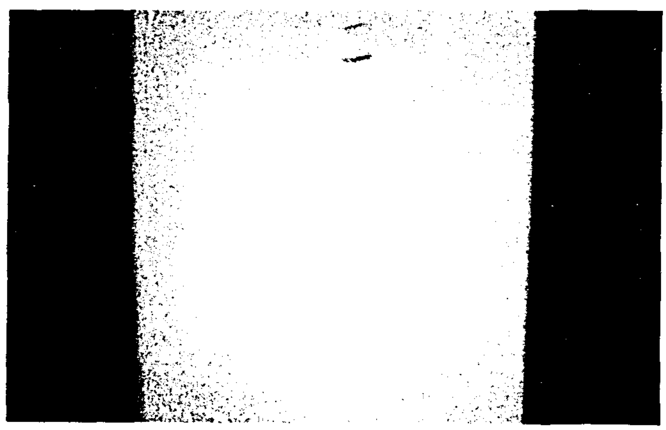

Fig. 4. Beam profile of the blue laser.