Sum frequency generation of UV laser radiation at 266 nm in LBO crystal

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Abstract—We report about investigation of laser generation at 266 nm in LBO crystal by frequency mixing of fundamental (1064 nm) and third harmonic (355 nm) of an ytterbium pulsed fiber laser radiation. UV output power of 3.3 W at 266 nm was achieved with 14% conversion efficiency in respect to fundamental pump radiation.

Keywords—LBO, FHG, 266 nm, deep UV, laser radiation

Ultraviolet (UV) lasers are widely used in industry for material processing of plastics, glasses, ceramics etc. Pulsed lasers in the deep UV region are attractive due to its high photon energy and possibility of strong focusing. Extracavity fourth harmonic generation (FHG) using nonlinear optical (NLO) conversion is a relatively simple and effective method to obtain high-power UV laser radiation at 266 nm. Usually frequency doubling of 532 nm is used for this purpose. Different nonlinear-optical (n-o) crystals can be used for FHG such as BBO, CLBO, LB4, DKDP. However these crystals have certain disadvantages and degrade under UV irradiation. Novel n-o crystals such as YAB, CBF have been recently researched for possibility of UV generation. Pressing task is to find best crystal for generation of UV radiation at 266 nm.

N-o crystal LiB3O5 (LBO) is widespread for generation of UV radiation at 355 nm [1]. It has high damage threshold, high nonlinearity, broad transmission band, small walk-off angle, large half-width of phase matching. Though LBO doesn't have phase-matching (p-m) conditions for fourth harmonic generation by direct doubling of second harmonic (532 nm), still it has p-m condition I type (oo→e, φ = 61°, θ = 90°) for frequency mixing of fundamental (1064 nm) and third harmonic (355 nm) [2,3].

In present paper, we report experimental results of generation 266 nm in LBO crystal by frequency mixing of fundamental (1064 nm) and third harmonic (355 nm) of an ytterbium pulsed fiber laser radiation. Simplified block scheme of experimental setup is shown in Fig.1. We used a relatively simple optical scheme with three samples of LBO. This approach doesn't require any additional components for matching polarizations of interacting waves.

Average power of 3.3 W at 266 nm with pulse duration 1 ns and 1 MHz repetition rate was achieved with 14% conversion efficiency in respect to fundamental pump radiation (1064 nm). See Fig.2 for reference. Phase matching temperature and angle bandwidths were also measured. Optical degradation of LBO crystal was observed during generation of high-power radiation at 266 nm. Several considerations concerning improving of LBO time performance during FHG are made.

Fig. 1. Experimental setup.

Fig. 2. Output 266 nm UV power and conversion efficiency versus power of fundamental pump radiation at 1064 nm.

References