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The correlation of point defects and UV induced degradation of $CsLiB_6O_{10}$

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1. Introduction

$CsLiB_6O_{10}$ (CLBO) is an excellent nonlinear optical crystal for generating high-power UV output with wavelengths below 300 nm [1]. Laser-induced damage of crystals is one of critical issues for scaling the UV power. Although CLBO has already been put to practical use in several UV laser sources developed for semiconductor inspection and material processing applications, the light scatters are observed in commercial CLBO. The light scatters can significantly reduce device performance by causing optical loss and bulk damage in nonlinear optical crystal. In this study, we investigated the light scatters and the UV laser-induced damage resistance of CLBO.

2. Experiment & Results

A green sheet laser (wavelength: 532 nm; average power: 30 mW) was passed through CLBO sample along *a*-axis, and the resulting light scatters, as viewed in the *c*-axis, was photographed. The polarization is vertical to the scattering plane. Figure 1 shows the result of camera observation in (a) low-quality and (b) conventional CLBO. It means that the point defects are distributed inside the crystal. We have recently reexamined the growth conditions and successfully grown high-quality CLBO crystals with lower point defects. The light scatters of the crystals were invisible to the naked eye as Fig. 1(c). Then we also investigated UV-induced degradation resistance of newly-developed CLBO with lower light scatters. Fig. 2 shows a schematic of the experimental setup for accelerated testing of UV-induced degradation [2]. The transmitted power through the aperture was measured to detect the UV-induced degradation that occurred near the focal point in CLBO. Figure 3 shows 266 nm transmitted power degradation through various samples. Undoped CLBO with lower light scatters shows similar long lifetime with Al-doped CLBO which is reported to have long lifetime in Ref. 2. It means that reduction of thelight scatters can slow down the degradation. Therefore, we consider that the point defects distributed inside the crystal may be an origin to produce carriers by UV light illumination. We will investigate the degradation resistance of Al-doped crystals grown by newly-developed growth condition.

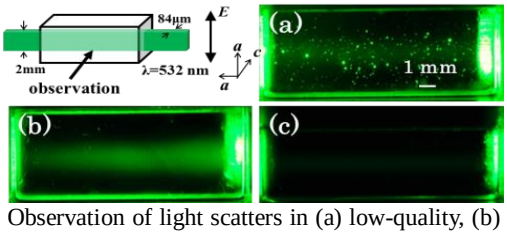
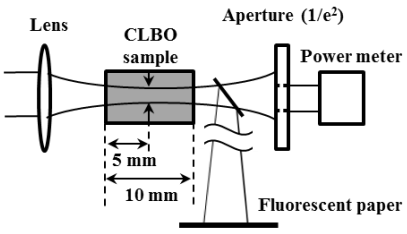


Fig.1. Observation of light scatters in (a) low-quality, (b) conventional, and (c) newly-developed CLBO



UV light at 266 nm
- **PRF: 30 kHz**
- **Pulse width: 8.2 ns**

Focusing conditions
- **Peak power density: 88 MW/cm²**
- ***e*-polarization**

Fig. 2. Schematic of the experimental setup

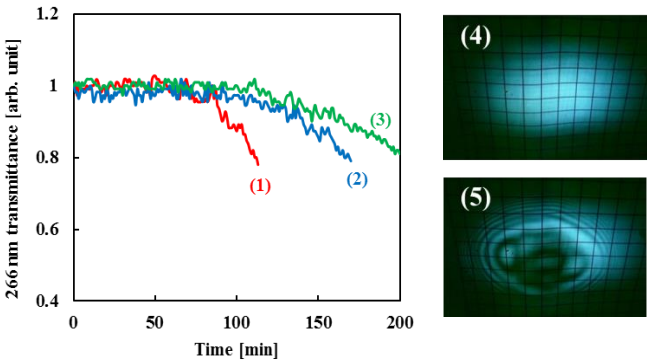


Fig. 3. Left: 266 nm transmitted power degradation through various samples at 150 °C after dehydration and aperture. Samples are (1) conventional quality undoped CLBO, (2) newly-developed undoped CLBO, and (3) conventional quality Al-doped CLBO. Right: (4) Initial and (5) distorted transmitted UV beam through CLBO. The distorted beam pattern was observed on a fluorescent paper in the far-field.

3. Conclusions

We investigated the light scatters and the UV-induced degradation resistance of CLBO. Reduction of the light scatters can slow down the degradation. We consider that the point defects distributed inside the crystal may be an origin of the degradation.

References

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