Measurement of Thermally Induced Depolarization in Flash-lamp Pumped Nd:YAG Laser Rod

Adam Říha[1], Helena Jelínková[1], Jan Šulc[1], David Vyhlídal[1], Karel Veselský[1], Kryštof Kadlec[1], and Karel Nejezchleb[2]

[1]*Czech Technical University in Prague, FNSPE, Department of Laser Physics and Photonics, Břehová 7, Prague 1, 115 19, Czech Republic*
[2]*Crytur, Ltd. Turnov, Na Lukách 2283, 511 01 Turnov, Czech Republic*

Nd^{3+}:YAG crystals are one of the most used crystals as the laser active medium of solid-state lasers. They first appeared in 1964 [1] and in the near infrared region at wavelength of 1064 nm quickly became popular due to their high output energy and wide range of applications, from industrial materials processing and medicine to scientific research [2-4]. One of the key factors affecting the performance and optical properties of Nd:YAG lasers is the growth orientation of the crystal influencing the specific application requirements. Two most used orientations include <100> and <111> [5]. Each of these orientations has its own specific properties and uses. For some medical applications (e.g. melanin spot or tattoo removal [6]), radiation in the green region of the spectrum, i.e. the second harmonic generation of the Nd:YAG laser with a wavelength of 532 nm, is used. An undesirable phenomenon for efficient conversion of radiation by a nonlinear crystal located directly in the laser cavity is the depolarization of the amplified radiation with each passage through the laser rod between the resonator mirrors. Even if the depolarization after a single pass is very weak, due to multiple passages of radiation inside the resonator before the laser radiation exits through an output coupler, the plane of polarization can be significantly twisted, or radiation can be even completely depolarized. From this point of view, it was found that a crystal with a <100> orientation can be more advantageous. Nevertheless, during the crystal growth this structure can be changed. For this reason, it is needed to have some experimental instrument for radiation depolarization measurement thanks to which these changes can be detected.

In this work, a method of depolarization effect measurement was suggested and was applied for investigation and comparison of the flashlamp pumped <111>- and <100>-oriented Nd:YAG laser rods (Nd^{3+} concentration of 1.1 at. % Nd/Y) with the diameter of 9.5 mm and length of 105 mm with faces bevelled at 4°/4° angles with antireflection coatings for the wavelength of the generated radiation. Depolarization was measured using a LD pumped compact passively Q-switched Nd:YAP/Cr:YAG nanosecond laser delivering a polarized radiation at the wavelength of 1078 nm.

This work was supported by OP JAK financed by European Structural and Investment Funds and the Czech MEYS, project No. CZ.02.01.01/00/23_020/0008525, LASCIMAT.

[1] J. E. Geusic et al., Appl. Phys. Lett., vol. 4(10), p. 182-184, 1964.

[2] K. Washio, Mater. Chem. and Phys., vol. 31(1), p. 57-66, 1992.

[3] L. Zhengjia et al., Laser/Optoelectronics in Medicine, Berlin, Springer, p. 267-267, 1986.

[4] M. K. A. A. Razab et al., J. of Radiat. Res. Appl. Sci., vol. 11(4), p. 393-402, 2018.

[5] H. Tünnermann et al., Opt. Express, vol. 19(14), p. 12992-12999, 2011.

[6] G. Pincelli et al., J. Lasers Med. Sci., vol. 13, p. e79, 2022.